

## Banasthali Vidyapith

Minutes of the Board of Studies in Bioscience & Biotechnology held on February 24<sup>th</sup>,  
2002 at 10.30 a.m.

Present

|                       |                 |
|-----------------------|-----------------|
| Prof. K. K. Sharma    | External Member |
| Dr. V.L. Tandon       | Internal Member |
| Mrs. Veena Garg       | Internal Member |
| Dr. Smita Choudhary   | Internal Member |
| Dr. Veena Sharma      | Internal Member |
| Dr. Jyoti Saxena      | Special Invitee |
| Mrs. Mamta Bauathiyal | Special Invitee |
| Mrs. Indu Ravi        | Special Invitee |
| Prof. Vinay Sharma    | Convener        |

Note : Prof. R.P. Sharma and Prof. V.K. Gera (External Members) and Dr. Savita Pareek (Internal Member) could not attend the meeting.

Before proceeding to the agenda items, the Board of Studies members expressed their great sorrow and grief on the sad demise of Sri Sudhakar Shastri, Treasurer, Banasthali Vidyapith. The Board remembered various contributions made by him towards all round progress of the Institution and observed two minutes silence. The Board prays to Almighty God for the peace of his soul, and to provide necessary strength to all of us to carry out his mission further.

1. The Board confirmed the minutes of its last meeting held on 28.1.2001.
2. The Board updated the panel of examiners for various examinations at Bachelor's and Master's degree in accordance with the Bye-laws of the Vidyapith.
3. The issue of introducing honours in Biotechnology at B.Sc. level was discussed in detail. The members were of the view that Biotechnology in itself is a highly enriched course, hence honours may not be offered at undergraduate level at present.
4. The Board finalized the title of the papers to be taught in B.Sc. II and III year of Biotechnology programme given as Appendix A. The detailed syllabi in various courses will be submitted in due course of time.
5. The Board discussed in detail the syllabi of various courses in M.Sc. Biotechnology, M.Sc. Bioscience and B.Sc. (pass) and B.Sc.(honours). The changes recommended are given as Appendix B- B.Sc. (Biotechnology, Botany) and Appendix C- M.Sc. Bioscience and Biotechnology.

The changes shall be in force as follows:

B.Sc. I, II & III Years- session 2002-2003

M.Sc. Ist to IVth Semesters- session 2002-2003

## Appendix - A

B.Sc. II Yr. : (Biotechnology)

Paper I : Biochemistry, Biophysics and Enzymology

Paper II : Genetics, Microbiology and Immunology

B.Sc. III Yr

Paper I : Genetic Engineering, Recombinant DNA Technology and Cell, Tissue culture.

Paper II : Plant, Animal and Environmental Biotechnology.

## Appendix - B

B.Sc. I yr. Botany

Paper II

Unit 3: delete (ii) "Other .....brief account"

Instead, add (ii) "A general account of mycorrhiza".

Unit 5: delete "importance of Rhynia and Psilotum in evolution".

Instead, add "importance of Psilophyta in evolution".

B.Sc. I yr. Biotechnology

Paper II : Biostatistics, Bioinformatics and Instrumentation.

Unit 1

(iii) Add "Collection of data".

The sequence should be : Collection of data, frequency distribution tabulation, graphic ..... curve.

Unit 4

(i) Balance : "Physical and chemical should be deleted".

B.Sc. III yr. Botany

Paper I

Unit 3 : delete "Differentiation and morphogenesis"

Delete "growth regulators : .....application of hormones".

Instead the following should be added "growth regulators : auxins, gibberellins, cytokinins, ethylene and abscissic acid, their physiological importance".

Unit 5 : (ii) "Environmental Pollution" should read as "Environmental Pollution : Air, water and Radioactive".

## Appendix - C

I Semester

C-3 Microbiology  
Section C

1. delete "Biocides"

2. delete "General ..... control".

Instead add "Biocides, Biopolymers and Biosurfactants"

**C-17 (Elective II) Plant Biotechnology**

**Section A**

(a) should read as : "Development of insect resistant plants with special reference to Bt gene".

**Section B**

Add at the end of section:

- "Chloroplast engineering"
- "Biotechnology of Biological Nitrogen fixation : nif genes"

**Section C**

delete "Cell suspension ..... cultures".

delete "Application .....improvement".

Instead add

- "Metabolic Engineering and Industrial products : Plant secondary metabolites ; control mechanism and manipulation of phenyl propanoids and shikimate pathways; general strategy towards production of plant cell products".
- "edible vaccines"

**M.Sc. III Semester Plant Science**

**C-13 Plant Pathology**

**Section B**

Add in 2.

Bacterial diseases : "Tundu disease of wheat"

**Section C**

4. should read as :

"Insect disease : general account of plant and animal galls with special reference to Mango and Ziziphus"

**M.Sc. IV Semester Plant Science**

**C-16 Physiology and metabolism II**

Title should read as :

"Plant Physiology and Metabolism"

**Section B**

delete

(c) "Indole acetic acid"

Instead add

(c) "Cytokinin".

**Department of Bioscience & Biotechnology**

**Banasthali Vidyapith, Banasthali**

**Minutes of the Board of Studies held on December 26, 2018 at 3:00 p.m. in the  
Conference Room, Department of Bioscience and Biotechnology, Banasthali Vidyapith**

**Present**

|                               |                                   |
|-------------------------------|-----------------------------------|
| 1. Prof. Arun Kumar Sharma    | External Member                   |
| 2. Dr. Asheesh Shanker        | External Member                   |
| 3. Prof. N. P. Singh          | External Member                   |
| 4. Dr. Afroz Alam             | Internal Member                   |
| 5. Shri Anand Prakash         | Internal Member                   |
| 6. Dr. Aneesh Goyal           | Internal Member                   |
| 7. Dr. Arindam Kuila          | Internal Member                   |
| 8. Dr. Arun Sharma            | Internal Member                   |
| 9. Prof. Dipjyoti Chakraborty | Convener (in the Chair)           |
| 10. Dr. Girish C. Pandey      | Internal Member                   |
| 11. Dr. Himani Kuntal         | Internal Member                   |
| 12. Dr. Jyoti Mathur          | Internal Member                   |
| 13. Dr. Kakoli Dutt           | Internal Member                   |
| 14. Dr. Laxmi Parwani         | Internal Member                   |
| 15. Dr. Monika Sharma         | Internal Member                   |
| 16. Dr. Nidhi Srivastava      | Internal Member                   |
| 17. Dr. Priyanka Singh        | Internal Member                   |
| 18. Dr. Rashmi Tripathi       | Internal Member                   |
| 19. Dr. Sangeeta Choudhary    | Internal Member                   |
| 20. Dr. Sarika Gupta          | Internal Member                   |
| 21. Dr. Sharad Vats           | Internal Member                   |
| 22. Dr. Surbhi Bajpai         | Internal Member                   |
| 23. Dr. Surya P Singh         | Internal Member                   |
| 24. Mr. Sushil Buriya         | Internal Member (Special Invitee) |
| 25. Dr. Swati Paliwal         | Internal Member                   |
| 26. Dr. Teena Agarwal         | Internal Member                   |
| 27. Prof. Veena Sharma        | Internal Member                   |
| 28. Prof. Chandra Kumar Jha   | Internal Member (Special Invitee) |

**Note:** Prof. Partha Roy, Dr. Shashi Kumar, Dr. Anil Prakash and Dr. Ashok Sharma, External Members and Prof. Veena Garg, Prof. Nilima Kumari, Dr. Suphiya Khan, Dr. Rupesh Kumar, Dr. Manisha Sharma, Internal Member could not attend the meeting.

The meeting started with a welcome of the members, by the convener of Board of Studies for Bioscience and Biotechnology, Prof. Dipjyoti Chakarborty, Head, Department of Bioscience and Biotechnology, Banasthali Vidyapith, Rajasthan.

1. The Board took up for confirmation of the minutes of its last meeting held on 04<sup>th</sup> May, 2013.

The Board resolved that the minutes of its last meeting be confirmed.

2. The board updated the panel of examiners for various examinations of Bachelor's and Master's degree in accordance with the Bye-laws 15.3.02 of the Vidyapith. The existing panel will continue to be retained. The updated list of examiners is submitted.
3. The Board discussed M. Tech. Bioinformatics programme and after considerable deliberations, it was suggested to discontinue the programme from the academic session 2018-19.
4. The various courses running in the department viz., B.Sc. Bioscience, B.Sc. Biotechnology, B.Tech. Biotechnology, M.Sc. Bioscience (Animal Science), M.Sc. Bioscience (Plant Science), M.Sc. Applied Microbiology and Biotechnology, M.Sc. Biotechnology, M.Sc. Bioinformatics, M.Tech. Biotechnology, Certificate Course in Molecular Modeling and Drug Designing, Diploma in Computational Biology were placed before the board, thoroughly discussed and revision proposed as under:

### 3. IA. B.Sc. Bioscience (Botany and Zoology):

|      |  |                     |
|------|--|---------------------|
| i.   | First Semester Examination, December, 2019   | Change <sup>a</sup> |
| ii.  | Second Semester Examination, April/May, 2020 | Change <sup>b</sup> |
| iii. | Third Semester Examination, December, 2020   | Change <sup>c</sup> |
| iv.  | Fourth Semester Examination, April/May, 2021 | Change <sup>d</sup> |
| v.   | Fifth Semester Examination, December, 2021   | Change <sup>e</sup> |
| vi.  | Sixth Semester Examination, April/May, 2022  | Change <sup>f</sup> |

- (a) In the first semester of B.Sc. Bioscience programme, laboratory course ZOO 102L is proposed to be modified by including the five major exercises: study of museum specimens, study of prepared slides, preparation of permanent mount, anatomical study of selected animals and collection & culture methods. Animals of invertebrate phyla (protozoa to protochordata) are included in these exercises. In the “anatomical study exercise”, the name of the animals and their anatomical systems have been specified for clear understanding. In addition to that, exercise related to study of

microscope, evolution & permanent mount preparation of mosquito are also proposed to be included in the revised syllabus.

Zoology course ZOO 102: Taxonomy, Classification and Evolution is proposed to be modified by inclusion of phyla of the non chordates for clear understanding of the topics to be covered.

The contents of the Botany course BOT 101: Algae, Fungi, Bryophyta, Pteridophyta and Gymnosperms and its laboratory course BOT 101L: Algae, Fungi, Bryophyta, Pteridophyta and Gymnosperms Lab are proposed to be revised and updated.

- (b)** In the second semester of B.Sc. Bioscience programme, laboratory course ZOO 101L is proposed to be modified by including the five major exercises as discussed in the first semester laboratory course ZOO 102L. These five major exercises are proposed to be included in laboratory courses of first (ZOO 102L) and second semester (ZOO 101L) because theory courses in these semesters deals with the study of invertebrates. Therefore, specimens of protozoa to protochordata phyla are placed in these five major exercises and are equally distributed in the first (ZOO 102L) and second semester (ZOO 101L) laboratory course. In addition to these five major exercises, permanent mount preparation of house fly is also proposed to be included.

In the second semester, the Zoology course ZOO 101: Non-Chordates and Proto-Chordates, is proposed to be modified.

- (c)** In the third semester, the Zoology course ZOO 201: Cell Biology, Molecular Biology, Histology and Genetics, Biochemistry is proposed to be modified with the contents of human genetics included in Unit-V.

The Laboratory course ZOO 201L: Cell Biology, Molecular Biology, Histology and Genetics Lab is proposed to be revised and updated.

The Botany course, BOT 201: Angiosperm Taxonomy and Economic Botany, is proposed to be modified with some topics from Unit-I elaborated for clear understanding.

The laboratory course BOT 201L: Angiosperm Taxonomy and Economic Botany is proposed to be modified with inclusion of preparation of herbarium sheets which is an important component of taxonomy.

- (d)** In the fourth semester, the course ZOO 202L: Comparative Anatomy and Embryology of Chordates Lab is proposed to be modified.

The course BOT 202: Microbiology and Plant Pathology, is proposed to be modified viz., bacteriological section in Unit-I and virology section in Unit-II is proposed to be more elaborated and related topics placed together. The laboratory course BOT 202L: Microbiology and Plant Pathology Lab is proposed to be modified by elaborating the

existing microbiological exercises and including certain more relevant experiments in microbiology.

(e) In the fifth semester, discipline electives are proposed to be offered in the fifth semester. For Botany discipline, four elective courses along with their practical exercises are proposed. The courses “Introduction to Genetics and Genetic Engineering” and “Plant Physiology and Ecology” are offered as core courses in the existing syllabus but now these two courses are proposed to be offered as a discipline electives along with the two newly introduced discipline elective courses “Ethnobotany” and “Horticulture”.

The complete list of elective courses of Botany discipline offered in the fifth semester are as follows

- Introduction to Genetics and Genetic Engineering
- Plant Physiology and Ecology
- Ethnobotany (Newly introduced)
- Horticulture (Newly introduced)

Similarly, for Zoology discipline, four elective courses along with their practical exercises are proposed to be offered in the fifth and sixth semesters. Out of these four courses, two courses “Animal Physiology” and “Environmental Biology and Biostatistics” are offered as core courses in the existing syllabus but now these two courses are proposed to be offered as discipline electives. In the Zoology discipline, two elective courses “Developmental Biology” and “Applied Zoology” are newly introduced.

These four elective courses are as follows

- Animal Physiology
- Environmental Biology and Biostatistics
- Developmental Biology (Newly introduced)
- Applied Zoology (Newly introduced)

The elective courses of Botany and Zoology disciplines are common with B.Sc. Biotechnology Programme.

The benefit of offering the discipline elective courses in stead of the core courses in the fifth and sixth semester is that the students can choose the course of their interest. Student has to opt one elective course from Botany discipline and one elective course from Zoology discipline in the fifth semester.

In the fifth semester, the course ZOO 302: Environmental Biology, the topic - 'pollution' which is already covered as such in the course BOT 303: Plant Physiology and Ecology is proposed to be replaced by biostatistics. It will introduce the fundamental principles of biostatistics and its role in the data analysis which would

help the students to apply the biostatistics tools for better presentation of the research data. The course is proposed to be renamed as 'Environmental Biology and Biostatistics'.

The laboratory course ZOO 302L: Environmental Biology Lab is proposed to be renamed as 'Environmental Biology and Biostatistics Lab'.

The syllabus of the Botany courses BOT 303: Plant Physiology and Ecology and BOT 303L: Plant Physiology and Ecology Lab are proposed to be revised and updated.

The vocational course, Analytical Lab Practice-I from fifth semester is proposed to be discontinued in the revised syllabus.

- (f) In the sixth semester, the elective courses of Botany and Zoology disciplines as mentioned above in the fifth semester minutes are also proposed to be offered in the sixth semester of B.Sc. Bioscience programme. Student has to opt one elective course from Botany discipline and one elective course from Zoology discipline in the sixth semester.

In the sixth semester, the course ZOO 301: Animal Physiology is proposed to be modified and certain topics elaborated. The sixth semester course BOT 302: Introduction to Genetics and Genetic Engineering is proposed to be modified. Experiments of molecular biology and basic bio-safety laboratory guidelines are proposed to be incorporated in the laboratory course BOT 302L: Introduction to Genetics and Genetic Engineering Lab.

The vocational course Analytical Lab Practice-II is proposed to be discontinued from the sixth semester.

Additionally, it is proposed that a student can opt for at most 2 additional Open (Generic) audit/credit Elective from other disciplines opting at most 1 per semester in Semesters III, IV, V or VI with prior permission of respective heads and time table permitting.

E-resources have been proposed for the theory courses and the list of recommended books has been updated. The board also reviewed the Programme Educational Objectives, Programme outcomes and the Learning outcomes of the courses keeping in view the proposed modifications.

The proposed Programme Educational Objectives, Programme outcomes and modified syllabus are included and marked as **Appendix-IA** (page 30), **Appendix-IB** (page 31) and **Appendix-IC** (pages 32-87) respectively.

### 3. IB. B.Sc. Biotechnology:

|     |  |                     |
|-----|--|---------------------|
| i.  | First Semester Examination, December, 2019   | Change <sup>a</sup> |
| ii. | Second Semester Examination, April/May, 2020 | Change <sup>b</sup> |



|      |  |                     |
|------|--|---------------------|
| iii. | Third Semester Examination, December, 2020   | Change <sup>c</sup> |
| iv.  | Fourth Semester Examination, April/May, 2021 | Change <sup>d</sup> |
| v.   | Fifth Semester Examination, December, 2021   | Change <sup>e</sup> |
| vi.  | Sixth Semester Examination, April/May, 2022  | Change <sup>f</sup> |

(a) In the first semester of the B.Sc Biotechnology programme, the Botany course BOT 101: Algae, Fungi, Bryophyta, Pteridophyta and Gymnosperms and its laboratory course BOT 101L: Algae, Fungi, Bryophyta, Pteridophyta and Gymnosperms Lab are proposed to be modified as per the proposed changes in B.Sc. Bioscience programme. Some topics of the Biotechnology course BT 102: Cell and Molecular Biology-I have been elaborated and specified for clear understanding of the topics to be covered. Some of the outdated laboratory experiments such as study of cell organelles under microscope are proposed to be replaced by more relevant experiments in the BT 102L: Cell and Molecular Biology-I Lab course.

(b) In the second semester, ZOO 101: Non-Chordates & Protochordates and ZOO 101L: Non-Chordates and Protochordates Lab courses are proposed to be modified as per the proposed changes in the same courses which are running common in second semester of B.Sc. Bioscience.

The contents of the course BT 101: Biostatistics, Bioinformatics and Instrumentation are proposed to be modified as per the present need of the course. Bioinformatics and biostatistics exercises have been elaborated and specified along with few modifications of existing practical exercises in the second semester course BT 101L: Biostatistics, Bioinformatics and Instrumentation Lab.

(c) In the third semester, the botany course BOT 201: Angiosperm Taxonomy and Economic Botany and its laboratory course i.e. BOT 201L: Angiosperm Taxonomy and Economic Botany Lab are proposed to be modified as per the proposed changes in the B.Sc. Bioscience programme.

Relevant modifications in the contents of Biotechnology course BT 202: Biochemistry, Biophysics and Enzymology and 202L: Biochemistry, Biophysics and Enzymology Lab are proposed. Enzymology exercises related to acid phosphatase extracted from moong is proposed to be replaced by the enzyme urease extracted from horse gram seeds.

(d) In the fourth semester, some experiments of the laboratory course ZOO 202L: Comparative Anatomy and Embryology of Chordates Lab are proposed to be more specified for clear understanding. The Genetics section in Unit-I is proposed to be extended by inclusion of some portion from the human genetics in the course BT 207: Genetics, Microbiology and Immunology. BT 207L: Genetics, Microbiology and

Immunology Lab is proposed to be modified by introduction of new microbiological exercises.

- (e) In the fifth semester, elective courses along with their practical exercises specific to Botany and Biotechnology disciplines are proposed to be offered as “Discipline Elective”. The course “Plant Physiology and Ecology” is already offered as a core course in the fifth semester but now it is proposed to be offered as a discipline elective course. Three elective courses of Botany discipline “Introduction to Genetics and Genetic Engineering”, “Ethnobotany” and “Horticulture” are proposed to be included for the first time in B.Sc Biotechnology programme.

The four elective courses of Botany discipline which are proposed to be offered common with B.Sc. Bioscience programme are as follows

- Introduction to Genetics and Genetic Engineering (Newly introduced)
- Plant Physiology and Ecology
- Ethnobotany (Newly introduced)
- Horticulture (Newly introduced)

Similarly, for Biotechnology discipline, four elective courses along with their laboratory components are proposed to be offered in the fifth semester. Among these, the courses “Genetic Engineering, rDNA Technology and Cell & Tissue Culture Technology” and “Advances in Biotechnology” which are already offered as core courses in the fifth and sixth semester are proposed to be offered as discipline elective courses. Two elective courses “Animal and Plant Biotechnology” and “Environmental Biotechnology” are proposed to be offered for the first time in B.Sc. Biotechnology programme.

The list of Biotechnology elective courses are as follows

- Genetic Engineering, rDNA Technology and Cell & Tissue Culture Technology
- Advances in Biotechnology
- Animal and Plant Biotechnology (Newly introduced)
- Environmental Biotechnology (Newly introduced)

The student has to opt one elective course from Botany discipline and another elective course from Biotechnology discipline.

Botany course BOT 303: Plant Physiology and Ecology and its laboratory course BOT 303L: Plant Physiology and Ecology Lab which are running common with B.Sc. Bioscience programme are proposed to be modified as per the proposed changes in the same courses/ semester of B.Sc. Bioscience programme.

The Biotechnology course BT 307: Genetic Engineering, rDNA Technology and Cell and Tissue Culture Technology is proposed to be modified as per the present need and advancement of the topic. Few modifications are proposed to be included in the

practical course BT 307L: Genetic Engineering, rDNA Technology and Cell and Tissue Culture Technology Lab.

The vocational course Analytical Lab Practice-I is proposed to be discontinued from the fifth semester.

- (f) In the sixth semester, elective courses along with their laboratory components specific to Zoology and Biotechnology disciplines are proposed to be offered as “Discipline Elective”. Four elective courses of Biotechnology discipline as mentioned above in the fifth semester minutes are also proposed to be offered in the sixth semester. The course “Animal Physiology” is already running in the sixth semester as core course but now it is proposed to be offered as discipline elective course. Three elective courses of Zoology discipline “Environmental Biology and Biostatistics”, “Developmental Biology” and “Applied Zoology” are proposed to be included for the first time in the B.Sc. Biotechnology programme.

The four elective courses of Zoology discipline which are proposed to be offered common with B.Sc. Bioscience programme are as follows

- Animal Physiology
- Environmental Biology and Biostatistics (Newly introduced)
- Developmental Biology (Newly introduced)
- Applied Zoology (Newly introduced)

The student has to opt one elective course from Botany discipline and another elective course from Biotechnology discipline.

The Zoology course ZOO 301: Animal Physiology is proposed to be modified according to the proposed changes in the same courses/semester of the B.Sc. Bioscience programme.

The Biotechnology course BT 301: Advances in Biotechnology is proposed to be modified by elaboration of some topics. The elaboration is necessary for the better understanding.

The Bioinformatics exercise-1 & 2 from the laboratory course BT 301L: Advances in Biotechnology Lab is proposed to be replaced by more relevant exercises as per the course contents.

The vocational course “Analytical Lab Practice-II” is proposed to be discontinued from the sixth semester.

Additionally, it is proposed that a student can opt for at most 2 additional Open (Generic) audit/credit Elective from other disciplines opting at most 1 per semester in Semesters III, IV, V or VI with prior permission of respective heads and time table permitting.

E-resources have been proposed for the theory courses and the list of recommended books has been updated. The board also reviewed the Programme Educational

Objectives, Programme outcomes and the Learning outcomes of the courses keeping in view the proposed modifications.

The proposed Programme Educational Objectives, Programme outcomes and modified syllabi are included and marked as **Appendix-IIA** (pages 88), **Appendix-IIB** (pages 89) and **Appendix-IIC** (pages 90-162) respectively.

### 3. II. B.Tech. Biotechnology:

|       |  |                     |
|-------|--|---------------------|
| i.    | First Semester Examination, December, 2019   | Change <sup>a</sup> |
| ii.   | Second Semester Examination, April/May, 2020 | Change <sup>a</sup> |
| iii.  | Third Semester Examination, December, 2020   | Change <sup>b</sup> |
| iv.   | Fourth Semester Examination, April/May, 2021 | Change <sup>c</sup> |
| v.    | Fifth Semester Examination, December, 2021   | Change <sup>d</sup> |
| vi.   | Sixth Semester Examination, April/May, 2022  | Change <sup>e</sup> |
| vii.  | Seventh Semester Examination, December, 2022 | Change <sup>f</sup> |
| viii. | Eighth Semester Examination, April/May, 2023 | Change <sup>g</sup> |

(a) In the first and second semester of the B. Tech Biotechnology programme, the contents of BIO101: Biology and ENGG 102L: Measurement Technique Lab is proposed to be revised by adding relevant topics/experiments.

(b) In the third semester new experiments are proposed to be introduced in BT 204L: Biotechnology Lab-I.

(c) The fourth semester course BT 203: Biophysics and Structural Biology is proposed to be revised and irrelevant portions removed. BT 205L: Biotechnology Lab-II is proposed to be modified. Seminar (BT 208S) is proposed to be shifted from the fifth semester to the third semester.

(d) In the fifth semester, the course 'Probability and Statistics' is proposed to be introduced. Some practical's of the course BT 303L: Biotechnology Lab-III are proposed to be incorporated in the fourth semester laboratory course.

The course BT 306: Enzyme Engineering and Technology which is running as a core course is now proposed as an Elective in the eighth semester.

(e) In the sixth 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.

(f) In the seventh semester, the reading electives BT 7.1.1: Plant Genetic Engineering and BT 7.1.2: 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 Technology

These courses will help in inculcating the habit of self study/reading in students.

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>

(g) In the eighth semester, the courses ‘Animal Biotechnology’ and ‘Plant Biotechnology’ and laboratory course: Biotechnology Lab V are proposed to be revised.

The course Bioethics and Biosafety which is running as a core course is now proposed as an Elective.

Moreover, the contents of discipline elective course ‘Food and Dairy Biotechnology’ are proposed to be revised and updated, and a course ‘Geoinformatics’ is proposed to be introduced.

Additionally, it is proposed that students can opt for at most 2 additional Open (Generic) audit/credit Elective from other disciplines opting at most 1 per semester in Semesters III-VI with prior permission of respective heads and time table permitting.

E-resources have been proposed for the theory courses and the list of recommended books has been updated. The BOS has recommended all the above mentioned modifications to the degree of B. Tech. (Biotechnology).

The complete list 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
- Bioethics and Biosafety
- Enzyme Engineering and Technology
- Geoinformatics (Newly proposed)

Additionally, the following online elective courses are also proposed to be offered in the eighth 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>

The board also reviewed the Programme Educational Objectives, Programme outcomes and the Learning outcomes of the courses keeping in view the proposed modifications.

The proposed Programme Educational Objectives, Programme outcomes, modified syllabi and details of the online courses offered are included and marked as **Appendix-III A** (pages 163), **Appendix-III B** (pages 164) and **Appendix-III C** (pages 165-228) and **Appendix-III D** (pages 229) respectively.

### 3. IIIA. M.Sc. Bioscience (Animal Science):

|      |  |                     |
|------|--|---------------------|
| i.   | First Semester Examination, December, 2019   | Change <sup>a</sup> |
| ii.  | Second Semester Examination, April/May, 2020 | Change <sup>b</sup> |
| iii. | Third Semester Examination, December, 2020   | Change <sup>c</sup> |
| iv.  | Fourth Semester Examination, April/May, 2021 | Change <sup>d</sup> |

(a) In the first semester, the course BIO 403: Biochemistry and Biophysics is proposed to be replaced by 'Biochemistry' as the subject needs to be dealt in more detail. The topics in enzymology are also proposed to be incorporated in this course from the course BT 406 Enzymology and Enzyme Technology running in the third semester which is proposed to be discontinued in its present form.

The syllabi of the courses 'Cell and Molecular Biology', 'Microbiology', 'Bioinformatics', 'Analytical Techniques-I' and 'Bioscience Lab-I' are proposed to be updated.

(b) In the second semester, the courses 'Genetics', 'Genetic Engineering' and 'Bioscience Lab-II' are proposed to be modified.

The course BT 406 Enzymology and Enzyme Technology is proposed to be discontinued in its present form. The course contents are proposed to be incorporated in the newly proposed course 'Biochemistry' in the first semester and 'Enzyme Technology', a newly proposed elective course in the third semester.

A new course 'Environmental Biology and Biotechnology' is proposed to be included as a core course. The syllabus of this new course is designed by updating the contents of the existing third semester course BIO 408: Environmental Biology and Toxicology and shifting it from the third semester in M.Sc. Bioscience and incorporating as a common course in M.Sc. Biotechnology, AMBT and Bioscience in the second semester. This proposed new course also incorporated some contents of the M.Sc. Biotechnology third semester core course BT 509 Environmental Biotechnology which is proposed to be discontinued.

Relevant modification are proposed to be included in the course BIO 411: Immunology.

- (c) In the third semester, BIO 408: Environmental Biology and Toxicology is proposed to be discontinued in the present form and with some updation it is proposed to be included as a core course in the second semester and named as 'Environmental Biology and Biotechnology'.

A new core course 'Biosystematics, Taxonomy and Evolution' is proposed to be introduced.

ZOO 503: Animal Diversity –I is proposed to be replaced by a new course 'Biology of Non-Chordates'.

The addition of these two courses will enhance the core Animal science component of the programme and provide much needed knowledge to the students in their preparations for various competitive examinations and also recruitment in various institutions where classical Zoology is in demand.

The course ZOO 507: Ethology and Neurobiology is proposed to be shifted to the fourth semester.

A course common with M.Sc. Biotechnology, BT 507: Cell and Tissue Culture Technology is proposed to be included in the third semester.

The course ZOO 508: Histology, is proposed to be discontinued and its relevant contents are proposed to be incorporated in a new course 'Biology of Chordates and Histology' in the fourth semester.

In the course ZOO 505L: Animal Science Lab-I which is laboratory based course, relevant modifications have been proposed to cater to the proposed modification in the theory courses.

Further, the discipline elective courses are proposed to be offered in the third semester. Discipline elective course provides the opportunity to the students to select

and study any discipline specific course of their choice from a pool of elective courses. The complete list of the elective courses are given in point (d).

- (d) In the fourth semester, ZOO501: Advance Animal Physiology, ZOO 504: Animal Diversity-II, ZOO 510: Medical Pathology, ZOO 511: Reproductive Biology and Endocrinology is proposed to be discontinued, and relevant contents incorporated in new courses proposed to be introduced viz., ‘Animal Physiology and Endocrinology’, ‘Biology of Chordates and Histology’, ‘Reproduction and Developmental Biology’, ‘Neurobiology and Animal Behavior’.

ZOO 502: Animal Cell and Tissue Culture Techniques is proposed to be discontinued as the course BT 507: Cell and Tissue Culture Technology (c.w. M.Sc. Biotechnology) is proposed to be offered in the third semester.

The laboratory based course, ZOO 506L: Animal Science Lab-II is proposed to be run with modified contents.

Reading elective courses are proposed to be introduced for in the fourth semester.

The following discipline elective courses are proposed to be introduced:

- Insect Diversity, Morphology, Physiology and Ecology
- Fish Biology
- Animal Biotechnology-I
- Applied Entomology and Pest Management
- Capture Fishery
- Animal Biotechnology-II
- Immunotechnology-I
- Immunotechnology (c.w. M.Sc. Biotechnology/ AMBT)
- Biophysics-I (newly introduced, c.w. M.Sc. Biotechnology/ AMBT/ Plant Science / Physics)
- Ecology and Environment (c.w. M.Sc. Plant Science, Environmental Science)
- Biophysics-II (c.w. M.Sc. Plant Science/ Physics)
- Biodiversity and Conservation (c.w. M.Sc. Plant Science, Environmental Science)
- Fundamentals of Ecology for Sustainable Ecosystem (online elective, c.w. M.Sc. Plant Science )

<https://www.extension.harvard.edu/academics/courses/fundamentals-ecology/12779>

The following reading elective courses are proposed to be newly offered in the fourth semester, viz.,

- Drug Discovery
- Human Genetics and Diseases
- Intellectual Property Rights



- Medical Microbiology
- Molecular Plant Breeding
- Protein Engineering

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

- Bio- organic Chemistry  
<http://nptel.ac.in/courses/104103018/#>
- Enzyme Science and Engineering  
<http://freevidelectures.com/Course/85/Enzyme-Science-and-Engineering/1>
- Biocatalysis in organic synthesis  
<http://nptel.ac.in/courses/104105032/>
- Comprehensive Disaster Risk Management Framework  
[www.nidm.gov.in/online.asp](http://www.nidm.gov.in/online.asp)
- General Course on Intellectual Property  
<https://welc.wipo.int/acc/index.jsf?page=courseCatalog.xhtml>
- Environmental Management - An Introduction  
<http://www.algonquincollege.com/ccol/courses/environmental-management-an-introduction/>

Students can opt for any one reading elective course (either in regular mode or in online mode) as per the above-mentioned lists in the IV semester.

These courses will help in inculcating the habit of self study/ reading amongst students.

Additionally, it is proposed that a students can opt for 1 Open (Generic) Elective as a credit course from any disciplines in Semester IV with prior permission of respective heads and time table permitting.

E-resources have been proposed for the theory courses and the list of recommended books has been updated. The proposed syllabus of M.Sc. Bioscience (Animal Science) will fulfill the needs of students in terms of their acquaintance regarding both the basic and advanced concepts of the programme.

The board also reviewed the Programme Educational Objectives, Programme outcomes and the Learning outcomes of the courses keeping in view the proposed modifications.

The proposed Programme Educational Objectives, Programme outcomes, modified syllabi and details of the online courses offered are included and marked as **Appendix-IVA** (pages 230), **Appendix-IVB** (pages 231), **Appendix-IVC** (pages 232-233) and **Appendix-IV D** (pages 324-325) respectively.

### 3. IIIB. M.Sc. Bioscience (Plant Science):

|      |  |                     |
|------|--|---------------------|
| i.   | First Semester Examination, December, 2019   | Change <sup>a</sup> |
| ii.  | Second Semester Examination, April/May, 2020 | Change <sup>b</sup> |
| iii. | Third Semester Examination, December, 2020   | Change <sup>c</sup> |
| iv.  | Fourth Semester Examination, April/May, 2021 | Change <sup>d</sup> |

(a) In the first semester, the course BIO 403: Biochemistry and Biophysics is proposed to be replaced by "Biochemistry".

The syllabi of the courses 'Cell and Molecular Biology', 'Microbiology', 'Bioinformatics', 'Analytical Techniques-I' and 'Bioscience Lab-I' are proposed to be updated.

(b) In the second semester, the courses 'Genetics', 'Genetic Engineering' and 'Bioscience Lab-II' are proposed to be modified.

The course BT 406 Enzymology and Enzyme technology is proposed to be discontinued as the contents are repeated in other sections of the syllabi.

A new course 'Environmental Biology and Biotechnology' is proposed to be included as a core course. The syllabus of this new course is designed by updating the contents of the existing third semester course BIO 408: Environmental Biology and Toxicology and shifting it from the third semester in M.Sc. Bioscience and incorporating as a common course in M.Sc. Biotechnology, AMBT and Bioscience in the second semester. This proposed new course also incorporated some contents of the M.Sc. Biotechnology third semester core course BT 509 Environmental Biotechnology which is proposed to be discontinued. The contents of the course BIO 411: Immunology are proposed to be modified and revised.

(c) In the third semester, BIO 408: Environmental Biology and Toxicology is proposed to be discontinued in the present form and with some updation it is proposed to be included as a core course in the second semester renamed as 'Environmental Biology and Biotechnology'.

'Phycology, Mycology and Lichenology' and 'Bryophyta, Pteridophyta and Gymnosperms' are proposed to be introduced as new core courses. The addition of these two courses will enhance the core plant science component of the programme and provide much needed knowledge to the students in their preparations for various competitive examinations and also their recruitment in various institutions where classical botany is in demand.

The course BOT 511: Plant Tissue Culture & Experimental Embryology is proposed to be replaced by 'Cell and Tissue Culture Technology'.

BOT 507: Plant Pathology is proposed to be shifted to semester IV and in its place BT 507: Cell and Tissue Culture Technology is proposed to be introduced. BOT 509L

which is laboratory based is proposed to be modified to cater to the courses introduced/ replaced.

Further, the discipline elective courses are proposed to be offered for the first time in the third semester. Discipline elective course provides the opportunity to the students to select and study any discipline specific course of their choice from a pool of elective courses. The complete list of the discipline elective courses are given below in the point (d).

**(d)** In the fourth semester BOT 501: Advanced Horticulture and Ethnobotany is proposed to be replaced by BOT: Angiosperms, while BOT 503: Current Trends in Plant Biotechnology is proposed to be dropped, as the content of this paper is already present in other courses.

BOT 506: Plant Ecology and Biodiversity Conservation is proposed to be discontinued as the contents of this course will be covered in the proposed electives, ENVS 402 course of Elective-I and ENVS 502 course of Elective-II. BOT 508:

An online course, 'Plant Physiology and Taxonomy', (URL- <https://www.acs.edu.au/courses/botany-i-plant-physiology-and-taxonomy-199.aspx>) offered by ACS distance education is proposed as an alternative for the core course - BOT 508 Plant Physiology.

Plant Pathology is proposed to be shifted from third semester to the fourth semester. The laboratory based course, BOT 510L: Plant Science Lab is proposed to be modified.

Reading elective courses are proposed to be introduced for the first time in the fourth semester.

The following discipline elective courses are proposed to be introduced.

- Phycology-I
- Bryology-I
- Angiosperms Taxonomy and Systematics-I
- Phycology-II,
- Bryology-II,
- Angiosperms Taxonomy and Biosystematics-II
- Advanced Plant Biotechnology
- Plant Biotechnology (c.w. M.Sc. Biotechnology/ AMBT)
- Biophysics-I (Newly introduced c.w. M.Sc. Biotechnology/ AMBT/Animal Science / Physics)
- Ecology and Environment (c.w. M.Sc Env. Sci./M.Sc. Animal Science)
- Biophysics-II (c.w. M.Sc. Physics / Animal Science)

- Biodiversity and Conservation (c.w. M.Sc. Animal Science, Environmental Science)
- Fundamentals of Ecology for Sustainable Ecosystem (Online elective, c.w. M.Sc. Biotechnology/ AMBT/Animal Science)  
<https://www.extension.harvard.edu/academics/courses/fundamentals-ecology/12779>.

The following reading elective courses are proposed to be offered in the fourth semester, viz.,

- Drug Discovery
- Human Genetics and Diseases
- Intellectual Property Rights
- Medical Microbiology
- Molecular Plant Breeding
- Protein Engineering

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

- Bio- organic Chemistry  
<http://nptel.ac.in/courses/104103018/#>
- Enzyme Science and Engineering  
<http://freevidelectures.com/Course/85/Enzyme-Science-and-Engineering/1>
- Biocatalysis in organic synthesis  
<http://nptel.ac.in/courses/104105032/>
- Comprehensive Disaster Risk Management Framework  
[www.nidm.gov.in/online.asp](http://www.nidm.gov.in/online.asp)
- General Course on Intellectual Property  
<https://welc.wipo.int/acc/index.jsf?page=courseCatalog.xhtml>
- Environmental Management - An Introduction  
<http://www.algonquincollege.com/ccol/courses/environmental-management-an-introduction/>

Students can opt for any one reading elective course (either in regular mode or in online mode) as per the above-mentioned lists in the IV semester.

These courses will help in inculcating the habit of self study/reading amongst students.

Additionally, it is proposed that a students can opt for 1 Open (Generic) Elective as a credit course from any disciplines in Semester IV with prior permission of respective heads and time table permitting.

E-resources have been proposed for the theory courses and the list of recommended books has been updated. The BOS has recommended all the above mentioned modifications to the degree of M.Sc. Bioscience (Plant Science) for the third and fourth semester.

The proposed syllabus of M.Sc. Bioscience (Plant Science) fulfills the needs of students in terms of their acquaintance regarding classical botany, especially lower plant groups and also the recent advances in the subject.

The board also reviewed the Programme Educational Objectives, Programme outcomes and the Learning outcomes of the courses keeping in view the proposed modifications.

The proposed Programme Educational Objectives, Programme outcomes, modified syllabi and details of the online courses offered are included and marked as **Appendix-VA** (pages 326), **Appendix-VB** (pages 327), **Appendix-VC** (pages 328-413) and **Appendix -VD** (pages 414-415) respectively.

### 3. IIIC. M.Sc. Applied Microbiology and Biotechnology:

|      |  |                     |
|------|--|---------------------|
| i.   | First Semester Examination, December, 2019   | Change <sup>a</sup> |
| ii.  | Second Semester Examination, April/May, 2020 | Change <sup>b</sup> |
| iii. | Third Semester Examination, December, 2020   | Change <sup>c</sup> |
| iv.  | Fourth Semester Examination, April/May, 2021 | Change <sup>c</sup> |

(a) In the first semester, the course BIO 403: Biochemistry and Biophysics is proposed to be replaced by 'Biochemistry'.

The syllabi of the courses 'Cell and Molecular Biology', 'General Microbiology', 'Bioinformatics', 'Analytical Techniques-I' and 'Bioscience Lab-I' are proposed to be updated.

(b) In the second semester, the courses 'Microbial Physiology' and Genetics', 'Genetic Engineering' and 'Microbial Technology Lab-I' are proposed to be modified.

BT 406 Enzymology and Enzyme technology is proposed to be discontinued in the present form. Some relevant portions of the syllabus of the course BT 406 Enzymology and Enzyme technology is proposed to be integrated with first semester core course 'Biochemistry'. Remaining part of the syllabus of course is updated and proposed to be offered in the third semester as an elective course named as 'Enzyme Technology'.

A new course 'Environmental Biology and Biotechnology' is proposed to be included as a core course. The syllabus of this new course is designed by updating the contents of the existing third semester course BIO 408: Environmental Biology and Toxicology and shifting it from the third semester in M.Sc. Bioscience and

incorporating as a common course in M.Sc. Biotechnology, AMBT and Bioscience in the second semester. This proposed new course also incorporated some contents of the M.Sc. Biotechnology third semester core course BT 509 Environmental Biotechnology which is proposed to be discontinued.

The change was suggested to fulfil the need for emerging environmental concerns. The course BIO 411 Immunology which is running in the second semester of M.Sc. Biotechnology programme is proposed to be introduced in the second semester. The contents of the course BIO 411: Immunology are proposed to be modified and revised. The course BIO 413 Medical Microbiology and Immunology is proposed to be discontinued as the course content will be covered in the proposed 'Immunology' course.

- (c) In the third semester, the course BT 522: Recombinant DNA Technology which is offered as a core course in the existing syllabus but now this course is proposed to be offered as an elective course. “Discipline Elective” course is proposed to be introduced in the third semester. Discipline elective course provides the opportunity to the students to select and study any discipline specific course of their choice from a pool of elective courses.

The core courses 'Bioprocess Engineering and Technology', and 'Microbial Ecology and Diversity' are proposed to be modified and updated.

BT507: Cell and Tissue Culture Technology is proposed to be discontinued.

'Critical Analysis of Classical Papers/ Landmark Discoveries' is proposed to be introduced in Seminar mode.

A new elective course 'Enzyme Technology' is proposed to be introduced incorporating relevant portions of the syllabus of the second semester course BT 406 “Enzymology and Enzyme Technology which is proposed to be discontinued.

The following list of elective courses is proposed to be offered in the third semester:

- Fundamentals of Bioentrepreneurship (Modified)
- Microbial Technology
- Food Process and Biotechnology (Modified)
- Genomics and Proteomics (Modified)
- Immunotechnology (Modified)
- Plant Biotechnology (Modified)
- Recombinant DNA Technology (Modified)
- Enzyme Technology (Newly introduced)
- Animal Biotechnology-I (Newly introduced)
- Biophysics-I (Newly introduced c.w. M.Sc. Biotechnology/ Animal Science /Plant Science/ Physics)

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

- Forensic Biology and Serology  
<https://swayam.gov.in/course/264-forensic-biology-and-serology>
- Water and Waste Treatment Engineering: Biochemical Technology  
<https://www.edx.org/course/water-wastewater-treatment-engineering-tsinghuax-40050455-2x-0>
- Industrial Biotechnology  
[https://onlinecourses.nptel.ac.in/noc17\\_bt23/preview](https://onlinecourses.nptel.ac.in/noc17_bt23/preview)  
<https://swayam.gov.in/search?keyword=Industrial%20Biotechnology>
- Fundamentals of Ecology for Sustainable Ecosystem  
<https://www.extension.harvard.edu/academics/courses/fundamentals-ecology/12779>

Students can opt for any one elective course (either in regular mode or in online mode) as per the above mentioned lists.

The following reading electives are proposed to be newly offered in the third and fourth semesters, viz.,

- Drug Discovery
- Human Genetics and Diseases
- Intellectual Property Rights
- Medical Microbiology
- Molecular Plant Breeding
- Protein Engineering

Additionally, the following online reading elective courses are also proposed to be offered in the third and fourth semesters:

- Bio- organic Chemistry  
<http://nptel.ac.in/courses/104103018/#>
- Enzyme Science and Engineering  
<http://freevideolectures.com/Course/85/Enzyme-Science-and-Engineering/1>
- Biocatalysis in organic synthesis  
<http://nptel.ac.in/courses/104105032/>
- Comprehensive Disaster Risk Management Framework  
[www.nidm.gov.in/online.asp](http://www.nidm.gov.in/online.asp)
- General Course on Intellectual Property  
<https://welc.wipo.int/acc/index.jsf?page=courseCatalog.xhtml>
- Environmental Management - An Introduction

<http://www.algonquincollege.com/ccol/courses/environmental-management-an-introduction/>

The reading electives are common for third and fourth semester. Students can opt for any one reading elective course (either in regular mode or in online mode) as per the above-mentioned lists in each of the III /IV semester.

These courses which will help in inculcating the habit of self study/ reading amongst students.

Additionally, it is proposed that a students can opt for 1 Open (Generic) Elective as a credit course from any disciplines in Semester III with prior permission of respective heads and time table permitting. E-resources have been proposed for the theory courses and the list of recommended books has been updated. All modifications have been done to suit the current requirements of various preparative exams and enhance the knowledge and skill component.

The board also reviewed the Programme Educational Objectives, Programme outcomes and the Learning outcomes of the courses keeping in view the proposed modifications. The proposed Programme Educational Objectives, Programme outcomes, modified syllabi and details of the online courses offered are included and marked as **Appendix-VIA** (pages 416), **Appendix-VIB** (pages 417) , **Appendix-VIC** (pages 418-486) and **Appendix VID** (pages 487-489) respectively.

### 3. IID M.Sc. Biotechnology:

|      |  |                     |
|------|--|---------------------|
| i.   | First Semester Examination, December, 2019   | Change <sup>a</sup> |
| ii.  | Second Semester Examination, April/May, 2020 | Change <sup>b</sup> |
| iii. | Third Semester Examination, December, 2020   | Change <sup>c</sup> |
| iv.  | Fourth Semester Examination, April/May, 2021 | Change <sup>d</sup> |

(a) In the first semester, the course BIO 403: Biochemistry and Biophysics is proposed to be replaced by 'Biochemistry'.

The syllabi of the courses 'Cell and Molecular Biology', 'Microbiology', 'Bioinformatics', 'Analytical Techniques-I' and 'Bioscience Lab-I' are proposed to be updated.

(b) In the second semester, the courses 'Genetics', 'Genetic Engineering' and 'Bioscience Lab-II' are proposed to be modified.

BT 406: Enzymology and Enzyme technology is proposed to be discontinued in the present form. Some relevant portions of the syllabus of the course BT 406 Enzymology and Enzyme technology is proposed to be integrated with first semester core course 'Biochemistry'. Remaining part of the syllabus of course is updated and



proposed to be offered in the third semester as an elective course named as 'Enzyme Technology'.

A new course 'Environmental Biology and Biotechnology' is proposed to be included as a core course. The syllabus of this new course is designed by updating the contents of the existing third semester course BIO 408: Environmental Biology and Toxicology and shifting it from the third semester in M.Sc. Bioscience and incorporating as a common course in M.Sc. Biotechnology, AMBT and Bioscience in the second semester. This proposed new course also incorporated some contents of the M.Sc. Biotechnology third semester core course BT 509 Environmental Biotechnology which is proposed to be discontinued. The change was suggested to fulfil the need for emerging environmental concerns. The contents of the course BIO 411: Immunology are proposed to be updated.

- (c) In the third semester, the course BT 522: Recombinant DNA Technology which is offered as a core course in the existing syllabus but now contents of this course have been modified and proposed to be offered as an elective course. "Discipline Elective" course is proposed to be introduced in the third semester. Discipline elective course provides the opportunity to the students to select and study any discipline specific course of their choice from a pool of elective courses.

The core courses 'Bioprocess Engineering and Technology', and 'Biotechnology Lab-I' are proposed to be modified. BT 509: Environmental Biotechnology which is a core course is proposed to be discontinued in the present form and with some updation it is proposed to be reintroduced as a core course 'Environmental Biology and Biotechnology' in the second semester.

'Critical Analysis of Classical Papers/ Landmark Discoveries' is proposed to be introduced in Seminar mode.

The following is the list of elective courses that are proposed to be offered in the third semester:

- Fundamentals of Bioentrepreneurship (Modified)
- Microbial Technology
- Food Process and Biotechnology (Modified)
- Genomics and Proteomics (Modified)
- Immunotechnology (Modified)
- Plant Biotechnology (Modified)
- Recombinant DNA Technology (Modified)
- Enzyme Technology (Newly introduced)
- Animal Biotechnology-I (Newly introduced)
- Biophysics-I (Newly introduced c.w. M.Sc. AMBT/ Animal Science /Plant Science/ Physics)

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

- Forensic Biology and Serology  
<https://swayam.gov.in/course/264-forensic-biology-and-serology>
- Water and waste treatment engineering: Biochemical Technology  
<https://www.edx.org/course/water-wastewater-treatment-engineering-tsinghuax-40050455-2x-0>
- Industrial Biotechnology  
[https://onlinecourses.nptel.ac.in/noc17\\_bt23/preview](https://onlinecourses.nptel.ac.in/noc17_bt23/preview)  
<https://swayam.gov.in/search?keyword=Industrial%20Biotechnology>
- Fundamentals of Ecology for Sustainable Ecosystem  
<https://www.extension.harvard.edu/academics/courses/fundamentals-ecology/12779>

Students can opt for any one elective course (either in regular mode or in online mode) as per the above mentioned lists.

**(d)** The following reading electives are proposed to be newly offered in the third and the fourth semesters, viz.,

- Drug Discovery
- Human Genetics and Diseases
- Intellectual Property Rights
- Medical Microbiology
- Molecular Plant Breeding
- Protein Engineering

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

- Bio- organic Chemistry  
<http://nptel.ac.in/courses/104103018/#>
- Enzyme Science and Engineering  
<http://freevideolectures.com/Course/85/Enzyme-Science-and-Engineering/1>
- Biocatalysis in organic synthesis  
<http://nptel.ac.in/courses/104105032/>
- Comprehensive Disaster Risk Management Framework  
[www.nidm.gov.in/online.asp](http://www.nidm.gov.in/online.asp)
- General Course on Intellectual Property  
<https://welc.wipo.int/acc/index.jsf?page=courseCatalog.xhtml>
- Environmental Management - An Introduction

<http://www.algonquincollege.com/ccol/courses/environmental-management-an-introduction/>

The reading electives are common for third and fourth semester. Students can opt for any one reading elective course (either in regular mode or in online mode) as per the above-mentioned lists in each of the III /IV semester.

These courses will help in inculcating the habit of self study/reading amongst students.

Additionally, it is proposed that a students can opt for 1 Open (Generic) Elective as a credit course from any disciplines in Semester III with prior permission of respective heads and time table permitting. E-resources have been proposed for the theory courses and the list of recommended books has been updated. All modifications have been done to suit the current requirements of various preparative exams and enhance the knowledge and skill component. The board also reviewed the Programme Educational Objectives, Programme outcomes of the programme and the Learning outcomes of the courses keeping in view the proposed modifications.

The proposed Programme Educational Objectives, Programme outcomes, modified syllabi and details of the online courses offered are included and marked as **Appendix-VIIA** (pages 490), **Appendix-VIIB** (pages 491), **Appendix-VIIC** (pages 492-568) **Appendix-VIID** (pages 569-571) respectively.

### 3. IIIE M.Sc. Bioinformatics:

|      |  |                     |
|------|--|---------------------|
| i.   | First Semester Examination, December, 2019   | Change <sup>a</sup> |
| ii.  | Second Semester Examination, April/May, 2020 | Change <sup>b</sup> |
| iii. | Third Semester Examination, December, 2020   | Change <sup>c</sup> |
| iv.  | Fourth Semester Examination, April/May, 2021 | Change <sup>d</sup> |

(a) In the first semester, the course BIO 402: Basic Cell, molecular Biology and Biological Database is proposed to be replaced by BIO407: Cell and Molecular Biology (c.w.: M.Sc. BT/ AMBT/ Bioscience. I sem).

The course of MATH406: Introductory Mathematic' is proposed to be modified with inclusion of relevant content of Statistics.

The course STAT405: Statistical Techniques is proposed to be discontinued. 'Biological Databases' is proposed as new core course.

The course CS410: Computer Fundamentals and Perl Programming is proposed to be discontinued and a new course - 'Fundamentals of Computer and Programming' is proposed to be introduced.

The course STAT405L: Statistical Techniques Lab is proposed to be discontinued.

To provide wet lab training, the course BIO404L: Bioscience Lab I (c.w. MSc. BT/AMBT/Bioscience I sem) is proposed to be introduced.

The syllabi of the courses 'Structural Biology' and 'Computer Fundamentals and Programming Lab' is proposed to be updated.

- (b)** In the second semester, the courses BIN402: Computational Biology and Molecular Modeling', 'BIN403: Proteomics, Sequence Analysis and Systems Biology' 'CS412: Computer Networks and Web Technologies' and 'BIO413: Medical Microbiology and Immunology' are proposed to be discontinued.

The courses 'Algorithms in Computational Biology', 'Sequence Analysis and Phylogenetics', 'Programming with Perl and R' and 'Genetic Engineering (c.w. MSc. BT/AMBT/Biosc. II sem) ' are being proposed to be introduced and some of the relevant portions of the discontinued courses have been incorporated with suitable updates into these newly proposed courses. The modifications are suggested to fulfill the need for emerging technologies in bioinformatics.

- (c)** In third semester, the core courses BIN504: Evolutionary Computing, 'BIN502: Computer Aided Drug Designing', 'BIN505: Functional and Comparative Genomics', 'BIN508: Molecular Structure Prediction and Visualization' and 'BIN508L: Molecular Structure Prediction and Visualization Lab' are proposed to be discontinued.

The courses 'Biomolecular Modelling and Computational Drug Design' is proposed to be newly introduced.

The course 'Genomics and Proteomics' currently offered as a elective course in the IIIrd sem. in M.Sc. Biotechnology and M.Sc AMBT is proposed to be offered as a core course.

The courses 'RNA Structure Function and Transcriptomics' 'Biomolecular Modelling and Computational Drug Design Lab' are proposed to be newly introduced and some of the relevant portions of the discontinued courses have been incorporated with suitable updates into these newly proposed courses.

'Python Programming' and 'Python Programming Lab' are proposed as new core courses to meet the current demands of Bioinformatics in academia and industry.

The core course 'BIN507: Mining and Warehousing of Biological Data' is being proposed as to be run as an elective course.

The courses 'CS512: Cloud Computing', 'CS530: Neural Networks' and 'Systems Biology' are proposed to be retained as elective courses.

- (d)** In the fourth semester the course 'CS427: Parallel Computing' is proposed to be discontinued.

A full semester ‘Project Dissertation’ is proposed to be introduced to develop in depth knowledge of the subject and skill development for writing projects and reports among students.

The following reading electives are proposed to be introduced:

- BIN601R:Chemoinformatics’ (previously run in M.Tech. Bioinformatics)
- BIN602:Immunoinformatics’ (previously run in M.Tech. Bioinformatics)
- Human Genetics and Diseases (c.w. M.Tech. BT, M.Sc. AMBT, BT, Biosci)
- Drug Discovery (c.w. M.Tech. BT, M.Sc. AMBT, BT, Biosci)
- Protein Engineering (c.w. M.Tech. BT, M.Sc. AMBT, BT, Biosci).

These courses will help in inculcating the habit of self study/reading amongst students. E-resources have been proposed for the theory courses and the list of recommended books has been updated. All modifications have been done to suit the current requirements of various preparative exams and enhance the knowledge and skill component.

The board also reviewed the Programme Educational Objectives (**Appendix-VIIIA**, page no.572), Programme outcomes (**Appendix-VIIIB**, page no. 573) and the Learning outcomes of the courses keeping in view the proposed modifications.

The proposed course of study, curricula and scheme of examination of the M. Sc. Bioinformatics (2019-2020) programme is attached and marked as **Appendix-VIIIC**, page no. 574-633.

### 3. IV M.Tech. Biotechnology:

|      |  |                     |
|------|--|---------------------|
| i.   | First Semester Examination, December, 2019   | Change <sup>a</sup> |
| ii.  | Second Semester Examination, April/May, 2020 | Change <sup>b</sup> |
| iii. | Third Semester Examination, December, 2020   | Change <sup>c</sup> |
| iv.  | Fourth Semester Examination, April/May, 2021 | Change <sup>c</sup> |

(a) In the first semester, the courses ‘Biological Databases and Computational Biology’, ‘Advanced Cell Biology’, ‘Biotechnology Lab – I’ are proposed to be updated with more relevant topics.

The course “Bioprocess Engineering-I” is proposed to be discontinued.

An elective course ‘Elective-I’ is proposed to be introduced.

Term paper-I/Minor project is proposed to be introduced in the first semester. The term paper essentially will help to enhance the critical thinking, writing and communication skills of the students. The core course BT 511: ‘Enzyme Technology’ of the first semester is proposed to be offered as an elective course.

**(b)** The contents of the second semester core course BT 503: “Bioprocess Engineering-II” and first semester core course BT 502: “Bioprocess engineering-I” are proposed to be merged and modified, and offered as new course named as “Bioprocess engineering” in the second semester of the programme.

Another elective course named as ‘Elective-II’ is proposed to be introduced. Term paper-II/Minor project is also proposed to be introduced in the second semester. The course BT 516: ‘Immunotechnology’ is proposed to be offered as an elective course. In the second semester, core course BT 520: ‘Plant and Animal Cell Culture Technology’ is proposed to be discontinued.

The contents of the course ‘Genetic Manipulation Technology’ are proposed to be rearranged in all the sections with incorporation of new and relevant topics. In the course ‘Biotechnology Lab – II’, the modifications in the practical exercises are proposed to properly categorize and introduce relevant experiments. The contents of the elective paper ‘Food Biotechnology’, is proposed to be updated with the removal of some repetitive portions.

The complete lists of elective courses proposed to be offered in the first and second semester are as follows:

- Computer Aided Drug Designing
- Elements of Bioinformatics
- Structural Biology
- Bioentrepreneurship
- Cancer Biology
- Environmental Biotechnology
- Food Biotechnology (Modified)
- Medical Biotechnology
- Nanobiotechnology
- Enzyme Technology (Newly introduced)
- Immunotechnology (Newly introduced)

Additionally, it is proposed that a student can opt for 1 Open (Generic) Elective as a credit course from any disciplines in Semester II with prior permission of respective heads and time table permitting.

**(c)** The reading electives viz., BIO 601R: Biodiversity and Conservation, BIO 602R: Bioethics, Biosafety and IPR and BT 604R: Renewable Energy Sources, which were offered in the third and fourth semesters are proposed to be replaced with newly introduced and more relevant reading electives viz.:

- Drug Discovery,
- Human Genetics and Diseases,
- Intellectual Property Rights,

- Medical Microbiology,
- Molecular Plant Breeding and
- Protein Engineering.

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

- Downstream Processing  
<http://nptel.ac.in/syllabus/102106022>
- Mass Spectrometry based Proteomics  
[https://onlinecourses.nptel.ac.in/noc15\\_bt05/preview](https://onlinecourses.nptel.ac.in/noc15_bt05/preview)  
<https://swayam.gov.in/search?keyword=Mass%20spectrometry%20based%20proteomics>
- Bioreactor  
<https://swayam.gov.in/course/1339-bioreactors>

The above courses will help in inculcating the habit of self study/reading in students. Moreover, the books of all the theory and practical papers have been updated following same format and e-resources have been introduced. E-resources have been proposed for the theory courses and the list of recommended books has been updated. The BOS has recommended all the above mentioned modifications to the degree of M. Tech. Biotechnology. The proposed syllabus of M. Tech. Biotechnology would fulfill the needs of students in terms of their knowledge of fundamental concepts and latest developments in the field of biotechnology. The board also reviewed the Programme Educational Objectives, Programme outcomes of the programme and the Learning outcomes of the courses keeping in view the proposed modifications.

The proposed Programme Educational Objectives, Programme outcomes, modified syllabi and details of the online courses offered are included and marked as **Appendix-VIIIA** (pages 572), **Appendix-VIIIB** (pages 573), **Appendix-VIIIC** (pages 574-621), **Appendix-VIIID** (pages 622) respectively.

### 3. V Certificate Course in Molecular Modeling and Drug Designing

The Convener briefed the board of the objectives for introducing the Certificate Course in Molecular Modeling and Drug Designing in the department. The Course is structured to provide theoretical and practical knowledge of computational methods used in biomolecular studies and the drug discovery programs to the students with background in biology, chemistry and pharmaceutical sciences. Further, this course also includes computer programming in order to enable the students to solve complex

biological problems computationally. Theoretical introduction to drugable targets and biomolecular structures helps in understanding the complexities in drug discovery process. The hands on experiences with software and programming further augment the skills to take on the challenges of drug discovery. The external experts appreciated the proposed certificate course and mentioned that the students trained could have better placement opportunity in the pharmaceutical industries as well as in research programmes. The proposed syllabus is included and marked as **Appendix –X** (pages –685-689).

### 3. VI Diploma in Computational Biology

The Convener briefed the board of the objectives for introducing the Diploma Course in Computational Biology in the department. The course has been structured to provide theoretical and practical knowledge of computational methods, used in the era of molecular biology, to the students without any prior knowledge of Bioinformatics. Theoretical introduction to computational biology methods will help in understanding the complexities in drug discovery process, sequence analysis and phylogenetic reconstruction. The hands on experiences with relevant software and programming further augment the skills to take on the current challenges of molecular biology research and pharmaceutical industries. The external experts appreciated the proposed certificate course and were of the opinion that the students trained could have better placement opportunity in the pharmaceutical industries as well be absorbed in various research programmes. The proposed syllabus is included and marked as **Appendix – XI** (pages 690-696).

A complete list of newly proposed online courses in the abovementioned courses viz., B.Tech. Biotechnology, M.Sc. Bioscience (Animal Science), M.Sc. Bioscience (Plant Science), M.Sc. Applied Microbiology and Biotechnology, M.Sc. Biotechnology, M.Tech. Biotechnology is enlisted below:

**Table-1:** List of proposed online elective courses

| S. No  | Online Course Name                                | URL   |
|--|---|---|
| <b>B.Tech. Biotechnology VIII Semester</b>                           |   |   |
| 1.   | Bioreactor  | <a href="https://swayam.gov.in/course/1339-bioreactors">https://swayam.gov.in/course/1339-bioreactors</a>   |
| 2.   | Principles of Downstream techniques in Bioprocess | <a href="http://nptel.ac.in/syllabus/102106048/">http://nptel.ac.in/syllabus/102106048/</a>   |
| 3.   | Industrial Biotechnology                          | <a href="https://www.coursera.org/learn/industrial-biotech">https://www.coursera.org/learn/industrial-biotech</a>   |
| <b>M.Sc. Bioscience (Animal Science, Plant Science) III Semester</b> |   |   |
| 1.   | Fundamentals of Ecology for Sustainable Ecosystem | <a href="https://www.extension.harvard.edu/academic/courses/fundamentals-ecology/12779">https://www.extension.harvard.edu/academic/courses/fundamentals-ecology/12779</a> |



| S. No   | Online Course Name  | URL  |
|---|---|--|
| <b>M.Sc. Applied Microbiology and Biotechnology, Biotechnology III Semester</b> |   |  |
| 1.  | Forensic Biology and Serology                                 | <a href="https://swayam.gov.in/course/264-forensic-biology-and-serology">https://swayam.gov.in/course/264-forensic-biology-and-serology</a>  |
| 2.  | Water and waste treatment engineering: Biochemical Technology | <a href="https://www.edx.org/course/water-wastewater-treatment-engineering-tsinghuax-40050455-2x-0">https://www.edx.org/course/water-wastewater-treatment-engineering-tsinghuax-40050455-2x-0</a>  |
| 3.  | Industrial Biotechnology                                      | <a href="https://onlinecourses.nptel.ac.in/noc17_bt23/preview">https://onlinecourses.nptel.ac.in/noc17_bt23/preview</a><br><a href="https://swayam.gov.in/search?keyword=Industrial%20Biotechnology">https://swayam.gov.in/search?keyword=Industrial%20Biotechnology</a> |
| 4.  | Fundamentals of Ecology for Sustainable Ecosystem             | <a href="https://www.extension.harvard.edu/academics/courses/fundamentals-ecology/12779">https://www.extension.harvard.edu/academics/courses/fundamentals-ecology/12779</a>  |

**Table-2:** List of proposed online reading elective courses

| S. No.   | Online Course Name                                      | URL  |
|--|---|--|
| <b>B.Tech. Biotechnology VII Semester</b>  |   |  |
| 1.   | Drug Discovery  | <a href="https://www.coursera.org/learn/drug-discovery">https://www.coursera.org/learn/drug-discovery</a>  |
| 2.   | Proteins and Gel-Based Proteomics                       | <a href="https://swayam.gov.in/course/1386-proteins-and-gel-based-proteomics">https://swayam.gov.in/course/1386-proteins-and-gel-based-proteomics</a>  |
| 3.   | Online course on IPR                                    | <a href="http://www.ili.ac.in/e-learnIPR.htm">http://www.ili.ac.in/e-learnIPR.htm</a>  |
| <b>M.Sc. Bioscience (Animal Science, Plant Science), Applied Microbiology and Biotechnology, Biotechnology - IV Semester</b> |   |  |
| 1.   | Bio- organic Chemistry                                  | <a href="http://nptel.ac.in/courses/104103018/#">http://nptel.ac.in/courses/104103018/#</a>  |
| 2.   | Enzyme Science and Engineering                          | <a href="http://freevidelectures.com/Course/85/Enzyme-Science-and-Engineering/1">http://freevidelectures.com/Course/85/Enzyme-Science-and-Engineering/1</a>  |
| 3.   | Biocatalysis in organic synthesis                       | <a href="http://nptel.ac.in/courses/104105032/">http://nptel.ac.in/courses/104105032/</a>  |
| 4.   | Comprehensive Disaster Risk Management Framework        | <a href="http://www.nidm.gov.in/online.asp">www.nidm.gov.in/online.asp</a>   |
| 5.   | DL101E - DL-101 General Course on Intellectual Property | <a href="https://welc.wipo.int/acc/index.jsf?page=courseCatalog.xhtml">https://welc.wipo.int/acc/index.jsf?page=courseCatalog.xhtml</a>  |
| 6.   | Environmental Management - An Introduction              | <a href="http://www.algonquincollege.com/ccol/courses/environmental-management-an-i">http://www.algonquincollege.com/ccol/courses/environmental-management-an-i</a>  |
| <b>M.Tech. Biotechnology III &amp; IV Semester</b>   |   |  |
| 1.   | Downstream Processing                                   | <a href="http://nptel.ac.in/syllabus/102106022/">http://nptel.ac.in/syllabus/102106022/</a>  |
| 2.   | Mass spectrometry based proteomics                      | <a href="https://onlinecourses.nptel.ac.in/noc15_bt05/preview">https://onlinecourses.nptel.ac.in/noc15_bt05/preview</a><br><a href="https://swayam.gov.in/search?keyword=Mass%20spectrometry%20based%20proteomics">https://swayam.gov.in/search?keyword=Mass%20spectrometry%20based%20proteomics</a> |
| 3.   | Bioreactor  | <a href="https://swayam.gov.in/course/1339-bioreactors">https://swayam.gov.in/course/1339-bioreactors</a>  |

**Table-3:** List of proposed online alternative core courses

| S.No.   | Online Course Name            | URL   |
|---|-------------------------------|---|
| <b>IIIB. M.Sc. Bioscience-Plant Science IV Semester - BOT 508: Plant Physiology</b> |                               |   |
| 1.  | Plant Physiology and Taxonomy | <a href="https://www.acs.edu.au/courses/botany-i-plant-physiology-and-taxonomy-199.aspx">https://www.acs.edu.au/courses/botany-i-plant-physiology-and-taxonomy-199.aspx</a> |

5. The Board noted the Curriculum for the courses running in the other programmes of the Vidyapith. The courses which are proposed to be modified/ updated/ discontinued are reviewed under point number 3 above.
6. The board considered the reports of examiners in various examinations of 2017-2018. 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, wherever necessary, the reports were brought to the notice of concerned teachers so that corrective measures could be taken.
7. In view of the note of the Vice-Chancellor regarding the standard of the question papers, the Board examined the question papers of periodical test and annual examinations of the session 2017-18.

The question papers were thoroughly studied by the various subject teachers and it was observed that quality of question papers has not deteriorated in the session 2017-18 vis-à-vis the previous years. At UG level, on an average, more than 80% questions belong to either High (Excellent) or Medium (Good) category. Similarly, at PG level too, the results are nearly same.

The analysis of the question papers summarized in **Appendix XIII A** (pages 697-698) and details given in various tables and figures **Appendix XIIB** (UG, pages 699-723), **Appendix XIIC** (PG, pages 724-732) and **Appendix XIID** (PG Bioinformatics, pages 733-736).

The meeting ended with vote of thanks.

**Department of Bioscience and Biotechnology, Banasthali Vidyapith**  
**B.Sc. Biotechnology Programme**

| Existing Courses            |   |           |          |          |           |
|-----------------------------|---|-----------|----------|----------|-----------|
| B. Sc. Biotechnology I Sem. |   | L         | T        | P        | C         |
| BT 102:                     | Cell and Molecular Biology-I  | 6         | 0        | 0        | 6         |
| BT102L:                     | Cell and Molecular biology-I Lab  | 0         | 0        | 4        | 2         |
| BOT 101:                    | Algae, Fungi, Bryophyta, Pteridophyta and Gymnosperms<br>(cw B.Sc Botany BOT 101)       | 6         | 0        | 0        | 6         |
| BOT 101L:                   | Algae, Fungi, Bryophyta, Pteridophyta and Gymnosperms Lab<br>(cw B.Sc Botany BOT 101 L) | 0         | 0        | 4        | 2         |
| <b>Total</b>                |   | <b>12</b> | <b>0</b> | <b>8</b> | <b>16</b> |

| Existing Courses             |  |           |          |          |           |
|------------------------------|--|-----------|----------|----------|-----------|
| B. Sc. Biotechnology II Sem. |  | L         | T        | P        | C         |
| BT 101:                      | Biostatistics, Bioinformatics and Instrumentation                  | 6         | 0        | 0        | 6         |
| BT101L:                      | Biostatistics, Bioinformatics and Instrumentation Lab              | 0         | 0        | 4        | 2         |
| ZOO 101:                     | Non-Chordates and Protochordates (cw B.Sc Zoology ZOO 101)         | 6         | 0        | 0        | 6         |
| ZOO 101L:                    | Non-Chordates and Protochordates Lab<br>(cw B.Sc Zoology ZOO 101L) | 0         | 0        | 4        | 2         |
| <b>Total</b>                 |  | <b>12</b> | <b>0</b> | <b>8</b> | <b>16</b> |

| Existing Courses              |   |           |          |          |           |
|-------------------------------|---|-----------|----------|----------|-----------|
| B. Sc. Biotechnology III Sem. |   | L         | T        | P        | C         |
| BT 202:                       | Biochemistry, Biophysics and Enzymology                                   | 6         | 0        | 0        | 6         |
| BT 202L:                      | Biochemistry, Biophysics and Enzymology Lab                               | 0         | 0        | 4        | 2         |
| BOT 201:                      | Angiosperm Taxonomy and Economic Botany<br>(cw B.Sc Botany BOT 201)       | 6         | 0        | 0        | 6         |
| BOT 201L:                     | Angiosperm Taxonomy and Economic Botany Lab<br>(cw B.Sc Botany BOT 201 L) | 0         | 0        | 4        | 2         |
| <b>Total</b>                  |   | <b>12</b> | <b>0</b> | <b>8</b> | <b>16</b> |

| Existing Courses             |  |           |          |          |           |
|------------------------------|--|-----------|----------|----------|-----------|
| B. Sc. Biotechnology IV Sem. |  | L         | T        | P        | C         |
| BT 207:                      | Genetics, Microbiology and Immunology  | 6         | 0        | 0        | 6         |
| BT 207L:                     | Genetics, Microbiology and Immunology Lab  | 0         | 0        | 4        | 2         |
| ZOO 202:                     | Comparative Anatomy and Embryology of Chordates<br>(cw B.Sc Zoology ZOO 202)       | 6         | 0        | 0        | 6         |
| ZOO 202L:                    | Comparative Anatomy and Embryology of Chordates Lab<br>(cw B.Sc Zoology ZOO 202 L) | 0         | 0        | 4        | 2         |
| <b>Total</b>                 |  | <b>12</b> | <b>0</b> | <b>8</b> | <b>16</b> |

| Proposed Courses            |  |           |          |          |           |
|-----------------------------|--|-----------|----------|----------|-----------|
| B. Sc. Biotechnology I Sem. |  | L         | T        | P        | C         |
| BT                          | Cell and Molecular Biology-I   | 6         | 0        | 0        | 6         |
| BT                          | Cell and Molecular Biology-I Lab   | 0         | 0        | 4        | 2         |
| BOT                         | Algae, Fungi, Bryophyta, Pteridophyta and Gymnosperms<br>(cw B.Sc. Bioscience)     | 6         | 0        | 0        | 6         |
| BOT                         | Algae, Fungi, Bryophyta, Pteridophyta and Gymnosperms Lab<br>(cw B.Sc. Bioscience) | 0         | 0        | 4        | 2         |
| <b>Total</b>                |  | <b>12</b> | <b>0</b> | <b>8</b> | <b>16</b> |

| Proposed Courses             |  |           |          |          |           |
|------------------------------|--|-----------|----------|----------|-----------|
| B. Sc. Biotechnology II Sem. |  | L         | T        | P        | C         |
| BT                           | Biostatistics, Bioinformatics and Instrumentation          | 6         | 0        | 0        | 6         |
| BT                           | Biostatistics, Bioinformatics and Instrumentation Lab      | 0         | 0        | 4        | 2         |
| ZOO                          | Non-Chordates and Protochordates (cw B.Sc. Bioscience)     | 6         | 0        | 0        | 6         |
| ZOO                          | Non-Chordates and Protochordates Lab (cw B.Sc. Bioscience) | 0         | 0        | 4        | 2         |
| <b>Total</b>                 |  | <b>12</b> | <b>0</b> | <b>8</b> | <b>16</b> |

| Proposed Courses              |   |           |          |          |           |
|-------------------------------|---|-----------|----------|----------|-----------|
| B. Sc. Biotechnology III Sem. |   | L         | T        | P        | C         |
| BT                            | Biochemistry, Biophysics and Enzymology                               | 6         | 0        | 0        | 6         |
| BT                            | Biochemistry, Biophysics and Enzymology Lab                           | 0         | 0        | 4        | 2         |
| BOT                           | Angiosperms Taxonomy and Economic Botany<br>(cw B.Sc. Bioscience)     | 6         | 0        | 0        | 6         |
| BOT                           | Angiosperms Taxonomy and Economic Botany Lab<br>(cw B.Sc. Bioscience) | 0         | 0        | 4        | 2         |
| <b>Total</b>                  |   | <b>12</b> | <b>0</b> | <b>8</b> | <b>16</b> |

| Proposed Courses             |  |           |          |          |           |
|------------------------------|--|-----------|----------|----------|-----------|
| B. Sc. Biotechnology IV Sem. |  | L         | T        | P        | C         |
| BT                           | Genetics, Microbiology and Immunology  | 6         | 0        | 0        | 6         |
| BT                           | Genetics, Microbiology and Immunology Lab                                    | 0         | 0        | 4        | 2         |
| ZOO 202                      | Comparative Anatomy and Embryology of Chordates<br>(cw B.Sc. Bioscience)     | 6         | 0        | 0        | 6         |
| ZOO                          | Comparative Anatomy and Embryology of Chordates Lab<br>(cw B.Sc. Bioscience) | 0         | 0        | 4        | 2         |
| <b>Total</b>                 |  | <b>12</b> | <b>0</b> | <b>8</b> | <b>16</b> |

| Existing Courses                   |   | L         | T        | P         | C         |
|------------------------------------|---|-----------|----------|-----------|-----------|
| <b>B. Sc. Biotechnology V Sem.</b> |   |           |          |           |           |
| 5.1:                               | Plant Physiology and Ecology (cw B.Sc Botany 5.1)                             | 6         | 0        | 0         | 6         |
| 5.2:                               | Plant Physiology and Ecology Lab (cw B.Sc Botany Lab 5.2)                     | 0         | 0        | 4         | 2         |
| 5.3:                               | Genetic Engineering, rDNA Technology and Cell & Tissue Culture Technology     | 6         | 0        | 0         | 6         |
| 5.4:                               | Genetic Engineering, rDNA Technology and Cell & Tissue Culture Technology Lab | 0         | 0        | 4         | 2         |
|                                    | Analytical Lab Practice-I   | 0         | 0        | 4         | 2         |
| <b>Total</b>                       |   | <b>12</b> | <b>0</b> | <b>12</b> | <b>18</b> |

| Existing Courses                    |   | L         | T        | P         | C         |
|-------------------------------------|---|-----------|----------|-----------|-----------|
| <b>B. Sc. Biotechnology VI Sem.</b> |   |           |          |           |           |
| 6.1:                                | Advances in Biotechnology                   | 6         | 0        | 0         | 6         |
| 6.2:                                | Advances in Biotechnology Lab               | 0         | 0        | 4         | 2         |
| 6.3:                                | Animal Physiology (cw B.Sc Zoology 6.1)     | 6         | 0        | 0         | 6         |
| 6.4:                                | Animal Physiology Lab (cw B.Sc Zoology 6.2) | 0         | 0        | 4         | 2         |
|                                     | Analytical Lab Practice-II                  | 0         | 0        | 4         | 2         |
| <b>Total</b>                        |   | <b>12</b> | <b>0</b> | <b>12</b> | <b>18</b> |

|  |                       |
|--|-----------------------|
|  | Syllabus modified     |
|  | Course discontinued   |
|  | New Course introduced |

| Proposed Courses                   |                              | L         | T        | P        | C         |
|------------------------------------|------------------------------|-----------|----------|----------|-----------|
| <b>B. Sc. Biotechnology V Sem.</b> |                              |           |          |          |           |
| BT                                 | Biotechnology Elective I     | 6         | 0        | 0        | 6         |
| BT L                               | Biotechnology Elective I Lab | 0         | 0        | 4        | 2         |
| BOT                                | Botany Elective I            | 6         | 0        | 0        | 6         |
| BOT L                              | Botany Elective I Lab        | 0         | 0        | 4        | 2         |
| <b>Total</b>                       |                              | <b>12</b> | <b>0</b> | <b>8</b> | <b>16</b> |

| Proposed Courses                    |                               | L         | T        | P        | C         |
|-------------------------------------|-------------------------------|-----------|----------|----------|-----------|
| <b>B. Sc. Biotechnology VI Sem.</b> |                               |           |          |          |           |
| BT                                  | Biotechnology Elective II     | 6         | 0        | 0        | 6         |
| BT L                                | Biotechnology Elective II Lab | 0         | 0        | 4        | 2         |
| ZOO                                 | Zoology Elective II           | 6         | 0        | 0        | 6         |
| ZOO L                               | Zoology Elective II Lab       | 0         | 0        | 4        | 2         |
| <b>Total</b>                        |                               | <b>12</b> | <b>0</b> | <b>8</b> | <b>16</b> |

| Proposed List of Discipline Electives to be offered in V & VI Semester  |   | L | T | P | C |
|---|---|---|---|---|---|
| <b>Proposed List of Discipline Elective I &amp; II (Botany)</b>         |   |   |   |   |   |
| BOT 302/ BOT 302L   | Introduction to Genetics and Genetic Engineering                          | 6 | 0 | 4 | 8 |
| BOT 303/ BOT 303L   | Plant Physiology and Ecology  | 6 | 0 | 4 | 8 |
| BOT / BOT L   | Ethnobotany   | 6 | 0 | 4 | 8 |
| BOT / BOT L   | Horticulture  | 6 | 0 | 4 | 8 |
| <b>Proposed List of Discipline Elective I &amp; II (Zoology)</b>        |   |   |   |   |   |
| ZOO 301/ ZOO 301L   | Animal Physiology   | 6 | 0 | 4 | 8 |
| ZOO302/ ZOO 302L  | Environmental Biology and Biostatistics                                   | 6 | 0 | 4 | 8 |
| ZOO / ZOO L   | Developmental Biology   | 6 | 0 | 4 | 8 |
| ZOO / ZOO L   | Applied Zoology   | 6 | 0 | 4 | 8 |
| <b>Proposed List of Discipline Electives I &amp; II (Biotechnology)</b> |   |   |   |   |   |
| BT /BT L  | Genetic Engineering, rDNA Technology and Cell & Tissue Culture Technology | 6 | 0 | 4 | 8 |
| BT /BT L  | Advances in Biotechnology   | 6 | 0 | 4 | 8 |
| BT /BT L  | Animal and Plant Biotechnology  | 6 | 0 | 4 | 8 |
| BT /BT L  | Environmental Biotechnology   | 6 | 0 | 4 | 8 |

Comparative Table: B.Sc. Biotechnology: Existing and Modified syllabus, Suggested Books and Suggested e-Resources

| S No.                                 | Course List  | Learning Outcomes   | Existing Syllabus   | Suggested Syllabus   | Remarks |
|---------------------------------------|--|---|---|--|---------|
| <b>B.Sc. Biotechnology I Semester</b> |  |   |   |  |         |
| 1.                                    | <b>BOT 101:</b><br>Algae, Fungi,<br>Bryophyta,<br>Pteridophyta<br>and<br>Gymnosperms | On completion of the course students will be able to:<br><ul style="list-style-type: none"> <li>Acquaint with the general characters and classification of cryptogams and phanerogames.</li> <li>Understand the evolutionary relationship among lower to higher plant species with differentiating characteristics.</li> <li>Appreciate and understand economic importance and application of every group of plants.</li> </ul> | <p><b>Unit 1</b></p> <ul style="list-style-type: none"> <li>Algae: Classification, General account with special reference to <i>Anabaena</i>, <i>Oscillatoria</i>, <i>Volvox</i>, <i>Chlamydomonas</i>, <i>Chara</i>, <i>Oedogonium</i>, <i>Ectocarpus</i>, <i>Polysiphonia</i>. Economic importance of Algae.</li> </ul> <p><b>Unit 2</b></p> <ul style="list-style-type: none"> <li>Fungi: Classification, General account with special reference to <i>Albugo</i>, <i>Aspergillus</i>, <i>Erysiphe</i>, <i>Puccinia</i>, <i>Ustilago</i> and <i>Alternaria</i>. Economic importance of Fungi.</li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>Bryophytes: Classification, General account with special reference to important features in the life cycles of <i>Riccia</i>, <i>Marchantia</i>, <i>Anthoceros</i> and Mosses: <i>Funaria</i>, <i>Sphagnum</i>.</li> </ul> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>Pteridophytes: Classification, General account, Evolution of stelar systems, apospory, apogamy and seed habit. Outline of life cycle of <i>Selaginella</i>, <i>Equisetum</i> and <i>Marsilea</i>.</li> </ul> <p><b>Unit 5</b></p> <ul style="list-style-type: none"> <li>Gymnosperms: Classification and Evolution, Distribution with special reference to Indian Gymnosperms. Special features in life cycle of <i>Cycas</i>, <i>Pinus</i> and <i>Ephedra</i>. Economic importance</li> </ul> <p><b>Books Recommended:</b></p> <ul style="list-style-type: none"> <li>➤ College Botany Vol. II: Ganguli.</li> <li>➤ A Text Book of Botany Vol. I &amp; II: Saxena &amp; Sarabhai, Ratan Prakash Mandir, Agra.</li> <li>➤ Text Book of Fungi: J.S.Gupta, Oxford &amp; IBH, New Delhi.</li> <li>➤ Introduction to Fungi: J. Webster, Cambridge University Press and McMillan, New York</li> </ul> | <p><b>Unit 1</b></p> <ul style="list-style-type: none"> <li>Algae: Classification, general account with special reference to <i>Anabaena</i>, <i>Oscillatoria</i>, <i>Volvox</i>, <i>Chara</i>, <i>Oedogonium</i>, <i>Ectocarpus</i>, <i>Polysiphonia</i>. Economic importance of algae.</li> </ul> <p><b>Unit 2</b></p> <ul style="list-style-type: none"> <li>Fungi: Classification, general account with special reference to <i>Albugo</i>, <i>Aspergillus</i>, <i>Puccinia</i>, <i>Ustilago</i> and <i>Alternaria</i>. Economic importance of fungi.</li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>Bryophytes: Classification, general account with special reference to important features in the life cycles of <i>Riccia</i>, <i>Marchantia</i>, <i>Anthoceros</i> and Mosses: <i>Funaria</i>, <i>Sphagnum</i>.</li> </ul> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>Pteridophytes: Classification, general account, evolution of stelar systems, apospory, apogamy and seed habit. Outline of life cycle of <i>Selaginella</i>, <i>Equisetum</i> and <i>Marsilea</i>.</li> </ul> <p><b>Unit 5</b></p> <ul style="list-style-type: none"> <li>Gymnosperms: Classification and evolution, distribution with special reference to Indian gymnosperms. Special features in life cycle of <i>Cycas</i>, <i>Pinus</i> and <i>Ephedra</i>. Economic importance.</li> </ul> <p><b>Suggested Books:</b></p> <ul style="list-style-type: none"> <li>➤ Alam, A. (2015). <i>Text book of Bryophyta</i>. New Delhi: I K International Publishers.</li> <li>➤ Alexopoulos, C. (1979). <i>Introductory Mycology</i>. New York: John Wiley &amp; Sons.</li> <li>➤ Bhatia, K. (1975). <i>A Treatise on Algae</i>. New Delhi: S. Chand &amp; Company.</li> <li>➤ Biswas, C., &amp; Johri, B.M. (2010). <i>Gymnosperm</i>.</li> </ul> |         |

| S No. | Course List | Learning Outcomes | Existing Syllabus   | Suggested Syllabus   | Remarks |
|-------|-------------|-------------------|---|--|---------|
|       |             |                   | <ul style="list-style-type: none"> <li>➤ Bryophyta &amp; Pteridophyta: N.S. Parihar, Central Book Depot, Allahabad.</li> <li>➤ Introductory Mycology: C.M Alexopoulos, John Wiley &amp; Sons, New York.</li> <li>➤ Introduction to Fungi: H.C. Dubey, Vikas Publishing House.</li> <li>➤ Bryophyta: B.R. Vashistha, S. Chand Publication, New Delhi.</li> <li>➤ Pteridophyta: P.C. Vashistha, S. Chand Publication, New Delhi.</li> <li>➤ Morphology of Pteridophytes: K.R. Sporne. B.I. Publications, New Delhi.</li> <li>➤ Botany (For degree students) – Part III Bryophyta: B.R. Vashishtha., S. Chand &amp; Co. Ltd., New Delhi.</li> <li>➤ A Treatise on Algae: K.N. Bhatia, S. Chand &amp; Company, New Delhi.</li> <li>➤ Algae: V. J. Chapman and D. J. Chapman, The English language Book Society.</li> <li>➤ Introductory Phycology: H.D. Kumar, Affiliated East-West, New Delhi.</li> <li>➤ An Introduction to Pteridophyta: A. Rashid, Vikas, New Delhi</li> <li>➤ Introduction to Gymnosperms: S.C. Dutta, Asia, Bombay.</li> <li>➤ Gymnosperms: P.C. Vashistha, S. Chand and Company, New Delhi.</li> <li>➤ Morphology of Gymnosperms: J.M. Coulter and C.J. Chamberlian, Central Book Depot, Allahabad.</li> <li>➤ Text Book of Gymnosperm, G.L. Chopra.</li> <li>➤ University Botany I, S.M. Reddy, New Age Publisher.</li> </ul> | <p>Springer-Verlag Berlin and Heidelberg GmbH &amp; Co. KG</p> <ul style="list-style-type: none"> <li>➤ Chamberlian, C. J. (1919). <i>Morphology of Gymnosperms</i>. Allahabad: Central Book Depot.</li> <li>➤ Chapman, V.J. (2013). <i>An Introduction to the Study of Algae</i>. UK: Cambridge University Press.</li> <li>➤ Dubey, H.C. (2011). <i>Introduction to Fungi</i>. India: Vikas Publishing House.</li> <li>➤ Dutta, S.C. (1967). <i>Introduction to Gymnosperms</i>. Asia Publishing House.</li> <li>➤ Ganguli, H.C., Das, K.S., Dutta C. (2011). <i>College Botany</i> Vol. I. India: New Central Book Agency.</li> <li>➤ Kumar, H.D. (1999). <i>Introductory Phycology</i>. New Delhi: Affiliated East-West.</li> <li>➤ Parihar, N.S. (1956). <i>Bryophyta Pteridophyta</i>. Allahabad: Central Book Depot.</li> <li>➤ Rashid, A. (1999). <i>An Introduction to Pteridophyta</i>. New Delhi: Vikas publications.</li> <li>➤ Saxena, S. (2000). <i>A text book of Botany</i> (Vol. I &amp; II). Agra: Ratan Prakash Mandir.</li> <li>➤ Sharma, O.P., &amp; Gupta, R.C. (2010). <i>Text Book of Fungi</i>. IBH. New Delhi, India: Vedams eBooks (P) Ltd.</li> <li>➤ Sporne, K.R. (1966). <i>Morphology of Pteridophytes</i>. London: Hutchinson University Library.</li> <li>➤ Vashistha, B.R., &amp; Sinha, A.K. (2010). <i>Botany for Degree Students-Algae</i>. New Delhi: S. Chand Publication.</li> <li>➤ Vashistha, B.R., &amp; Sinha, A.K. (2016). <i>Botany for Degree Students-Fungi</i>. New Delhi: S. Chand Publication.</li> <li>➤ Vashistha, B.R., Sinha, A.K., &amp; Kumar, A. (1987). <i>Botany for Degree classes- Gymnosperms</i>. New Delhi: S. Chand Publication.</li> <li>➤ Vashistha, B.R., Sinha, A.K., &amp; Kumar, A. (2010). <i>Botany for Degree Students-Bryophyta</i>. New Delhi: S.</li> </ul> |         |

| S No. | Course List   | Learning Outcomes   | Existing Syllabus  | Suggested Syllabus   | Remarks |
|-------|---|---|--|--|---------|
|       |   |   |  | Chand Publication.<br>➤ Vashisthai, B.R., & Vashistha, P.C. (1987). <i>Botany for Degree Students Pteridophyta</i> . New Delhi: S. Chand Publication.<br>➤ Webster, J., & Weber, R. (2007). <i>Introduction to Fungi</i> . Cambridge University Press, New York Press.<br><b>Suggested e-Resources:</b><br>➤ <b>Bryophytes: General account, classification and structure</b><br><a href="http://nsdl.niscair.res.in/jspui/bitstream/123456789/150/1/BRYOPHYTES%20.pdf">http://nsdl.niscair.res.in/jspui/bitstream/123456789/150/1/BRYOPHYTES%20.pdf</a><br>➤ <b>Gymnosperms</b><br><a href="http://www.plb.ucdavis.edu/courses/bis/1c/text/Chapter24nf.pdf">http://www.plb.ucdavis.edu/courses/bis/1c/text/Chapter24nf.pdf</a><br>➤ <b>Pteridophytes</b><br><a href="http://nsdl.niscair.res.in/jspui/bitstream/123456789/556/1/PTERIDOPHYTES%20april609%20-%20formatted.pdf">http://nsdl.niscair.res.in/jspui/bitstream/123456789/556/1/PTERIDOPHYTES%20april609%20-%20formatted.pdf</a> |         |
| 2.    | <b>BOT 101L:</b><br>Algae, Fungi, Bryophyta, Pteridophyta and Gymnosperms Lab | On completion of the course students will be able to:<br>• Identify bryophyte and pteridophyte material for specimens of lower group of plants.<br>• Interpret the characteristics & life cycles of various lower plants.<br>• Learn about practical technique in lab for detail study of plant | 1. Study of Algae and Fungi as mentioned in the syllabus (museum specimen of the affected plants and permanent prepared slides).<br>2. Study of vegetative and reproductive parts in <i>Selaginella</i> , <i>Equisetum</i> and <i>Marsilea</i> .<br>3. Study of vegetative and reproductive parts in <i>Riccia</i> , <i>Marchantia</i> , <i>Anthoceros</i> and <i>Funaria</i> .<br>4. Gymnosperms: study of <i>Cycas</i> (coralloid root, rachis, leaflet, male cone, megasporophyll), <i>Pinus</i> (needle, dwarf shoot, long shoot, male cone, female cone), <i>Ephedra</i> (morphology, stem, male cone, female cone) | 1. Study of algae and fungi as mentioned in the syllabus (museum specimen of the affected plants and permanent prepared slides).<br>2. Study of vegetative and reproductive parts in <i>Selaginella</i> , <i>Equisetum</i> and <i>Marsilea</i> .<br>3. Study of vegetative and reproductive parts in <i>Riccia</i> , <i>Marchantia</i> , <i>Anthoceros</i> and <i>Funaria</i> by the preparation of temporary slides.<br>4. Gymnosperms: Study of <i>Cycas</i> (coralloid root, rachis, leaflet, male cone, megasporophyll), <i>Pinus</i> (needle, dwarf shoot, long shoot, male cone, female cone) <i>Ephedra</i> (morphology, stem, male cone, female cone) by the preparation of temporary slides.<br><b>Suggested Books:</b><br>➤ Bendre, A., & Kumar, A. (2009). <i>A Textbook of Practical Botany- I</i> . Meerut: Rastogi Publications.   |         |

| S No. | Course List                                  | Learning Outcomes  | Existing Syllabus   | Suggested Syllabus   | Remarks |
|-------|--|--|---|--|---------|
|       |  | structure and anatomy, reproduction.   |   |  |         |
| 3.    | <b>BT102:</b> Cell and Molecular Biology - I | <p>On completion of the course, students will be able to:</p> <ul style="list-style-type: none"> <li>Gain expertise in the ultra structural information of cell besides the detailed views of the cell interior.</li> <li>Understand the complex molecular mechanisms occurring in the cell.</li> <li>Describe types, structural organization and packaging of chromosomes.</li> </ul> | <p><b>Unit 1</b></p> <ul style="list-style-type: none"> <li>General introduction to the science of Biotechnology, Cell Biology, Molecular Biology and their scope.</li> <li>Structural and functional organization of prokaryotic and eukaryotic cell, difference between prokaryotic and eukaryotic cell.</li> <li>Molecular structure of cell wall and plasma membrane.</li> <li>Ultrastructural organization of cilia, flagella and basal bodies.</li> <li>Basic idea of different types of cell junctions.</li> </ul> <p><b>Unit 2</b></p> <ul style="list-style-type: none"> <li>Transport across cell membrane: active and passive transport.</li> <li>Role of extra cellular signals in cellular metabolism.</li> <li>Basic concept of receptors that mediate the response to extra cellular signals.</li> <li>Basic concept of signal transduction (inositol lipid pathway and adenylate cyclase pathway).</li> <li>Cell division and cell cycle.</li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>A study of ultrastructural organization and functions of eukaryotic cell organelles:</li> <li>Mitochondria.</li> <li>Chloroplast.</li> <li>Endoplasmic reticulum.</li> <li>Golgi complex.</li> <li>Lysosomes.</li> <li>Peroxisomes.</li> </ul> | <p><b>Unit 1</b></p> <ul style="list-style-type: none"> <li>General introduction to the science of biotechnology, cell biology, molecular biology and their scope.</li> <li>Structural and functional organization of prokaryotic and eukaryotic cell, difference between prokaryotic and eukaryotic cell.</li> <li>Molecular structure of cell wall and plasma membrane of eukaryotic cell.</li> <li>Ultrastructural organization of cilia, flagella and basal bodies.</li> <li>Basic idea of different types of cell junctions.</li> </ul> <p><b>Unit 2</b></p> <ul style="list-style-type: none"> <li>Transport across cell membrane: Passive transport (simple &amp; facilitated diffusion) and active transport (primary &amp; secondary).</li> <li>Role of extra cellular signals in cellular metabolism.</li> <li>Basic concept of receptors (GPCR, receptor tyrosine kinase and intracellular receptors) that mediate the response to extra cellular signals.</li> <li>Basic concept of signal transduction (adenylate cyclase pathway and inositol lipid pathway).</li> <li>Cell division, cell cycle &amp; its regulation.</li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>A study of ultrastructural organization and functions of eukaryotic cell organelles: <ul style="list-style-type: none"> <li>Mitochondria.</li> <li>Chloroplast.</li> <li>Endoplasmic reticulum.</li> <li>Golgi complex.</li> <li>Lysosomes.</li> <li>Peroxisomes.</li> </ul> </li> </ul> |         |



| S No. | Course List | Learning Outcomes | Existing Syllabus  | Suggested Syllabus   | Remarks |
|-------|-------------|-------------------|--|--|---------|
|       |             |                   | <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>• Ultrastructural organization of nucleus and nucleolus.</li> <li>• Structural organization of chromosomes including lampbrush and polytene chromosomes.</li> <li>• Molecular structure and types of DNA, denaturation and renaturation, T<sub>m</sub> value.</li> <li>• Molecular structure and types of RNA.</li> <li>• <del>Replication of genetic material.</del></li> </ul> <p><b>Unit 5</b></p> <ul style="list-style-type: none"> <li>• Mechanism of transcription in prokaryotes.</li> <li>• Mechanism of transcription in eukaryotes, RNA processing.</li> <li>• Genetic code.</li> <li>• Translation in prokaryotes.</li> <li>• Difference between translation of eukaryotes and prokaryotes.</li> </ul> <p><b>Books recommended:</b></p> <ul style="list-style-type: none"> <li>➤ The world of cell: W.M. Backer, Pearson Education.</li> <li>➤ Gene VIII: Lewin, Pearson Education.</li> <li>➤ Cell and Molecular Biology: De Robertis &amp; De Robertis, B.I. Waverly Pvt. Ltd., New Delhi.</li> <li>➤ Cell and Molecular Biology: P.K. Gupta, Rastogi Publications, Meerut.</li> <li>➤ Molecular Cell Biology: Lodish, Baltimore, W. H. Freeman &amp; Co.</li> <li>➤ Essentials of Cytology: C.B. Powar, Himalaya Publications.</li> <li>➤ Cytology: V.B. Rastogi, Kedarnath and Ramnath, Meerut.</li> <li>➤ Concepts of Genetics 7th Ed.: William S. Klug, Pearson Education.</li> <li>➤ Principles of Genetics: R.H. Tamarin, Tata McGraw</li> </ul> | <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>• Ultrastructural organization of nucleus and nucleolus.</li> <li>• Structural organization of chromosomes including lampbrush and polytene chromosomes. DNA packaging into chromosomes.</li> <li>• Types of chromosomes based on number and position of centromere. Karyotype.</li> <li>• Molecular structure and types of DNA, denaturation and renaturation, T<sub>m</sub> value.</li> <li>• Molecular structure and types of RNA.</li> <li>• DNA replication in prokaryotes and eukaryotes.</li> </ul> <p><b>Unit 5</b></p> <ul style="list-style-type: none"> <li>• Mechanism of transcription in prokaryotes.</li> <li>• Mechanism of transcription in eukaryotes, RNA processing.</li> <li>• Genetic code.</li> <li>• Mechanism of translation in prokaryotes and eukaryotes.</li> <li>• Difference between translation of prokaryotes and eukaryotes.</li> </ul> <p><b>Suggested Books:</b></p> <ul style="list-style-type: none"> <li>➤ De Robertis, E.D.P., De Robertis, E.M.F. (1987). <i>Cell and Molecular Biology</i> (8<sup>th</sup> ed.). USA: Lea &amp; Febiger.</li> <li>➤ Gupta, P.K. (2005). <i>Cell and Molecular Biology</i>. Meerut: Rastogi Publications.</li> <li>➤ Hardin, J., Bertoni, G.P. (2016). <i>Becker's World of the Cell</i> (9<sup>th</sup> ed.). USA: Pearson education.</li> <li>➤ Klug, W.S., Cummings, M.R., Spencer, C.A., Palladino, M.A., Killian, D. (2018). <i>Concepts of Genetics</i> (12<sup>th</sup> ed.). USA: Pearson.</li> <li>➤ Krebs, J.E., Goldstein, E.S., Kilpatrick, S.T. (2012). <i>Lewin's Genes XI</i> (11<sup>th</sup> ed.). USA: Jones and Bartlett Publishers.</li> <li>➤ Lodish, H., Berk, A. Kaiser, C.A., Krieger, M. Scott, M.P. (2007). <i>Molecular Cell Biology</i> (6<sup>th</sup> ed.). USA: W H Freeman.</li> </ul> |         |

| S No. | Course List | Learning Outcomes | Existing Syllabus   | Suggested Syllabus  | Remarks |
|-------|-------------|-------------------|---|---|---------|
|       |             |                   | Hill.<br>➤ Principles of Genetics: Gardner, Simmons, Snustad, John Wiley & Sons.<br>➤ Molecular Biology: David Freifelder, Narosa Publishing House, New Delhi<br>➤ Molecular Biology: R. Weaver, WCB Mc Graw Hill.<br>➤ Cell Biology, Genetics, Molecular Biology, Ecology and Evolution: Verma and Aggarwal, S. Chand & Co.<br>➤ Fundamentals of Molecular Biology. Veer Bala Rastogi, Ane Books, India.<br>➤ Biotechnology, B.D. Singh, Kalyani Publishers. | ➤ Malacinski, G.M. (2015). <i>Freifelders Essentials of Molecular Biology</i> (4 <sup>th</sup> ed.). USA: Jones & Bartlett.<br>➤ Paul, A. (2011). <i>Textbook of Cell &amp; Molecular Biology</i> . Kolkata: Books & Allied Ltd.<br>➤ Powar, C.B. (2014). <i>Essentials of Cytology</i> . Mumbai: Himalaya Publishing House.<br>➤ Rastogi, V.B. (2010). <i>Fundamental of Molecular Biology</i> . New Delhi: ANE Books.<br>➤ Rastogi, V.B. (2016). <i>Introductory Cytology – Knrn</i> . Meerut: Kedar Nath Ram Nath Publishers.<br>➤ Singh, B.D. (2015). <i>Biotechnology</i> . New Delhi: Kalyani Publishers.<br>➤ Tamarin, R.H. (2004). <i>Principles of Genetics</i> (7 <sup>th</sup> ed.). USA: McGraw-Hill Higher Education.<br>➤ Verma, P.S., Agarwal, V.K. (2004). <i>Cell Biology, Genetics, Molecular Biology, Evolution &amp; Ecology</i> . New Delhi: S. Chand Publisher.<br>➤ Weaver, R.F. (2011). <i>Molecular Biology</i> (5 <sup>th</sup> ed.). USA: McGraw-Hill Education.<br><b>Suggested e-Resources:</b><br>➤ <b>Cell organelles</b><br><a href="https://www.khanacademy.org/test-prep/mcat/cells/eukaryotic-cells/a/organelles-article">https://www.khanacademy.org/test-prep/mcat/cells/eukaryotic-cells/a/organelles-article</a><br><a href="https://www.ncbi.nlm.nih.gov/books/NBK21743/">https://www.ncbi.nlm.nih.gov/books/NBK21743/</a><br>➤ <b>DNA packaging</b><br><a href="https://www.nature.com/scitable/topicpage/dna-packaging-nucleosomes-and-chromatin-310">https://www.nature.com/scitable/topicpage/dna-packaging-nucleosomes-and-chromatin-310</a><br>➤ <b>Replication, transcription, translation</b><br><a href="https://www.atdbio.com/content/14/Transcription-Translation-and-Replication">https://www.atdbio.com/content/14/Transcription-Translation-and-Replication</a><br>➤ <b>Signal transduction pathway</b><br><a href="https://www.ncbi.nlm.nih.gov/books/NBK9870/">https://www.ncbi.nlm.nih.gov/books/NBK9870/</a><br>➤ <b>Cell biology</b><br><a href="https://nptel.ac.in/courses/102103012/6">https://nptel.ac.in/courses/102103012/6</a><br>➤ <b>Cell biology &amp; organelles</b> |         |

| S No.                                  | Course List   | Learning Outcomes  | Existing Syllabus  | Suggested Syllabus   | Remarks |
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|  |   |  |  | <a href="https://www.nicholls.edu/biol-ds/biol155/Lectures/Cell%20Biology.pdf">https://www.nicholls.edu/biol-ds/biol155/Lectures/Cell%20Biology.pdf</a><br>➤ <b>Molecular cell biology</b><br><a href="https://nptel.ac.in/courses/102106025/">https://nptel.ac.in/courses/102106025/</a><br><a href="https://nptel.ac.in/courses/122103039/22">https://nptel.ac.in/courses/122103039/22</a>   |         |
| 4.                                     | <b>BT 102L:</b><br>Cell and Molecular Biology - I Lab               | On completion of the course, students will be able to: <ul style="list-style-type: none"> <li>• Understand the basics of cell structure and transport mechanism.</li> <li>• Gain knowledge about isolation and estimation of nucleic acid from cell.</li> <li>• Perform analysis of chromosomes and types of cell division.</li> </ul> | <ol style="list-style-type: none"> <li>1. To examine the phenomenon of cell permeability using hypotonic, isotonic and hypertonic solutions.</li> <li>2. Preparation of salivary gland chromosomes.</li> <li>3. Study and preparation of various stages of mitosis and meiosis and to find out mitotic index.</li> <li>4. Study of cell organelles with the aid of slides available in the lab.</li> <li>5. Find out the O.D. of the samples provided with the aid of colorimeter/spectrophotometer (Preparation of standard curve).</li> <li>6. Cell counting (RBC) using Hemocytometer.</li> <li>7. Measurement of cell size using ocular micrometer.</li> <li>8. Colorimetric estimation of DNA.</li> <li>9. Preparation of permanent slides by some commonly used method of double staining.</li> <li>10. To determine the <math>\lambda_{max}</math> for given DNA sample.</li> </ol> | <ol style="list-style-type: none"> <li>1. Organization and working of optical microscope: Dissecting and compound microscopes.</li> <li>2. To examine the phenomenon of cell permeability using hypotonic, isotonic and hypertonic solutions.</li> <li>3. Study of salivary gland chromosomes.</li> <li>4. Preparation of various stages of mitosis and meiosis.</li> <li>5. Cell counting (RBC) using hemocytometer.</li> <li>6. Calibration of microscope using stage and ocular micrometer with the help of camera lucida.</li> <li>7. Determination of DNA content by DPA method.</li> <li>8. To determine the <math>\lambda_{max}</math> for given DNA sample.</li> <li>9. Double staining of <i>Calotropis</i> sp. stem, leaf material.</li> <li>10. To observe cyclosis through temporary mount of a plant cell.</li> <li>11. Preparation and precipitation of casein from buffalo milk.</li> </ol> <p><b>Suggested Books:</b></p> <ul style="list-style-type: none"> <li>➤ Ghose, K., &amp; Manna, B. (2016). <i>Practical Zoology</i> (4<sup>th</sup> ed.). Kolkata: New Central Book Agency.</li> <li>➤ Lal, S.S. (2016). <i>A Textbook of Practical Zoology Vol-III</i> (2<sup>nd</sup> ed.). Meerut: Rastogi Publication.</li> </ul> |         |
| <b>B.Sc. Biotechnology II Semester</b> |   |  |  |  |         |
| 5.                                     | <b>BT 101:</b><br>Biostatistics, Bioinformatics and Instrumentation | On completion of the course, students will be able to: <ul style="list-style-type: none"> <li>• Gain fundamental knowledge of biostatistics including</li> </ul>   | <b>Unit 1</b> <ul style="list-style-type: none"> <li>• Introduction to Biostatistics and its scope.</li> <li>• Sampling techniques.</li> <li>• Collection of data, frequency distribution, tabulation, graphical representation of data by histogram, frequency polygon, frequency curve and cumulative frequency curve.</li> </ul>  | <b>Unit 1</b> <ul style="list-style-type: none"> <li>• Introduction to biostatistics and its scope.</li> <li>• Sampling techniques.</li> <li>• Collection of data, frequency distribution, tabulation, graphical representation of data by histogram, frequency polygon, frequency curve and cumulative frequency curve.</li> </ul>  |         |

| S No. | Course List | Learning Outcomes   | Existing Syllabus  | Suggested Syllabus  | Remarks |
|-------|-------------|---|--|---|---------|
|       |             | <p>sampling, data collection, measures of central tendency and dispersion.</p> <ul style="list-style-type: none"> <li>Gain introductory knowledge of bioinformatics including biological databases, protein structure prediction and phylogenetic analysis.</li> <li>Understand the working principle and applications of various analytical instruments to explore biological activities.</li> </ul> | <ul style="list-style-type: none"> <li>Measures of central tendency: Mean, Median, Mode.</li> </ul> <p><b>Unit 2</b></p> <ul style="list-style-type: none"> <li>Measures of dispersion: Mean Deviation, Standard Deviation and Variance.</li> <li>Correlation and regression analysis.</li> <li>Law of Probability, concept and calculation.</li> <li>Introduction to computer, its evolution, different generation, classification and characteristics.</li> <li>Basic components and their functions: Hardware, various input and output devices, concept of CD-ROM, Software.</li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>Internal representation of data: Bits and bytes, binary, decimal, octal and hexadecimal system.</li> <li>Introduction and applications of programming languages.</li> <li>Elementary idea of development of computer programme.</li> <li>Concept of Internet, Networking, Websites, e-mail.</li> <li>Introduction to Bioinformatics, Biological databases.</li> <li>Scope of Bioinformatics, Bioinformatics centres in India.</li> </ul> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>Principle, working and applications of: <ul style="list-style-type: none"> <li>Balance (Electrical and Electronic)</li> <li>pH meter (with the example of glass electrode)</li> </ul> </li> <li>Colorimeter and Spectrophotometer (UV-VIS) and fluorimetry.</li> <li>Microscopy (Compound, Phase Contrast and Electron)</li> </ul> <p><b>Unit 5</b></p> <ul style="list-style-type: none"> <li>Principle, working and applications of Centrifuge</li> <li>Chromatography: Paper, TLC, brief idea about different</li> </ul> | <ul style="list-style-type: none"> <li>Measures of central tendency: Mean, median, mode.</li> <li>Measures of dispersion: Mean deviation, standard deviation and variance.</li> </ul> <p><b>Unit 2</b></p> <ul style="list-style-type: none"> <li>Correlation and regression analysis.</li> <li>Law of probability, concept and calculation.</li> <li>Introduction to computers; hardware and software.</li> <li>Data representation</li> <li>Number systems; binary, octal, decimal and hexadecimal.</li> <li>Computer programming; Algorithm and flowchart.</li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>Introduction and scope of bioinformatics</li> <li>Introduction to biological database.</li> <li>Databases at NCBI; nucleotide, gene protein, MMDB, Pubmed and Bookshelf.</li> <li>Introduction to sequence alignment; dot plot method.</li> <li>Concept of phylogenetics tree; sequence analysis based phylogenetics.</li> </ul> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>Introduction to protein secondary structure prediction; Chou-Fasman method.</li> <li>A brief introduction to computational drug design.</li> <li>Working principle and applications of: <ul style="list-style-type: none"> <li>Colorimeter and spectrophotometer (UV-VIS) and fluorimetry.</li> <li>Microscopy (compound, phase contrast and electron).</li> </ul> </li> </ul> <p><b>Unit 5</b></p> <ul style="list-style-type: none"> <li>Working principle and applications of: <ul style="list-style-type: none"> <li>Centrifuge.</li> </ul> </li> </ul> |         |

| S No. | Course List | Learning Outcomes | Existing Syllabus   | Suggested Syllabus   | Remarks |
|-------|-------------|-------------------|---|--|---------|
|       |             |                   | <p>types of columns. Electrophoresis: Paper, PAGE, Agarose gel.</p> <p><b>Books Recommended:</b></p> <ul style="list-style-type: none"> <li>➤ Introduction to Bioinformatics: T.K. Attwood, Pearson Education.</li> <li>➤ Fundamentals of Computers: P.K. Sinha, New Delhi, BPB Publication.</li> <li>➤ Statistical Methods: S.P. Gupta, S. Chand &amp; Company, New Delhi.</li> <li>➤ Practical Biochemistry: Keith Wilson and John Walker, Cambridge University Press.</li> <li>➤ At the Bench of laboratory Navigator: Kathy Barker, I.K. International.</li> <li>➤ Biotechniques: S.V.S. Rana, Rastogi Publications, Meerut.</li> <li>➤ Physical Biochemistry: David Friefelder, New York: W.H. Freeman, C 1982.</li> <li>➤ Instrumental Methods of Chemical Analysis: Chatwal and Anand, Himalaya Publishing House.</li> <li>➤ Instrumental Methods of Chemical Analysis: B.K. Sharma, Goel Publishing House.</li> <li>➤ Text Book of Bioinformatics, Sharma, Munjal and Shankar, Rastogi Publications.</li> </ul> | <p>- Chromatography: Paper, TLC, brief idea about different types of columns.</p> <p>- Electrophoresis: Paper, PAGE (native and SDS), agarose gel.</p> <p><b>Suggested Books:</b></p> <ul style="list-style-type: none"> <li>➤ Attwood, T. (2007). <i>Introduction to Bioinformatics</i>. USA: Pearson Education.</li> <li>➤ Barker, K. (2004). <i>At the Helm: A Laboratory Navigator</i>. New Delhi: I K International Publishing House.</li> <li>➤ Bhuyan, K.C. (2017). <i>Advanced Biostatistics</i>. Kolkata: New Central Book Agency.</li> <li>➤ Chatwal, G.R., Anand, S. (2011). <i>Instrumental Methods of Chemical Analysis</i>. Mumbai: Himalaya Publishing House.</li> <li>➤ Datta, A.K. (2014). <i>Basic Biostatistics and Application</i>. Kolkata: New Central Book Agency.</li> <li>➤ Friefelder, D.M. (1983). <i>Physical Biochemistry: Applications to Biochemistry and Molecular Biology</i>. USA: W. H. Freeman.</li> <li>➤ Gupta, S.P. (2018). <i>Statistical Methods</i> (45<sup>th</sup> ed.). New Delhi: Sultan Chand &amp; Sons.</li> <li>➤ Pandey, M. (2015). <i>Biostatistics: Basic and Advanced</i>. New Delhi: MV Learning.</li> <li>➤ Rana, S.V.S. (2012). <i>Biotechniques: Theory &amp; Practice</i> (3<sup>rd</sup> ed.). Meerut: Rastogi Publications.</li> <li>➤ Rao, P.H., &amp; Janardhan, K. (2014). <i>Fundamentals of Biostatistics</i>. New Delhi: I. K. International Publishing House.</li> <li>➤ Rastogi, S.C., Mendiratta, N., &amp; Rastogi, P. (2018). <i>Bioinformatics: Concepts, Skills &amp; Applications</i> (2<sup>nd</sup> ed.). New Delhi: CBS Publishers &amp; Distributors.</li> <li>➤ Sharma, B.K. (2011). <i>Instrumental Methods of Chemical Analysis</i>. Mumbai: Meerut: Goel Publishing House.</li> </ul> |         |

| S No. | Course List  | Learning Outcomes  | Existing Syllabus  | Suggested Syllabus   | Remarks |
|-------|--|--|--|--|---------|
|       |  |  |  | <ul style="list-style-type: none"> <li>➤ Sharma, V., Munjal, A., &amp; Shanker, A. (2008). <i>A Text Book of Bioinformatics</i>. Meerut: Rastogi Publications.</li> <li>➤ Sinha, P.K., &amp; Sinha, P. (2004). <i>Computer Fundamentals</i> (6<sup>th</sup> ed.). New Delhi: BPB Publications.</li> <li>➤ Walker, J.M., &amp; Wilson, K. (2000). <i>Practical Biochemistry Principles and Techniques</i> (5<sup>th</sup> ed.). New Delhi: Cambridge University Press.</li> </ul> <p><b>Suggested e-Resources:</b></p> <ul style="list-style-type: none"> <li>➤ <b>Analytical techniques</b><br/> <a href="https://nptel.ac.in/courses/102107028/">https://nptel.ac.in/courses/102107028/</a><br/> <a href="http://www.tulane.edu/~wiser/methods/notes.pdf">http://www.tulane.edu/~wiser/methods/notes.pdf</a></li> <li>➤ <b>Basic bioinformatics</b><br/> <a href="https://courses.cs.ut.ee/MTAT.03.242/2017_fall/uploads/Main/Basics_of_Bioinformatics.pdf">https://courses.cs.ut.ee/MTAT.03.242/2017_fall/uploads/Main/Basics_of_Bioinformatics.pdf</a></li> <li>➤ <b>Analytical techniques &amp; bioinformatics</b><br/> <a href="https://nptel.ac.in/courses/102103044/38">https://nptel.ac.in/courses/102103044/38</a></li> <li>➤ <b>Biostatistics</b><br/> <a href="https://nptel.ac.in/courses/102106051/">https://nptel.ac.in/courses/102106051/</a><br/> <a href="https://nptel.ac.in/courses/102101056/">https://nptel.ac.in/courses/102101056/</a></li> <li>➤ <b>Measures of central tendency</b><br/> <a href="https://www.tutorialspoint.com/statistics/arithmetc_mean.htm">https://www.tutorialspoint.com/statistics/arithmetc_mean.htm</a></li> </ul> |         |
| 6.    | <b>BT 101L:</b><br>Biostatistics,<br>Bioinformatics<br>and<br>Instrumentation<br>Lab | On completion of the course, students will be able to:<br><ul style="list-style-type: none"> <li>• Separate the obtained biological data and make valid inferences that can be used to solve problems in various disciplines of science and technology.</li> <li>• Learn sequence</li> </ul> | <ol style="list-style-type: none"> <li>1. Demonstration including working, principle and applications of the following instruments: <ol style="list-style-type: none"> <li>i. pH meter</li> <li>ii. Balance</li> <li>iii. Centrifuge</li> <li>iv. Autoclave</li> <li>v. Different types of Microscopes</li> <li>vi. Incubator and Oven</li> <li>vii. Shaker</li> <li>viii. Spectrophotometer/Colorimeter</li> <li>ix. <del>Computer (Hardware)</del></li> </ol> </li> <li>2. Statistical problem</li> <li>3. Bioinformatics exercise: <del>Inter conversion of values</del></li> </ol> | <ol style="list-style-type: none"> <li>1. Demonstration including working principle and applications of the following instruments: <ol style="list-style-type: none"> <li>i. pH meter</li> <li>ii. Balance</li> <li>iii. Centrifuge</li> <li>iv. Autoclave</li> <li>v. Different types of microscopes</li> <li>vi. Incubator and oven</li> <li>vii. Shaker</li> <li>viii. Spectrophotometer/Colorimeter</li> <li>ix. Server</li> </ol> </li> <li>2. Statistical problems (exercise on mean, mode, median, standard deviation, standard error).</li> </ol>  |         |

| S No. | Course List  | Learning Outcomes  | Existing Syllabus  | Suggested Syllabus  | Remarks |
|-------|--|--|--|---|---------|
|       |  | <p>analysis and molecular visualization using bioinformatics tools.</p> <ul style="list-style-type: none"> <li>• Safety measures in laboratory, handling and care of instruments.</li> </ul>                               | <p><del>in various number systems.</del></p> <ol style="list-style-type: none"> <li>4. Preparation of solutions of different of molarities. Concept of buffers- preparations of few buffers e.g. Tris (alkaline range), acetate/ citrate (acidic range).</li> <li>5. To determine the pH of five aliquots of the given sample and plot a graph of the same.</li> <li><del>6. To prepare a pellet from the sample provided by centrifugation technique.</del></li> <li>7. Separation of cell organelles using sucrose density gradient.</li> <li>8. Separation of amino acids by paper chromatography.</li> <li><del>9. Sterilization of glassware and surgical instruments.</del></li> <li><del>10. Demonstration of SDS-PAGE for separation of proteins.</del></li> </ol> | <ol style="list-style-type: none"> <li>3. Bioinformatics exercise: <ul style="list-style-type: none"> <li>• Dot plot; palindrome and repeat sequence identification.</li> <li>• Visualization of biomolecular structures; PyMol.</li> </ul> </li> <li>4. Preparation of solutions of different of molarities. Concept of buffers- preparations of few buffers e.g. Tris (alkaline range), acetate/ citrate (acidic range).</li> <li>5. To determine the pH of five aliquots of the given soil sample and plot a graph of the same.</li> <li>6. Separation of cell organelles using sucrose density gradient.</li> <li>7. Separation of amino acids by paper chromatography and thin layer chromatography.</li> <li>8. Demonstration of SDS-PAGE for separation of proteins.</li> <li>9. To prepare standard curve of ammonium sulfate.</li> </ol> <p><b>Suggested Books:</b></p> <ul style="list-style-type: none"> <li>➤ Boya, R.F. (2006). <i>Modern Experimental Biochemistry</i> (3<sup>rd</sup> ed.). Noida: Pearson Education.</li> <li>➤ Ghose, K., &amp; Manna, B. (2016). <i>Practical Zoology</i> (4<sup>th</sup> ed.). Kolkata: New Central Book Agency.</li> <li>➤ Lal, S.S. (2016). <i>A Textbook of Practical Zoology Vol-III</i> (2<sup>nd</sup> ed.). Meerut: Rastogi Publication.</li> <li>➤ Sharma, S., &amp; Sharma, R. (2016). <i>Practical Manual of Biochemistry</i> (2<sup>nd</sup> ed.). New Delhi: Medtech.</li> </ul> |         |
| 7.    | <b>ZOO 101:</b><br>Non-Chordates and Proto-Chordates | <p>On completion of the course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Describe the habit, habitat, morphology, structure and functions of important animals of different major</li> </ul> | <p><b>Unit 1</b><br/><b>Protozoa</b></p> <ul style="list-style-type: none"> <li>• Habitat, habits, external features, locomotion, osmoregulation, nutrition, reproduction and life cycle of <i>Euglena</i>, <i>Paramecium</i> and <i>Monocystis</i>.</li> <li>• Economic importance of protozoans.</li> </ul> <p><b>Porifera</b></p> <ul style="list-style-type: none"> <li>• Habitat, habits, structural organization, canal system, reproduction and development of <i>Sycon</i> including evolution of canal system in sponges.</li> </ul>  | <p><b>Unit 1</b><br/><b>Protozoa</b></p> <ul style="list-style-type: none"> <li>• Habitat, habits, external features, locomotion, osmoregulation, nutrition, reproduction and life cycle of <i>Euglena</i>, <i>Paramecium</i> and <i>Monocystis</i>.</li> <li>• Economic importance of protozoans.</li> </ul> <p><b>Porifera</b></p> <ul style="list-style-type: none"> <li>• Habitat, habits, structural organization, canal system, reproduction and development of <i>Sycon</i> including evolution of canal system in sponges.</li> </ul>   |         |

| S No. | Course List | Learning Outcomes  | Existing Syllabus   | Suggested Syllabus   | Remarks |
|-------|-------------|--|---|--|---------|
|       |             | <p>phyla of invertebrates and lower chordates.</p> <ul style="list-style-type: none"> <li>Understand the economic importance of various invertebrate phyla and affinities of lower chordate animals.</li> <li>Gain a high degree of competence in its field of specialization in response to the changing demands of the times.</li> </ul> | <ul style="list-style-type: none"> <li>Economic importance of sponges.</li> </ul> <p><b>Unit 2</b><br/><b>Coelenterata</b></p> <ul style="list-style-type: none"> <li>Habitat, habits, external features, nutrition, structural organization, reproduction and life cycle of <i>Obelia</i>.</li> <li>Corals and coral reefs.</li> </ul> <p><b>Helminthes</b></p> <ul style="list-style-type: none"> <li>Habitat, habits, external features, different systems and life history of following animal types: <i>Fasciola</i>, <i>Taenia</i> and <i>Ascaris</i>.</li> <li>Parasitic adaptations and diseases caused by helminthes.</li> </ul> <p><b>Unit 3</b><br/><b>Annelida</b></p> <ul style="list-style-type: none"> <li>Habitat, habits, external features, different systems and development of <i>Pheretima</i>.</li> <li>Salient features of <i>Neanthes</i>.</li> </ul> <p><b>Arthropoda</b></p> <ul style="list-style-type: none"> <li>Habitat, habits, external features and different systems of <i>Palaemone</i>.</li> <li>Economic importance of insecta.</li> </ul> <p><b>Unit 4</b><br/><b>Mollusca</b></p> <ul style="list-style-type: none"> <li>Habitat, habits, external features, various organs and organ systems of <i>Pila</i> and <i>Unio</i>; pearl formation.</li> <li>Economic importance of mollusca.</li> </ul> <p><b>Echinodermata</b></p> <ul style="list-style-type: none"> <li>Habitat, habits, external features and water-vascular system of <i>Asterias</i>.</li> <li>Larval forms of echinoderms.</li> </ul> <p><b>Hemichordata</b></p> <ul style="list-style-type: none"> <li>Habitat, habits, external features and different system of <i>Balanoglossus</i>.</li> <li>Affinities of hemichordates.</li> </ul> | <ul style="list-style-type: none"> <li>Economic importance of sponges.</li> </ul> <p><b>Unit 2</b><br/><b>Coelenterata</b></p> <ul style="list-style-type: none"> <li>Habitat, habits, external features, nutrition, structural organization, reproduction and life cycle of <i>Obelia</i>.</li> <li>Corals and coral reefs.</li> </ul> <p><b>Helminthes</b></p> <ul style="list-style-type: none"> <li>Habitat, habits, external features, different systems and life history of following animal types: <i>Fasciola</i>, <i>Taenia</i> and <i>Ascaris</i>.</li> <li>Parasitic adaptations and diseases caused by helminthes.</li> </ul> <p><b>Unit 3</b><br/><b>Annelida</b></p> <ul style="list-style-type: none"> <li>Habitat, habits, external features, different systems and development of <i>Pheretima</i>.</li> <li>Habitat, habits, external features and life history of <i>Neanthes</i>.</li> </ul> <p><b>Arthropoda</b></p> <ul style="list-style-type: none"> <li>Habitat, habits, external features and different systems of <i>Palaemone</i>.</li> <li>Economic importance of insecta.</li> </ul> <p><b>Unit 4</b><br/><b>Mollusca</b></p> <ul style="list-style-type: none"> <li>Habitat, habits, external features, various organs and organ systems of <i>Pila</i> and <i>Unio</i>; pearl formation.</li> <li>Economic importance of mollusca.</li> </ul> <p><b>Echinodermata</b></p> <ul style="list-style-type: none"> <li>Habitat, habits, external features and water-vascular system of <i>Asterias</i>.</li> <li>Larval forms of echinoderms.</li> </ul> <p><b>Hemichordata</b></p> <ul style="list-style-type: none"> <li>Habitat, habits, external features and different system of <i>Balanoglossus</i>.</li> <li>Affinities of hemichordates.</li> </ul> |         |



| S No. | Course List | Learning Outcomes | Existing Syllabus   | Suggested Syllabus  | Remarks |
|-------|-------------|-------------------|---|---|---------|
|       |             |                   | <p><b>Unit 5</b></p> <p><b>Urochordata</b></p> <ul style="list-style-type: none"> <li>Habitat, habits, structural organisation and various systems of <i>Herdmania</i>.</li> <li>Tadpole larva and retrogressive metamorphosis in <i>Herdmania</i>.</li> </ul> <p><b>Cephalochordata</b></p> <ul style="list-style-type: none"> <li>Habitat, habits, morphology, different systems and affinities of <i>Amphioxus</i>.</li> <li>Development of coelom and atrium of <i>Amphioxus</i>.</li> </ul> <p><b>Books recommended :</b></p> <ul style="list-style-type: none"> <li>➤ Invertebrates: R. L. Kotpal, Rastogi Publications, Meerut.</li> <li>➤ A text book of Zoology: S.N. Prasad, Allahabad, Kitab Mahal.</li> <li>➤ A text book of Zoology: H.C. Nigam Delhi, S.Nagin.</li> <li>➤ A text book of Zoology: P.S. Dhami, New Delhi, R. Chand.</li> <li>➤ A text book of Zoology: T.C. Majupuria, Jallundhur City, S. Nagin.</li> <li>➤ A text book of Zoology: V.B. Rastogi, Ram Nath Kedar Nath, Meerut.</li> <li>➤ Kotpal Series Vol. I to IX, Rastogi Publication, Meerut.</li> <li>➤ CNH Series Vol. I to IX.</li> <li>➤ Hymen Series Vol. I to IX, Mc Graw Hill.</li> </ul> | <p><b>Unit 5</b></p> <p><b>Urochordata</b></p> <ul style="list-style-type: none"> <li>Habitat, habits, structural organisation and various systems of <i>Herdmania</i>.</li> <li>Tadpole larva and retrogressive metamorphosis in <i>Herdmania</i>.</li> </ul> <p><b>Cephalochordata</b></p> <ul style="list-style-type: none"> <li>Habitat, habits, morphology, different systems and affinities of <i>Amphioxus</i>.</li> <li>Development of coelom and atrium of <i>Amphioxus</i>.</li> </ul> <p><b>Suggested Books:</b></p> <ul style="list-style-type: none"> <li>➤ Chaki, K.K., Kundu, G., &amp; Sarkar, S. (2014). <i>Introduction to Economic Zoology</i>. Kolkata: New Central Book Agency.</li> <li>➤ Chaki, K.K., Kundu, G., &amp; Sarkar, S. (2015). <i>Introduction to General Zoology</i> Vol-I. Kolkata: New Central Book Agency.</li> <li>➤ Dhami P.S., &amp; Dhami, J.K. (2015). <i>Invertebrate Zoology</i>. New Delhi: R. Chand and Co.</li> <li>➤ Hyman, L.H. <i>The Invertebrates</i>. Vol-I-IX. New York: McGraw Hill.</li> <li>➤ Jordan, E.L., &amp; Verma, P.S. (2018). <i>Invertebrate Zoology</i>. New Delhi: S. Chand &amp; Company Ltd.</li> <li>➤ Kotpal, R.L. (2014). <i>Modern Textbook of Zoology: Invertebrates</i> (11<sup>th</sup> ed.). Meerut: Rastogi Publications.</li> <li>➤ Kotpal, R.L. (2018). <i>Modern Text book of Zoology: Vertebrates</i> (4<sup>th</sup> ed.). Meerut: Rastogi Publications.</li> <li>➤ Lahiri, B.K. (2013). <i>College Zoology</i> Vol-I. Mumbai: Himalaya Publishing House.</li> <li>➤ Majupuria, T.C. (1962). <i>A textbook of invertebrate Zoology</i> (1<sup>st</sup> ed.). Jullundur City: S. Nagin Publishers.</li> <li>➤ Nigam, H.C. (2013). <i>Biology of Non-Chordates</i>. New Delhi: Vishal Publishing Co.</li> <li>➤ Pechenik, J.A. (2015). <i>Biology of the Invertebrates</i> (7<sup>th</sup> ed.). New Delhi: Mc Graw Hill Education.</li> </ul> |         |

| S No. | Course List   | Learning Outcomes   | Existing Syllabus  | Suggested Syllabus  | Remarks   |
|-------|---|---|--|---|---|
|       |   |   |  | <ul style="list-style-type: none"> <li>➤ Prasad, S.N., &amp; Kashyap, V. (2012). <i>A text book of Invertebrate Zoology</i> (14<sup>th</sup> ed.). New Delhi: New Age International (P) Limited.</li> <li>➤ Rastogi, V.B. (2017). <i>Invertebrate Zoology</i>. Meerut: Kedar Nath Ram Nath.</li> <li>➤ Shukla, G.S., &amp; Upadhyay, V.B. (2017). <i>Economic Zoology</i> (5<sup>th</sup> ed.). Meerut: Rastogi Publication.</li> </ul> <p><b>Suggested e-Resources:</b></p> <ul style="list-style-type: none"> <li>➤ <b>Corals</b><br/><a href="https://www.icriforum.org/about-coral-reefs/what-are-corals">https://www.icriforum.org/about-coral-reefs/what-are-corals</a></li> <li>➤ <b>Paramecium</b><br/><a href="https://www.microscopemaster.com/paramecium.html">https://www.microscopemaster.com/paramecium.html</a></li> <li>➤ <b>Prawn</b><br/><a href="http://www.biologydiscussion.com/invertebrate-zoology/phylum-arthropoda/study-notes-on-prawn/33417">http://www.biologydiscussion.com/invertebrate-zoology/phylum-arthropoda/study-notes-on-prawn/33417</a></li> <li>➤ <b>Amphioxus</b><br/><a href="https://embryology.med.unsw.edu.au/embryology/index.php/Book_-_Text-Book_of_Embryology_4">https://embryology.med.unsw.edu.au/embryology/index.php/Book_-_Text-Book_of_Embryology_4</a></li> <li>➤ <b>Invertebrate animals</b><br/><a href="http://www.iaszoology.com/category/animal-diversity-nonchordata/">http://www.iaszoology.com/category/animal-diversity-nonchordata/</a></li> <li>➤ <b>Non chordate animals</b><br/><a href="https://www.slideshare.net/godhxbwnkkn/animal-diversity-zoology-notes">https://www.slideshare.net/godhxbwnkkn/animal-diversity-zoology-notes</a><br/><a href="http://abacus.bates.edu/acad/depts/biobook/AnimPhyl.pdf">http://abacus.bates.edu/acad/depts/biobook/AnimPhyl.pdf</a></li> </ul> |   |
| 8.    | <b>ZOO 101L:</b><br>Non-Chordates and Proto-Chordates Lab | On completion of the course, students will be able to:<br><ul style="list-style-type: none"> <li>• Identify and characterize different organisms of invertebrate based</li> </ul> | <p>1. <b>Anatomy :</b></p> <ul style="list-style-type: none"> <li>• Anatomical study of various systems with the help of chart/model/CD.</li> <li>• Identification, localization and labeling of various organs in dissected animal specimen/models/chart/CD.</li> </ul> <p><b>1. Study of Museum Specimens :</b></p> <ul style="list-style-type: none"> <li>• Porifera: Sycon, Euplectella, Hyalonema, Euspongia</li> </ul> | <p><b>1. Study of museum specimens:</b></p> <ul style="list-style-type: none"> <li>• Porifera: <i>Euplectella</i>, <i>Chalina</i>, <i>Grantia</i> and <i>Spongilla</i>.</li> <li>• Coelenterata: <i>Physalia</i>, <i>Aurelia</i>, <i>Millipora</i>, <i>Tubipora</i>, <i>Corallium</i>, <i>Antipathes</i> (black only), <i>Fungia</i> (mushroom coral).</li> <li>• Platyhelminthes: <i>Schistosoma</i> and <i>Taenia</i>.</li> <li>• Nematelminthes: Male and female <i>Ascaris</i>.</li> </ul>  | Name of the animals and their anatomical systems have been specified for clear understanding of the practical.<br>Study of museum |

| S No. | Course List | Learning Outcomes   | Existing Syllabus  | Suggested Syllabus   | Remarks  |
|-------|-------------|---|--|--|--|
|       |             | <p>on the external features.</p> <ul style="list-style-type: none"> <li>Describe different organ systems of important invertebrate animals like <i>Palaemone</i>, <i>Pila</i> and <i>Asterias</i>.</li> <li>Gain practical understanding of preparation of permanent slide and study of internal structures of higher invertebrate animals through microscopic study of prepared slides.</li> <li>Understand the collection of certain arthropods from their natural habitat and develop the skills of vermiculture.</li> </ul> | <p>and Spongilla.</p> <ul style="list-style-type: none"> <li>Coelenterata: <del>Porpita, Veleva, Physalia, Aurelia, Gorgonia, Pennatula, Aleyonium, Millipora, Tubipora, Corallium, Antipathes (Black only), Fungia, (Mushroom, Coral) and Adamsia.</del></li> <li><del>Platyhelminthes: Fasciola, Schistosoma, Echinococcus and Taenia.</del></li> <li>Nemathelminthes: Male and Female Ascaris, <del>Dracunculus and Entrobium.</del></li> <li><del>Annelida: Aphrodite, Chaetopterus, Terebella, Sabella, Arenicola, Pontobdella and Hirudinaria.</del></li> <li>Arthropoda: <del>Lepus, Balanus, Sacculina, Squilla, Crab, Hermit crab,</del> Julus, Scolopendra, Locust, <del>Melanopus,</del> Butterfly, Queen termite, Cimex, Limulus, Scorpion, Spider and Peripatus.</li> <li>Mollusca: <del>Chiton, Patella, Cypraea, Aplysia, Dentalium, Mytilus, Pecten, Tereedo, Sepia, Loligo, Octopus, Nautilus.</del></li> <li>Echinodermata: Antedon, <del>Holothuria, Echinus, Clypeaster</del> and Ophiothrix.</li> <li>Hemichordata: Balanoglossus.</li> <li>Protochordata: <del>Aseidia, Ciona, Botryllus</del> and Salpa.</li> </ul> | <ul style="list-style-type: none"> <li>Annelida: <i>Nereis</i>, <i>Chaetopterus</i>, <i>Sabella</i>, <i>Arenicola</i>, <i>Hirudinaria</i>.</li> <li>Arthropoda: <i>Balanus</i>, <i>Squilla</i>, <i>Julus</i>, <i>Scolopendra</i>, Locust, Butterfly, <i>Cimex</i>, Scorpion, Spider.</li> <li>Mollusca: <i>Patella</i>, <i>Cypraea</i>, <i>Pecten</i>, <i>Octopus</i>, <i>Pearl oyster</i>, <i>Nautilus</i>.</li> <li>Echinodermata: <i>Antedon</i>, <i>Clypeaster</i>, <i>Cucumara</i>, <i>Ophiothrix</i>.</li> <li>Hemichordata: <i>Balanoglossus</i>.</li> <li>Protochordata: <i>Ciona</i> and <i>Salpa</i>.</li> </ul> <p><b>2. Study of microscopic slides:</b></p> <ul style="list-style-type: none"> <li>Protozoa: <i>Amoeba</i>, <i>Polystomella</i>, <i>Monocystis</i>, Binary fission and conjugation in <i>Paramecium</i>.</li> <li>Porifera: T.S. and L.S. of <i>Sycon</i>, Spicules of sponge, Canal system of sponge.</li> <li>Coelenterata: <i>Obelia</i>.</li> <li>Platyhelminthes: W.M. of miracidium, sporocyst, redia, cercaria and metacercaria larva of <i>Fasciola</i>.</li> <li>Annelida: T.S. of <i>Nereis</i> through trunk region, T.S. of <i>Pheretima posthuma</i> through gizzard, typhlosolar region, prostrate glands and seminal vesicles.</li> <li>Arthropoda: V.S. of compound eye, <i>Pediculus</i>.</li> <li>Mollusca: T.S. of gill of <i>Unio</i>, Glochidium larva.</li> <li>Echinodermata: Larval forms (<i>Bipinnaria</i>, <i>Echinopluteus</i>, <i>Ophiopluteus</i>).</li> <li>Hemichordata: T.S. of <i>Balanoglossus</i> through proboscis, collar and trunk region.</li> <li>Protochordata: W.M. velum and pharyngeal wall of <i>Amphioxus</i>, T.S. of <i>Amphioxus</i> through various regions; tadpole larva of <i>Ascidia</i>.</li> </ul> <p><b>3. Anatomy:</b></p> <ul style="list-style-type: none"> <li>Anatomical study of various systems with the help of chart/model/CD.</li> </ul> <p><i>Palaemon</i></p> | specimens have been replaced by preparation of permanent slides and study of microscopic slides. |

| S No.                                   | Course List | Learning Outcomes | Existing Syllabus | Suggested Syllabus  | Remarks |
|---|-------------|-------------------|-------------------|---|---------|
|   |             |                   |                   | 1. Appendages<br>2. Digestive system<br>3. Nervous system<br><b><i>Pila globosa</i></b><br>1. Digestive system<br>2. Structure of radula<br>3. Nervous system<br><b><i>Asterias</i></b><br>1. Water vascular system<br>4. To study methods of preservation of museum specimens.<br><b>5. Preparation of permanent slides</b><br><ul style="list-style-type: none"> <li>• Protozoa: <i>Paramecium</i>.</li> <li>• Porifera: Spongin fibers and gemmule.</li> <li>• Coelenterata: <i>Obelia</i> colony and medusa of <i>Obelia</i>.</li> <li>• Annelida: Parapodium of heteronereis.</li> <li>• Arthropoda: Crustacean larva (nauplius, metanauplius, megalopa, Zoea).</li> <li>• Mollusca: Glochidium larva of <i>Unio</i>.</li> <li>• Echinodermata: Tube feet of <i>Asterias</i>.</li> </ul> <b>6. Collection and culture methods</b><br>(i) Collection of animals from their natural habitat: <i>Pheretima</i> , <i>Daphnia</i> , <i>Cyclops</i> , house flies, mosquitoes.<br>(ii) Culture of <i>Pheretima</i> .<br><b>7. Preparation of permanent mount of mouth parts of cockroach/housefly.</b><br><b>Suggested Books:</b><br><ul style="list-style-type: none"> <li>➤ Lal, S.S. (2015). <i>Practical Zoology: Invertebrates</i> (11<sup>th</sup> ed.). Meerut: Rastogi Publication.</li> <li>➤ Lal, S.S. (2015). <i>Practical Zoology: Vertebrates</i> (11<sup>th</sup> ed.). Meerut: Rastogi Publication.</li> <li>➤ Verma, P.S. (2010). <i>A Manual of Practical Zoology: Invertebrates</i> (11<sup>th</sup> ed.). New Delhi: S Chand Publishing.</li> </ul> |         |
| <b>B.Sc. Biotechnology III Semester</b> |             |                   |                   |   |         |

| S No. | Course List  | Learning Outcomes   | Existing Syllabus   | Suggested Syllabus  | Remarks  |
|-------|--|---|---|---|--|
| 9.    | <b>BOT 201:</b><br>Angiosperms<br>Taxonomy<br>and Economic<br>Botany | On completion of this course, students will be able to:<br><ul style="list-style-type: none"> <li>Identify characteristic features of angiosperm families and their interdisciplinary approaches.</li> <li>Understand plant morphology terminologies and distinguishing features with morphological peculiarities.</li> <li>Know the economic importance of angiosperms and its use in various industries.</li> </ul> | <p><b>Unit 1</b></p> <ul style="list-style-type: none"> <li><del>Taxonomy: Importance, a brief account of the historical development. Code, binomial nomenclature, International rules of Botanical nomenclature, Units of classification, Principles of priority, Type method, Citation of author's name.</del></li> <li>Numerical Taxonomy and Chemical Taxonomy (brief ideas only).</li> <li>A brief account of National Herbaria and Botanical Gardens of India.</li> </ul> <p><b>Unit 2</b></p> <ul style="list-style-type: none"> <li>Classification : System of Bentham and Hooker, a brief account of classification by Engler and Prantl, Hutchinson and Takhtajan, merits and demerits.</li> <li>Study of following families with emphasis on their diagnostic features:</li> <li>Ranunculaceae, Papaveraceae, Capparidaceae, Caryophy-llaceae, Rutaceae, Myrtaceae, Malvaceae.</li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>Study of following families with emphasis on their diagnostic features :<br/>Cucurbitaceae, Rubiaceae, Asclepiadaceae, Apocynaceae, Asteraceae, <del>Boraginaceae</del>, Acanthaceae, <del>Scrophulariaceae</del>, Lamiaceae, Euphorbiaceae, Brassicaceae, Fabaceae, Caesalpinaceae, Mimosaceae, Poaceae, Arecaceae, Liliaceae.</li> </ul> | <p><b>Unit-I</b></p> <ul style="list-style-type: none"> <li>International code of nomenclature for algae, fungi and plants- history, rules, principles. Concept of family, genus and species, citation of author's name.</li> <li>Numerical taxonomy and chemical taxonomy (brief ideas only).</li> <li>A brief account of national herbaria and botanical gardens of India.</li> </ul> <p><b>Unit 2</b></p> <ul style="list-style-type: none"> <li>Classification: System of Bentham and Hooker, a brief account of classification by Engler and Prantl, Hutchinson and Takhtajan, merits and demerits.</li> <li>Study of following families with emphasis on their diagnostic features: <ul style="list-style-type: none"> <li>Ranunculaceae</li> <li>Papaveraceae</li> <li>Capparidaceae</li> <li>Caryophyllaceae</li> <li>Rutaceae</li> <li>Myrtaceae</li> <li>Malvaceae</li> </ul> </li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>Study of following families with emphasis on their diagnostic features: <ul style="list-style-type: none"> <li>Cucurbitaceae</li> <li>Rubiaceae</li> <li>Asclepiadaceae</li> <li>Apocynaceae</li> <li>Asteraceae</li> <li>Amaranthaceae</li> <li>Acanthaceae</li> <li>Solanaceae</li> </ul> </li> </ul> | <p>This brings more clarity to the syllabus. These are already covered in Code. This inclusion will help in explaining plant taxonomy.</p> <p>The suggested families are of more relevance</p> |

| S No. | Course List | Learning Outcomes | Existing Syllabus  | Suggested Syllabus  | Remarks |
|-------|-------------|-------------------|--|---|---------|
|       |             |                   | <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>• Food Plants: Maize, Bajra, Wheat, Legumes, Potato, Sugarcane.</li> <li>• Spices: General account (Coriander, Turmeric, Chillies, Cumin, Fennel, Asafoetida).</li> <li>• Beverages: Tea and Coffee</li> <li>• Fatty Oils: Mustard, Groundnut, Sesame, Coconut.</li> </ul> <p><b>Unit 5</b></p> <ul style="list-style-type: none"> <li>• Fibre Plants: Gossypium, Corchorus, Saccharaum munja.</li> <li>• Drug Plants: Cinchona, Rauwolfia, Papaver, Digitalis.</li> <li>• Timber Plants: Tectona, Dalbergia, Pinus. Rubber : Hevea brasiliensis</li> </ul> <p><b>Books recommended :</b></p> <ul style="list-style-type: none"> <li>➤ A Hand Book of Systematic Botany: S.C. Dutta, Asia.</li> <li>➤ An Introduction to the Taxonomy of Angiosperms: Y.D. Tiagi &amp; S. Khetrapal, Ramesh Book Depot, Jaipur.</li> <li>➤ Economic Botany: Bendre &amp; Kumar, Rastogi Publications, Meerut.</li> <li>➤ Economic Botan: Sambamurthy.</li> <li>➤ A text book of economic botany: V. Verma, Emkay publications, New Delhi.</li> <li>➤ Economic Botany: S. Kumar, Campus Books, New</li> </ul> | <ul style="list-style-type: none"> <li>- Apiaceae</li> <li>- Lamiaceae</li> <li>- Euphorbiaceae</li> <li>- Brassicaceae</li> <li>- Fabaceae</li> <li>- Caesalpinaceae</li> <li>- Mimosaceae</li> <li>- Poaceae</li> <li>- Arecaceae</li> <li>- Liliaceae</li> </ul> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>• Food plants: Maize, bajra, wheat, legumes, potato, sugarcane.</li> <li>• Spices: General account (coriander, turmeric, chillies, <i>Cumin</i>, fennel, <i>Asafoetida</i>).</li> <li>• Beverages: Tea and coffee.</li> <li>• Fatty oils: Mustard, groundnut, sesame, coconut.</li> </ul> <p><b>Unit 5</b></p> <ul style="list-style-type: none"> <li>• Fibre plants: <i>Gossypium</i>, <i>Corchorus</i>, <i>Saccharaum munja</i>.</li> <li>• Drug plants: <i>Cinchona</i>, <i>Rauwolfia</i>, <i>Papaver</i>, <i>Digitalis</i>.</li> <li>• Timber plants: <i>Tectona</i>, <i>Dalbergia</i>, <i>Pinus</i>. Rubber: <i>Hevea brasiliensis</i>.</li> </ul> <p><b>Suggested Books:</b></p> <ul style="list-style-type: none"> <li>➤ Alam, A., &amp; Sharma, V. (2012). <i>Economic Botany</i>. Jaipur: Pointer Publishers.</li> <li>➤ Dutta, S. (2009). <i>A Hand Book of Systematic Botany</i>. New Delhi: New Age International (P) Limited.</li> <li>➤ Khetrapal, Y.T. <i>An Introduction to the Taxonomy of Angiosperms</i>. Jaipur: Ramesh Book Depot.</li> <li>➤ Kochhar, S.L. (2016). <i>Economic Botany of the Tropics</i>. London: Macmillan India Limited.</li> <li>➤ Kumar, A., &amp; Bendra, A. (1983). <i>Economic Botany: for university students</i>. Meerut: Rastogi Publications.</li> <li>➤ Lawrence, G.H.M. (2017). <i>Taxonomy of vascular plants</i>.</li> </ul> |         |

| S No. | Course List   | Learning Outcomes   | Existing Syllabus   | Suggested Syllabus  | Remarks  |
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|       |   |   | Delhi.<br>➤ Fundamentals of Plant systematics - Albert E. Radford.<br>➤ Taxonomy of vascular plants: G.H.M. Lawrence.<br>➤ Economic Botany of the Tropics– S.L. Kochhar.<br>➤ Taxonomy of Angiosperm: R.K. Jain & V. Singh.<br>➤ Taxonomy of Angiosperm: O.P. Sharma. | Jodhpur: Scientific publisher<br>➤ Radford, A.R., & Caddell, G.M. (1986). <i>Fundamentals of Plant systematics</i> . USA: Harper & Row Publishers.<br>➤ Sharma, O.P. (2011). <i>Taxonomy of Angiosperm</i> . New Delhi: TATA McGraw-Hill.<br>➤ Singh, V. & Jain, D.K. (2010). <i>Taxonomy of Angiosperm</i> . Meerut: Rastogi Publication.<br>➤ Verma, V. (2010). <i>A text book of economic botany</i> . New Delhi: Emkay publications.<br><b>Suggested e-Resources:</b><br>➤ <b>Angiosperms: APG system of classification</b><br><a href="https://academic.oup.com/botlinnean/article/181/1/1/2416499">https://academic.oup.com/botlinnean/article/181/1/1/2416499</a><br>➤ <b>Angiosperms: Classification and reproduction</b><br><a href="https://www.toppr.com/guides/biology/plant-kingdom/angiosperms/">https://www.toppr.com/guides/biology/plant-kingdom/angiosperms/</a><br>➤ <b>Economic botany</b><br><a href="http://nsdl.niscair.res.in/jspui/bitstream/123456789/130/1/beverages.pdf">http://nsdl.niscair.res.in/jspui/bitstream/123456789/130/1/beverages.pdf</a> |  |
| 10.   | <b>BOT 201L:</b><br>Angiosperms<br>Taxonomy<br>and Economic<br>Botany Lab | On completion of this course, students will be able to:<br>• Develop skills for plant identification, with reference to systematic position, morphological characters, floral formula and floral diagram.<br>• Diagnose the structural features of plant organs and differentiate | 1. Study of locally available <del>flowers</del> of the families mentioned in the syllabus.<br>2. Study of economically important plant products as mentioned in the syllabus.  | 1. Study of locally available <b>plants</b> of the families mentioned in the syllabus.<br>2. Study of economically important plant products as mentioned in the syllabus.<br>3. <b>Preparation of herbarium.</b><br><b>Suggested Books:</b><br>➤ Sahu, A.C. (2015). <i>Textbook of Practical Botany</i> . New Delhi: Kalyani Publishers.  | Preparation of herbarium<br>Is important part in the taxonomy. |

| S No. | Course List   | Learning Outcomes  | Existing Syllabus   | Suggested Syllabus   | Remarks |
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|       |   | <p>microscopically their tissue elements.</p> <ul style="list-style-type: none"> <li>Study fiber, gum, resin, timber, spices and medicinal plants and its applications</li> </ul>  |   |  |         |
| 11.   | <b>BT 202:</b><br>Biochemistry, Biophysics and Enzymology | <p>On completion of the course, students will be able to:</p> <ul style="list-style-type: none"> <li>To demonstrate an understanding of fundamental biochemical principles, such as the structure/function of biomolecules, metabolic pathways, and the regulation of biological/biochemical processes.</li> <li>Gain knowledge of basic energy metabolism of cells and identify some of common reaction mechanisms in biochemical processes.</li> <li>Describe structure, functions, kinetics,</li> </ul> | <p><b>Unit 1</b></p> <ul style="list-style-type: none"> <li>Structure and colligative properties of water</li> <li>pH, pK, acids, bases, buffers. Ionic product of water, Henderson-Hasselbach equation.</li> <li>Carbohydrates – structure, classification and properties.</li> <li>Amino acids and proteins– structure, classification and properties.</li> <li>Lipids – Structure, nomenclature and properties.</li> </ul> <p><b>Unit 2</b></p> <ul style="list-style-type: none"> <li>Bioenergetics – Energy and its forms, Principles of Thermodynamics.</li> <li>Energy rich biomolecules –(ATP, NADP and other phosphorylated compounds).</li> <li>Coordinated control of metabolism: Methods of studying metabolism. Some key metabolic pathways: Glycolysis, citric acid cycle and pentose phosphate pathway.</li> <li>Metabolism of Tryptophan, Palmitic acid, Purine and Pyrimidines.</li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>Classification, nomenclature and general properties of enzymes</li> <li>Coenzymes.</li> <li>Vitamins: structure and functions.</li> <li>Classification, properties and metabolic significance of</li> </ul> | <p><b>Unit 1</b></p> <ul style="list-style-type: none"> <li>Structure and colligative properties of water.</li> <li>pH, pK, acids, bases, buffers. Ionic product of water, Henderson-Hasselbalch equation.</li> <li>Carbohydrates- Classification, structure, properties and functions.</li> <li>Amino acids and proteins- Classification, structure, properties and functions.</li> <li>Lipids- Classification, structure, properties and functions.</li> </ul> <p><b>Unit 2</b></p> <ul style="list-style-type: none"> <li>Bioenergetics-Energy and its forms, principles of thermodynamics.</li> <li>Energy rich biomolecules-(ATP, NADP and other phosphorylated compounds).</li> <li>Coordinated control of metabolism: Various techniques used to study metabolism. Some key metabolic pathways: Glycolysis, citric acid cycle and pentose phosphate pathway.</li> <li>Metabolism of tryptophan, palmitic acid, purine and pyrimidines.</li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>Classification, structure and functions of coenzymes.</li> <li>Vitamins: Classification, structure and functions.</li> <li>Classification, properties and metabolic significance of secondary metabolites (terpenoids, alkaloids, phenols).</li> <li>Three dimensional structure of proteins: Peptide bonds,</li> </ul> |         |



| S No. | Course List | Learning Outcomes   | Existing Syllabus   | Suggested Syllabus  | Remarks |
|-------|-------------|---|---|---|---------|
|       |             | <p>regulation and the mechanisms of action of enzymes.</p> <ul style="list-style-type: none"> <li>• Explain chemical messenger molecules of the nervous system including neurotransmitters and synaptic neurotransmission.</li> </ul> | <p>secondary metabolites (Terpenoids, alkaloids, phenols).</p> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>• Three dimensional structure of proteins: Peptide bonds, disulphide cross links, Alpha-helix, <math>\beta</math>-sheet, helix-coil transitions. Ramachandran plots.</li> <li>• Nucleic acids – Various confirmations of nucleotides, glycosidic bond rotation. Base stacking.</li> <li>• Electrical properties of biological compartments, Electrochemical gradients, membrane potential.</li> <li>• Mechanism of ATP synthesis: Oxidative phosphorylation, chemiosmotic hypothesis and photophosphorylation.</li> <li>• Nerve transmission: resting membrane potential, Propagation of nerve impulse and an idea about neurotransmitters.</li> <li>• Structure of striated muscle, muscle proteins and biophysical events of muscle contraction.</li> </ul> <p><b>Unit 5</b></p> <ul style="list-style-type: none"> <li>• Introduction to mechanism of enzyme action (Lock and Key hypothesis, Induced fit hypothesis)</li> <li>• Enzyme inhibition: competitive and non- competitive type</li> <li>• Isolation and purification of enzymes.</li> <li>• Kinetics of enzyme catalyzed reaction (Michaelis-Menten law), Double reciprocal plot.</li> </ul> <p><b>Books recommended :</b></p> <ul style="list-style-type: none"> <li>➤ Principles of Biochemistry: A.L. Lehninger, Nelson and Cox, McMillan Worth Publishers.</li> <li>➤ Biochemistry: Christopher K. Mathews Von Holde &amp; Ahern, Pearson Education.</li> <li>➤ Biochemistry: Voet and Voet, John Wiley and Sons, Inc. USA.</li> </ul> | <p>disulphide cross links, <math>\alpha</math>-helix, <math>\beta</math>-sheet, helix-coil transitions. Ramachandran plots.</p> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>• Nucleic acids-Variations confirmations of nucleotides, glycosidic bond rotation. Base stacking.</li> <li>• Electrical properties of biological compartments, electrochemical gradients, membrane potential.</li> <li>• Mechanism of ATP synthesis: Oxidative phosphorylation, chemiosmotic hypothesis and photophosphorylation.</li> <li>• Nerve transmission: Resting membrane potential, propagation of nerve impulse and an idea about neurotransmitters.</li> <li>• Structure of striated muscles, muscle proteins and biophysical events of muscle contraction.</li> </ul> <p><b>Unit 5</b></p> <ul style="list-style-type: none"> <li>• Classification, nomenclature and general properties of enzymes.</li> <li>• Introduction to mechanism of enzyme action (lock and key hypothesis, induced fit hypothesis).</li> <li>• Enzyme inhibition: competitive, non- competitive and uncompetitive.</li> <li>• Isolation and purification of enzymes.</li> <li>• Kinetics of enzyme catalyzed reaction (Michaelis-Menten law), double reciprocal plot.</li> </ul> <p><b>Suggested Books:</b></p> <ul style="list-style-type: none"> <li>➤ Berg, J.M., Stryer, L. Tymoczko, J.L. &amp; Gatto, G.J. (2015). <i>Biochemistry</i> (8<sup>th</sup> ed.). New York, USA: WH Freeman.</li> <li>➤ Cantor, C.R., &amp; Schimmel, P.R. (1980). <i>Biophysical Chemistry, Part 2: Techniques for the Study of Biological Structure and Function</i> (1<sup>st</sup> ed.). New York,</li> </ul> |         |

| S No. | Course List | Learning Outcomes | Existing Syllabus   | Suggested Syllabus   | Remarks |
|-------|-------------|-------------------|---|--|---------|
|       |             |                   | <ul style="list-style-type: none"> <li>➤ Harper's review of Biochemistry: R.K. Murray et al., Prentice-Hall International Inc.</li> <li>➤ Fundamentals of Biochemistry: Cohn and Stumpf.</li> <li>➤ Molecular Biophysics-Structure in Motion: Michel Daune, Oxford University Press.</li> <li>➤ Basic Biophysics: R. Narayanan, New Age Publisher.</li> <li>➤ Biophysical Chemistry Vol. I, II &amp; III: Cantor and Schimmel, Freeman.</li> <li>➤ Biochemistry: Zubey, WCB, Place Dabuque</li> <li>➤ Biochemistry: Stryer, W. H. Freeman, New York.</li> <li>➤ Understanding Enzymes: T. Palmer, Pub. Horword, Chichester, England.</li> <li>➤ Fundamentals of Biochemistry: J.L. Jain, S. Chand &amp; Company limited.</li> </ul> | <p>USA: W. H. Freeman and Company.</p> <ul style="list-style-type: none"> <li>➤ Cantor, C.R., &amp; Schimmel, P.R. (1980). <i>Biophysical Chemistry: Part 1: The Conformation of Biological Macromolecules</i>. New York, USA: W. H. Freeman and Company.</li> <li>➤ Cantor, C.R., &amp; Schimmel, P.R. (1980). <i>Biophysical Chemistry: Part 3: The Behaviour of Biological Macromolecules</i>. New York, USA: W. H. Freeman and Company.</li> <li>➤ Conn, E.E., Stumpf, P.K., &amp; Bruening, G. (2006). <i>Outlines of Biochemistry</i> (5<sup>th</sup> ed.). New Jersey: Wiley-Blackwell.</li> <li>➤ Copeland, R.A. (2008). <i>Enzymes: A Practical Introduction to Structure, Mechanism &amp; Data Analysis</i> (2<sup>nd</sup> ed.). India: Wiley-VCH.</li> <li>➤ Daune, M., Duffin, W.J., &amp; Blow, D. (1999). <i>Molecular Biophysics: Structures in Motion</i>. UK: UK: Oxford University Press.</li> <li>➤ Gupta, S.N. (2015). <i>Biochemistry</i> (2<sup>nd</sup> ed.). Meerut: Rastogi Publication.</li> <li>➤ Jain, J.L., Jain, S., &amp; Jain, N. (2016). <i>Fundamentals of Biochemistry</i> (7<sup>th</sup> ed.). New Delhi: S Chand.</li> <li>➤ Mathews, C.K., Van Holde, K.E., Appling, D.R., &amp; Anthony-Cahill, S.J. (2012). <i>Biochemistry</i> (4<sup>th</sup> ed.). London, UK: Pearson Education.</li> <li>➤ Narayanan, P. (2007). <i>Essentials of Biophysics</i> (2<sup>nd</sup> ed.). New Delhi: New Age Internationals.</li> <li>➤ Nelson, D.L., &amp; Cox, M.M. (2017). <i>Lehninger Principles of Biochemistry</i> (7<sup>th</sup> ed.). USA: W H Freeman &amp; Co.</li> <li>➤ Palmer, T. (2001). <i>Enzymes: Biochemistry, Biotechnology, Clinical Chemistry</i> (V Ed.). Cambridge: Horwood Publishing Ltd.</li> <li>➤ Rajeswari, M.R. (2013). <i>An Introduction to Biophysics</i> (1<sup>st</sup> ed.). Meerut: Rastogi Publication.</li> </ul> |         |

| S No. | Course List  | Learning Outcomes  | Existing Syllabus   | Suggested Syllabus  | Remarks                              |
|-------|--|--|---|---|--------------------------------------|
|       |  |  |   | <ul style="list-style-type: none"> <li>➤ Rodwell, V., Bender, D., Kennelly, P., &amp; Weil, P.A. (2015). <i>Harpers Illustrated Biochemistry</i> (30th ed.). New York, USA: McGraw-Hill Education / Medical.</li> <li>➤ Satyanarayana, U., &amp; Chakrapani, U. (2017). <i>Essentials of Biochemistry</i> (end ed.). Kolkata: Booka &amp; Allied Ltd.</li> <li>➤ Voet, D., &amp; Voet, J.G. (2010). <i>Biochemistry</i> (4<sup>th</sup> ed.). New York, USA: John Wiley &amp; Sons Inc.</li> <li>➤ Zubay, G., Parson, W.W., &amp; Vance, D.E. (1995). <i>Principles of Biochemistry</i>. USA: Brown (William C.) Co.</li> </ul> <p><b>Suggested e-Resources:</b></p> <ul style="list-style-type: none"> <li>➤ <b>Enzymology</b><br/><a href="https://nptel.ac.in/courses/102102033/14">https://nptel.ac.in/courses/102102033/14</a></li> <li>➤ <b>Biomolecules</b><br/><a href="http://www.biologie.ens.fr/~mthomas/L3/intro_biologie/2-sucres-lipides-acides-nucleiques.pdf">http://www.biologie.ens.fr/~mthomas/L3/intro_biologie/2-sucres-lipides-acides-nucleiques.pdf</a></li> <li>➤ <b>ETC</b><br/><a href="https://www.khanacademy.org/science/biology/cellular-respiration-and-fermentation/oxidative-phosphorylation/a/oxidative-phosphorylation-etc">https://www.khanacademy.org/science/biology/cellular-respiration-and-fermentation/oxidative-phosphorylation/a/oxidative-phosphorylation-etc</a><br/><a href="http://courses.chem.indiana.edu/c483/documents/lecture23.pdf">http://courses.chem.indiana.edu/c483/documents/lecture23.pdf</a></li> <li>➤ <b>Biochemistry</b><br/><a href="https://nptel.ac.in/courses/102105034/3">https://nptel.ac.in/courses/102105034/3</a></li> <li>➤ <b>Muscle structure &amp; contraction</b><br/><a href="https://opentextbc.ca/biology/chapter/19-4-muscle-contraction-and-locomotion/">https://opentextbc.ca/biology/chapter/19-4-muscle-contraction-and-locomotion/</a></li> </ul> |                                      |
| 12.   | <b>BT 202L:</b><br>Biochemistry,<br>Biophysics<br>and<br>Enzymology<br>Lab | On completion of this course, students should be able to:<br><ul style="list-style-type: none"> <li>• Apply the scientific method to the biochemical processes of</li> </ul> | <ol style="list-style-type: none"> <li>1. To find out the <math>\lambda_{max}</math> of protein (BSA).</li> <li>2. Qualitative analysis of carbohydrates (Reducing and Non Reducing).</li> <li>3. Qualitative test for Proteins.</li> <li>4. Qualitative analysis of Lipids.</li> <li>5. Determination of Iodine number.</li> <li>6. Determination of the acid value of Lipid.</li> </ol> | <ol style="list-style-type: none"> <li>1. To find out the <math>\lambda_{max}</math> of protein (BSA).</li> <li>2. Qualitative analysis of carbohydrates (reducing and non Reducing): Molisch's test, Benedict's test, Fehling's test, Tollen's phloroglucinol, Barfoed's test, Seliwanoff's test, acidic hydrolysis test for sucrose.</li> <li>3. Qualitative test for proteins: Biuret's test, Ninhydrin test, Xanthoproteic test, Million's test, Sakaguchi test,</li> </ol>   | Qualitative test have been specified |

| S No.                                  | Course List    | Learning Outcomes  | Existing Syllabus   | Suggested Syllabus   | Remarks |
|--|----------------|--|---|--|---------|
|  |                | <p>experimentation and hypothesis testing.</p> <ul style="list-style-type: none"> <li>Identify and distinguish the carbohydrates, proteins and lipids based on specific biochemical tests.</li> <li>Understand the molecular basis of various pathological conditions from the perspective of biochemical reactions.</li> <li>Gain an understanding of the preparation of crude protein lysate, enzymatic assay, effect of time and enzyme concentration on its activity.</li> </ul> | <p>7. Separation of amino acids using T.L.C.</p> <p>8. Titration curve of Glycine (Determination of Isoelectric point).</p> <p>9. Preparation of Enzyme extract.</p> <p>10. Determination of Enzyme activity.</p> <p>11. Stability of Enzyme (Salivary amylase) with respect to temperature and pH.</p> | <p>Fohl's test.</p> <p>4. Qualitative analysis of lipids: Solubility test, Grease spot test, Emulsification test, Saponification test, Unsaturation test, Acrolein test, Salkowski test, Lieberman-Burchard's test.</p> <p>5. Determination of iodine number.</p> <p>6. Determination of the acid value of lipid.</p> <p>7. Determination of saponification value of fats and oil.</p> <p>8. Titration curve of glycine (determination of isoelectric point).</p> <p>9. Preparation of enzyme extract from horse gram seeds and determination of urease activity.</p> <p>10. To check time linearity and protein linearity of urease catalyzed reaction.</p> <p>11. Determination of salivary amylase activity.</p> <p>12. Stability of salivary amylase with respect to temperature and pH.</p> <p><b>Suggested Books:</b></p> <ul style="list-style-type: none"> <li>➤ Deb, A.C. (2013). <i>Comprehensible Viva &amp; Practical Biochemistry</i> (2<sup>nd</sup> ed.). Kolkata: New Central Book Agency.</li> <li>➤ Kumar, A., Grg, S., &amp; Garg, N. (2017). <i>Biochemical Tests: Principles &amp; Protocols</i>. New Delhi: Viva Books.</li> <li>➤ Rao, B.S., &amp; Deshpande, V. (2012). <i>Experimental Biochemistry</i>. New Delhi: I.K. International Publisher.</li> <li>➤ Sadasivam, S., &amp; Manickam, A. (1996). <i>Biochemical Methods</i> (2<sup>nd</sup> ed.). New Delhi: New Age International Publishers.</li> <li>➤ Saxena, J., Baunthiyal., &amp; Ravi, I. (2015). <i>Laboratory Manual of Microbiology, Biochemistry and Molecular Biology</i>. Jodhpur: Scientific Publishers.</li> <li>➤ Sharma, S. (2007). <i>Experiments and Techniques in Biochemistry</i> (1<sup>st</sup> ed.). New Delhi: Galgotia Publication.</li> </ul> |         |
| <b>B.Sc. Biotechnology IV Semester</b> |                |  |   |  |         |
| 13.                                    | <b>BT 207:</b> | On completion of   | <b>Unit 1</b>   | <b>Unit 1</b>  |         |

| S No. | Course List                                    | Learning Outcomes   | Existing Syllabus   | Suggested Syllabus   | Remarks |
|-------|--|---|---|--|---------|
|       | Genetics,<br>Microbiology<br>and<br>Immunology | <p>the course, students will be able to:</p> <ul style="list-style-type: none"> <li>Learn fundamental molecular principles of genetics and relationship between phenotype and genotype in human genetic traits.</li> <li>Understand the characteristic features and ultrastructure of bacteria, fungi, yeast and viruses.</li> <li>Gain theoretical knowledge of techniques in microbiology.</li> <li>Understand about the immune system and various related mechanisms of cells and molecules involved in fighting pathogens.</li> </ul> | <ul style="list-style-type: none"> <li><del>Genetic terminology</del></li> <li>Mendel's laws</li> <li>Gene-gene interaction, multiple alleles</li> <li>Linkage and Crossing over</li> <li>Sex determination, Sex linked inheritance</li> <li>Cytoplasmic inheritance</li> </ul> <p><b>Unit 2</b></p> <ul style="list-style-type: none"> <li>Chromosomal aberrations: Structural and Numerical</li> <li>Mutation: Spontaneous and Induced, Chemical and Physical mutagens, Induced mutations in plants, animals and microbes for economic benefit of <del>man</del></li> <li>Regulation of gene expression in prokaryotes: Lac and Trp operons</li> <li>Population genetics: Hardy Weinberg law</li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>Characteristic features and ultrastructure of bacteria.</li> <li>General account of different groups : cyanobacteria, fungi, yeast, viruses, mycoplasma and actinomycetes</li> <li>General characteristics of bacteriophage (T<sub>4</sub>, <del>lambda</del> and phi X174)</li> <li>Industrial applications of microorganisms in food and medicines</li> </ul> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>Bacterial genetics: Brief idea of plasmids, transposable elements, transformation, transduction, conjugation.</li> <li>Techniques in Microbiology: Media preparation, sterilization methods, isolation and pure culture techniques, staining techniques, preservation and maintenance of culture.</li> <li>An introduction to science of Immunology</li> <li>Innate and Acquired immunity, Active and Passive Immunity.</li> </ul> <p><b>Unit 5</b></p> | <ul style="list-style-type: none"> <li>An overview of Mendel's law of inheritance.</li> <li>Gene-gene interaction, multiple alleles.</li> <li>Linkage and crossing over.</li> <li>Sex determination, sex linked inheritance.</li> <li>Cytoplasmic inheritance.</li> <li>Human genetics: Pedigree analysis.</li> </ul> <p><b>Unit 2</b></p> <ul style="list-style-type: none"> <li>Chromosomal aberrations: Structural and numerical.</li> <li>Mutation: Spontaneous and induced, chemical and physical mutagens, induced mutations in plants, animals and microbes for economic benefit of <u>human</u>.</li> <li>Regulation of gene expression in prokaryotes: Lac and Trp operons.</li> <li>Population genetics: Hardy Weinberg law.</li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>Characteristic features and ultrastructure of bacteria.</li> <li>General account of different groups: Cyanobacteria, fungi, yeast, viruses, <i>Mycoplasma</i> and actinomycetes.</li> <li>General characteristics of bacteriophage (T<sub>4</sub>, <u>λ</u> and phi x 174).</li> <li>Industrial applications of microorganisms in food and medicines.</li> </ul> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>Bacterial genetics: Brief idea of plasmids, transposable elements, transformation, transduction, conjugation.</li> <li>Techniques in microbiology: Media preparation, sterilization methods, isolation and pure culture techniques, staining techniques (<u>Gram's, negative and endospore staining</u>), preservation and maintenance of culture.</li> <li>An introduction to science of immunology.</li> <li>Innate and acquired immunity, active and passive immunity.</li> </ul> <p><b>Unit 5</b></p> |         |

| S No. | Course List | Learning Outcomes | Existing Syllabus  | Suggested Syllabus  | Remarks |
|-------|-------------|-------------------|--|---|---------|
|       |             |                   | <ul style="list-style-type: none"> <li>• Phylogeny and ontogeny of immune system: Cells of immune system and preliminary idea about their differentiation, organization and structure of lymphoid organs.</li> <li>• Nature of antigens: Antigenicity and immunogenicity, Factors affecting them, Epitopes and Haptens,</li> <li>• Structure and function of Antibodies: Classes and subclasses, <del>gross and fine structure.</del></li> <li>• Nature of immune response: Cell mediated and Humoral immune response</li> <li>• General idea of Major Histocompatibility complex (MHC) and their significance. Monoclonal Antibodies and their applications</li> </ul> <p><b>Books recommended :</b></p> <ul style="list-style-type: none"> <li>➤ Concepts of Genetics 7th Ed.: William S. Klug, Pearson Education.</li> <li>➤ Principles of Genetics: R.H. Tamarin, Tata McGraw Hill.</li> <li>➤ Principles of Genetics 8th: Gardner, Simmons, Snustad, John Wiley &amp; Sons.</li> <li>➤ Genetics: P.K. Gupta, Rastogi Publications.</li> <li>➤ Genetics –A molecular approach: T.A. Brown, Chapman and Hall.</li> <li>➤ Gardner Principles of Genetics – Snustad &amp; Simmons.</li> <li>➤ Genetics-From Genes to Genomes: Hartwell, McGraw Hill.</li> <li>➤ Genetics 5th Ed: D.L. Hartl and E.W. Jones, Jones and Barlett Publishers, Canada.</li> <li>➤ Molecular Biology: R. Weaver, WCB Mc Graw Hill.</li> <li>➤ Immunology 4th Ed: J. Kuby, W.H. Freeman.</li> <li>➤ Immunology: Nandini Shetty, New Age Publishers.</li> <li>➤ Microbiology - An Introduction 8th Ed: Tortora, Pearson Education.</li> <li>➤ Microbiology: Pelczar, Tata McGraw Hill.</li> <li>➤ Microbial Genetics: D. Friefelder.</li> </ul> | <ul style="list-style-type: none"> <li>• Phylogeny and ontogeny of immune system: Cells of immune system and preliminary idea about their differentiation, organization and structure of lymphoid organs.</li> <li>• Nature of antigens: Antigenicity and immunogenicity, factors affecting them, epitopes and haptens,</li> <li>• Structure and function of antibodies: Classes and subclasses.</li> <li>• Nature of immune response: Humoral and cell mediated immune response.</li> <li>• General idea of Major Histocompatibility Complex (MHC) and their significance. Monoclonal antibodies and their applications.</li> </ul> <p><b>Suggested Books :</b></p> <ul style="list-style-type: none"> <li>➤ Gardner, E.J., Simmons, M.J., &amp; Snustad, D.P. (2005). <i>Principles of Genetics</i> (8<sup>th</sup> ed.). New Jersey, USA: John Wiley &amp; Sons Ltd.</li> <li>➤ Hartl, D.L. &amp; Jones, E.W. (1998). <i>Genetics: Principles &amp; Analysis</i> (4<sup>th</sup> ed.). Canada: Jones and Barlett Publishers.</li> <li>➤ Hartwell (2010). <i>Genetics-From Genes to Genomes</i> (4<sup>th</sup> ed.) USA: McGraw-Hill Education.</li> <li>➤ Khan, F. H. (2009). <i>Elements of Immunology</i> (1<sup>st</sup> ed.). Pearson Education India.</li> <li>➤ Kindt, T.J., Osborne, B.A., &amp; Goldsby, R.A. (2006). <i>Kuby Immunology</i> (6<sup>th</sup> ed.). New York, USA: W. H. Freeman &amp; Company.</li> <li>➤ Klug, W.S., Cummings, M.R., Spencer, C.A. &amp; Palladino, M.A. (2015). <i>Essential of Genetics</i> (9<sup>th</sup> ed.). Noida: Pearson Education India.</li> <li>➤ Madigan, M. T., Martinko, J. M., Dunlap, P. V., &amp; Clark, D. P. (2005). <i>Brock Biology of Microorganisms</i> (12<sup>th</sup> ed.). San Fransisco: Benjamin Cummings.</li> <li>➤ Maloy, S.R., Cronan, J.E., &amp; Friefelder, D. (1994). <i>Microbial Genetics</i> (2<sup>nd</sup> ed.). USA: Jones and Bartlett.</li> </ul> |         |

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|-------|-------------|-------------------|---|---|---------|
|       |             |                   | <ul style="list-style-type: none"> <li>➤ An introduction to Immunology: I.R. Tizzard.</li> <li>➤ Genetics: VB Rastogi.</li> <li>➤ Immunology: Fahim Khan, Pearson Publisher.</li> <li>➤ Microbiology: Prescott, Harley and Klein.</li> <li>➤ Biology of Microorganism: Brock.</li> <li>➤ Genetics: Peter J. Russell.</li> </ul> | <ul style="list-style-type: none"> <li>➤ Owen, J., Punt, J., Stranford, S., &amp; Jones, P. (2018). <i>Kuby Immunology</i> (7<sup>th</sup> ed.). USA: W. H. Freeman and Company.</li> <li>➤ Pelczar, M.J., Chan, E.C.S., &amp; Krieg, N.R. (2007). <i>Microbiology</i> (5<sup>th</sup> ed.). New York, U.S.: Tata McGraw-Hill Inc.</li> <li>➤ Rastogi, V.B. (2018). <i>Genetics</i> (4<sup>th</sup> ed.). Medtech.</li> <li>➤ Shetty, N. (2005). <i>Immunology: Introductory Textbook</i>. New Delhi: New Age International Publishers.</li> <li>➤ Singh, B.D. (2014). <i>Fundamentals of Genetics</i> (332<sup>nd</sup> ed.). New Delhi: Kalyani Publishers.</li> <li>➤ Tamarin, R.H. (2004). <i>Principles of Genetics</i> (7<sup>th</sup> ed.). USA: McGraw-Hill Higher Education.</li> <li>➤ Tizard, I.R. (1995). <i>Immunology: Introduction</i> (4<sup>th</sup> ed.). Philadelphia: Saunders College Publishing.</li> <li>➤ Tortora, G.J., Funke, B.R., &amp; Case, C.L. (2016) <i>Microbiology: An Introduction</i> (12<sup>th</sup> ed.). London, UK: Pearson.</li> <li>➤ Verma, P.S. &amp; Agarwal, V.K. (2010). <i>Genetics</i> (9<sup>th</sup> ed.). New Delhi: S. Chand and company.</li> <li>➤ Weaver, R.F. (2011). <i>Molecular Biology</i> (5<sup>th</sup> ed.). New York, USA: McGraw-Hill Education.</li> <li>➤ Willey, J.M., Sherwood, L., &amp; Woolverton, C.J. (2007). <i>Prescott, Harley and Klein's Microbiology</i>, (7<sup>th</sup> ed.). USA: Mc Graw Hill Higher Education.</li> </ul> <p><b>Suggested e-Resources:</b></p> <ul style="list-style-type: none"> <li>➤ <b>Immunology</b><br/><a href="https://nptel.ac.in/courses/102103038/3">https://nptel.ac.in/courses/102103038/3</a></li> <li>➤ <b>Immunity</b><br/><a href="https://www.khanacademy.org/science/high-school-biology/hs-human-body-systems/hs-the-immune-system/a/hs-the-immune-system-review">https://www.khanacademy.org/science/high-school-biology/hs-human-body-systems/hs-the-immune-system/a/hs-the-immune-system-review</a></li> <li>➤ <b>Microbiology</b><br/><a href="https://nptel.ac.in/courses/102103015/">https://nptel.ac.in/courses/102103015/</a></li> <li>➤ <b>Structure of bacteria &amp; viruses</b></li> </ul> |         |

| S No. | Course List  | Learning Outcomes   | Existing Syllabus   | Suggested Syllabus   | Remarks   |
|-------|--|---|---|--|---|
|       |  |   |   | <p><a href="https://instruct.uwo.ca/biology/090b/1290b%201-7.pdf">https://instruct.uwo.ca/biology/090b/1290b%201-7.pdf</a><br/> <a href="http://ocw.jhsph.edu/courses/EpiInfectiousDisease/PDFs/EID_lec2_Dick.pdf">http://ocw.jhsph.edu/courses/EpiInfectiousDisease/PDFs/EID_lec2_Dick.pdf</a></p> <p>➤ <b>Mendelian genetics &amp; deviation</b><br/> <a href="https://www.khanacademy.org/science/biology/classical-genetics/variations-on-mendelian-genetics/a/multiple-alleles-incomplete-dominance-and-codominance">https://www.khanacademy.org/science/biology/classical-genetics/variations-on-mendelian-genetics/a/multiple-alleles-incomplete-dominance-and-codominance</a><br/> <a href="http://download.nos.org/srsec314newE/PDFBIO.EL21.pdf">http://download.nos.org/srsec314newE/PDFBIO.EL21.pdf</a></p>   |   |
| 14.   | <b>BT 207L:</b><br>Genetics,<br>Microbiology<br>and<br>Immunology<br>Lab | <p>On completion of the course, students will be able to:</p> <ul style="list-style-type: none"> <li>Understand the clinical relevance of genetic concepts, inheritance and expression of human blood groups.</li> <li>Acquire and demonstrate competency in routine microbiological laboratory skills applicable to microbiological research and clinical methods.</li> <li>Explain basic immunological laboratory techniques and use immunoassays to</li> </ul> | <ol style="list-style-type: none"> <li><del>Media preparation: L.B., preparation of slants.</del></li> <li>Streak plate technique.</li> <li><del>Dilution plate technique.</del></li> <li>Gram staining and endospore staining.</li> <li>Lactic acid estimation.</li> <li>Antibiotic sensitivity test using <i>Bacillus subtilis</i>.</li> <li>Problems of Genetics.</li> <li>Slides of Meiosis showing chiasma formation and calculation of chiasma frequency.</li> <li><del>Practicals related to Human Genetics : Widow's peak, earlobe, index finger, straight and curly hair, rolling of tongue.</del></li> <li>Testing of blood groups including Rh factors to observe the phenomenon of agglutination.</li> <li>To study the various lymphoid glands (Spleen and Thymus).</li> <li>To study different type of cells participating in specific and non-specific immunity.</li> <li>Immunological diagnosis of pregnancy / infection / cancer.</li> <li>Immuno precipitation by precipitin reaction</li> </ol> | <ol style="list-style-type: none"> <li>To prepare basic liquid media, solid media, agar slants and agar deep tube for the routine cultivation of bacteria and fungi.</li> <li>Isolation of pure culture by streak plate method.</li> <li>Isolation of microorganisms from soil by serial dilution and determination of CFU.</li> <li>Isolation of microorganisms from air by direct plate exposure method.</li> <li>Preservation of microbial cultures by making glycerol stock and revival of culture.</li> <li>To perform Gram's staining, endospore staining and negative staining of bacteria.</li> <li>Assessment of bacterial motility by hanging drop method.</li> <li>Antibiotic sensitivity test using <i>Bacillus subtilis</i>.</li> <li>Lactic acid estimation.</li> <li>Study of chiasma formation and calculation of chiasma frequency in meiosis.</li> <li>Problems of genetics: <ul style="list-style-type: none"> <li>Mendel's law and its deviation.</li> <li>Human genetics: Widow's peak, earlobe, index finger, straight and curly hair, rolling of tongue.</li> </ul> </li> <li>Testing of blood groups including Rh factors to observe the phenomenon of agglutination.</li> <li>To study the various lymphoid glands (spleen and</li> </ol> | Microbiological exercise have been more specified |



| S No. | Course List  | Learning Outcomes   | Existing Syllabus  | Suggested Syllabus   | Remarks |
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|       |  | analyze unknown samples successfully.   |  | <p>thymus).</p> <p>14. To study different type of cells participating in non-specific immunity.</p> <p>15. Immuno precipitation by double diffusion technique.</p> <p><b>Suggested Books:</b></p> <ul style="list-style-type: none"> <li>➤ Aneja, K.R. (1996). <i>Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation</i> (2<sup>nd</sup> ed.). New Delhi: Wishwa Prakashan.</li> <li>➤ Ghose, K., &amp; Manna, B. (2016). <i>Practical Zoology</i> (4<sup>th</sup> ed.). Kolkata: New Central Book Agency.</li> <li>➤ Kumar, V. (2011). <i>Laboratory Manual of Microbiology</i>. New Delhi: Scientific Publishers.</li> <li>➤ Mahajan, R., Sharma, J., &amp; Mahajan, R.K. (2010). <i>Practical Manual of Biotechnology</i> (1<sup>st</sup> ed.). New Delhi: Vayu Education of India.</li> </ul> |         |
| 15.   | <b>ZOO 202:</b><br>Comparative Anatomy and Embryology of Chordates | <p>On completion of the course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Understand the comparative anatomy of various organ systems with special reference to <i>Scoliodon, Rana, Uromastix, Columba</i> and <i>Oryctolagus</i>.</li> <li>• Gain the fundamental knowledge about the development of frog, Hen's egg and chick to understand the principles of</li> </ul> | <p><b>Unit 1</b></p> <ul style="list-style-type: none"> <li>• Comparative anatomy with special reference to <i>Scoliodon, Rana, Uromastix, Columba</i> and <i>Oryctolagus</i>:</li> <li>• Integumentary system: Skin and its derivatives.</li> <li>• Skeleton system: Development of chondrocranium and vertebra; jaw suspension.</li> <li>• Digestive system: Alimentary canal and associated glands.</li> </ul> <p><b>Unit 2</b></p> <ul style="list-style-type: none"> <li>• Comparative anatomy with special reference to <i>Scoliodon, Rana, Uromastix, Columba</i> and <i>Oryctolagus</i>:</li> <li>• Respiratory system: Respiratory organs.</li> <li>• Circulatory system: Evolution of heart and aortic arches.</li> <li>• Urinogenital system: Evolution of kidney and urinogenital ducts.</li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>• Comparative anatomy with special reference to</li> </ul> | No change in the syllabus  |         |

| S No. | Course List | Learning Outcomes   | Existing Syllabus  | Suggested Syllabus  | Remarks |
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|       |             | developmental biology.<br>• Gain an elementary idea about reproductive biology. | <p><i>Scoliodon, Rana, Uromastix, Columba</i> and <i>Oryctolagus</i>:</p> <ul style="list-style-type: none"> <li>• Nervous System: Brain and spinal cord.</li> <li>• Eye.</li> <li>• Ear.</li> </ul> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>• Elementary idea about the formation of egg and sperm.</li> <li>• Fertilization, parthenogenesis, induction and regeneration.</li> <li>• Development of frog upto the end of neurulation, tadpole larva and its metamorphosis.</li> </ul> <p><b>Unit 5</b></p> <ul style="list-style-type: none"> <li>• Detailed structure of Hen's egg and its development upto 4th somite stage.</li> <li>• Structure, development and functions of extraembryonic membranes in chick.</li> <li>• Definition of placenta, types and functions of mammalian placenta.</li> </ul> <p><b>Books Recommended:</b></p> <ul style="list-style-type: none"> <li>➤ Chordates: R. L. Kotpal, Rastogi Publications, Meerut.</li> <li>➤ A text book of Zoology: Chordates (Comparative anatomy): P.S. Dhami and J.K. Dhami, Pradeep's Publication.</li> <li>➤ Vertebrates: Comparative Anatomy, fanctron Evolution 3rd Ed.: Kardong, TMH.</li> <li>➤ A text book of Chordate Zoology: S.N. Prasad.</li> <li>➤ A text book of Chordate Zoology: H.C. Nigam, Pub. Sohanlal Nagin Chand, 1995.</li> <li>➤ Comparative anatomy of Chordates: Charles. J. Weichert.</li> <li>➤ Development Biology: P.C. Jain.</li> <li>➤ Development Biology: Balinsky.</li> </ul> | <p><b>Suggested Books:</b></p> <ul style="list-style-type: none"> <li>➤ Balinsky, B.I. (2012). <i>An Introduction to Embryology</i> (5<sup>th</sup> ed.). New Delhi: Cengage Learning India.</li> <li>➤ Chaki, K.K., Kundu, G., &amp; Sarkar, S. (2016). <i>Introduction to General Zoology Vol-II</i>. Kolkata: New Central Book Agency.</li> <li>➤ Dhami P.S., &amp; Dhami, J.K. <i>Chordate Zoology</i>. New Delhi: R. Chand and Co.</li> <li>➤ Jain, P.C. (2013). <i>Elements of Developmental Biology (Chordate Embryology)</i> (7<sup>th</sup> ed.). New Delhi: Vishal Publishing Co.</li> <li>➤ Kardong, K.V. (2011). <i>Vertebrates: Comparative Anatomy, Function, Evolution</i> (6<sup>th</sup> ed.). McGraw-Hill Education.</li> <li>➤ Kent, G.C., &amp; Carr, R.K. (2000). <i>Comparative Anatomy of the Vertebrates</i> (9<sup>th</sup> ed.). Europe:</li> </ul> |         |

| S No. | Course List | Learning Outcomes | Existing Syllabus | Suggested Syllabus  | Remarks |
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|       |             |                   |                   | <p>McGraw-Hill Science.</p> <ul style="list-style-type: none"> <li>➤ Kotpal, R.L. (2018). <i>Modern Text book of Zoology: Vertebrates</i> (4<sup>th</sup> ed.). Meerut: Rastogi Publications.</li> <li>➤ Kotpal, R.L., Sastry, K.V., &amp; Shukla, V. (2017). <i>Comparative Anatomy &amp; Developmental Biology</i>. Meerut: Rastogi Publication.</li> <li>➤ Lahiri, B.K. (2014). <i>College Zoology Vol-II</i>. Mumbai: Himalaya Publishing House.</li> <li>➤ Prasad, S.N., &amp; Kashyap, V. (2010). <i>A text book of Vertebrate Zoology</i> (XIV Ed.). New Delhi: New Age International (P) Limited.</li> <li>➤ Sastry, K.V., &amp; Shukla, V. (2017). <i>Developmental Biology</i>. Meerut: Rastogi Publications.</li> <li>➤ Saxena, R.K. &amp; Saxena, S. (2016). <i>Comparative Anatomy of Vertebrates</i> (2<sup>nd</sup> ed.). Viva Books Private Limited.</li> <li>➤ Srivastava, M.L. (1985). <i>An introduction to the Comparative Anatomy of Vertebrates</i>. Allahabad: Central Book Depot.</li> <li>➤ Verma, P.S., &amp; Agrawal, V.K. (2017). <i>Chordate Embryology: Developmental Biology</i>. New Delhi: S Chand.</li> </ul> <p><b>Suggested e-Resources:</b></p> <ul style="list-style-type: none"> <li>➤ <b>Comparative anatomy</b><br/><a href="http://www.iaszoology.com/category/comparative-anatomy/">http://www.iaszoology.com/category/comparative-anatomy/</a></li> <li>➤ <b>Chick development</b><br/><a href="http://www.notesonzoology.com/vertebrates/chick/development-of-chick-with-diagram-vertebrates-chordata-zoology/8645">http://www.notesonzoology.com/vertebrates/chick/development-of-chick-with-diagram-vertebrates-chordata-zoology/8645</a><br/><a href="http://www.macollege.in/app/webroot/uploads/department_materials/doc_139.pdf">http://www.macollege.in/app/webroot/uploads/department_materials/doc_139.pdf</a></li> <li>➤ <b>Developmental biology</b><br/><a href="https://www.shomusbiology.com/developmental-biology.html">https://www.shomusbiology.com/developmental-biology.html</a></li> </ul> |         |

| S No. | Course List   | Learning Outcomes  | Existing Syllabus  | Suggested Syllabus   | Remarks |
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| 16.   | <b>ZOO 202L:</b><br>Comparative Anatomy and Embryology of Chordates Lab | On completion of the course, students will be able to: <ul style="list-style-type: none"> <li>Identify higher chordate animals based on the external features.</li> <li>Identify and distinguish bones of <i>Rana</i>, <i>Varanus</i>, Fowl and <i>Oryctolagus</i>.</li> <li>Understand histology of organs and endocrine glands through microscopic study of slides.</li> <li>Understand the development of frog and chick through microscopic slides.</li> </ul> | <ul style="list-style-type: none"> <li>Permanent mountings : <ol style="list-style-type: none"> <li>Placoid and ctenoid scales.</li> <li>Cartilage and striated muscle fibres of amphibian.</li> <li>Filoplumes.</li> <li>Blood film of mammal.</li> </ol> </li> <li>Osteology: A comparative study of articulated and disarticulated bones of <i>Rana</i>, <i>Varanus</i>, Fowl and <i>Oryctolagus</i>.</li> <li>Study of Microscopic slides. <ol style="list-style-type: none"> <li>Comparative study of microscopic slides with special reference to <i>Rana</i>, <i>Varanus</i>, bird and Mammal: V.S. of skin, oesophagus, stomach, intestine, liver, pancreas, Lung, Kidney, Testis, Ovary, Spinal Cord.</li> <li>T.S. of endocrine glands of a mammal.</li> </ol> </li> <li>Study of Museum specimens : <ol style="list-style-type: none"> <li>Cyclostomata : <i>Amnocoete</i> larva, <i>Petromyzon</i>, <i>Myxine</i> and <i>Bdellostoma</i>.</li> <li>Pisces: <i>Sphyrna</i>, <i>Torpedo</i>, <i>Pristis</i>, <i>Stingray</i>, <i>Chimaera</i>, <i>Acipensor</i>, <i>Amia</i>, <i>Labeo</i>, <i>Wallago</i>, <i>Saccobranclus</i>, <i>Anguilla</i>, <i>Exocoetus</i>, <i>Belone</i>, <i>Hippocampus</i>, <i>Syngnathus</i>, <i>Echeries</i>, <i>Porcupine</i> and <i>Protopterus</i>.</li> <li>Amphibia: <i>Ichthyophis</i>, <i>Ambystoma</i>, Axolotal Larva, <i>Salamandra</i>, <i>Necturus</i>, <i>Siren</i>, <i>Alytes</i>, <i>Pipa</i>, <i>Hyla</i> and <i>Rhacophorus</i>.</li> <li>Reptilia: <i>Chelone</i>, turtle, <i>Testudo</i>, <i>Sphenodon</i>, <i>Phrynosoma</i>, <i>Chaemeleon</i>, <i>Calotes</i>, <i>Hemidactylus</i>, <i>Draco</i>, <i>Hydrophis</i>, <i>Eryx</i>, <i>Python</i>, <i>Naja</i>, <i>Viper</i>, <i>Bungarus</i> and <i>Crocodilus</i>.</li> <li>Aves: <i>Archaeopteryx</i>, <i>Psittaculla</i>, <i>Passer</i>, <i>Columba</i> and <i>Pavo</i>.</li> </ol> </li> </ul> | <p>➤ <b>Frog development</b><br/><a href="http://www.notesonzooology.com/frog/development-of-frog-with-diagram-vertebrates-chordata-zoology/8626">http://www.notesonzooology.com/frog/development-of-frog-with-diagram-vertebrates-chordata-zoology/8626</a></p> <ol style="list-style-type: none"> <li>Permanent mountings: <ol style="list-style-type: none"> <li>Placoid and ctenoid scales</li> <li>Cartilage and striated muscle fibres of amphibian.</li> <li>Filoplumes.</li> <li>Blood film of mammal.</li> </ol> </li> <li>Osteology: A comparative study of articulated and disarticulated bones of <i>Rana</i>, <i>Varanus</i>, Fowl and <i>Oryctolagus</i>.</li> <li>Comparative study of microscopic slides with special reference to amphibian and mammal: <ol style="list-style-type: none"> <li>V.S. of skin, oesophagus, stomach, intestine, liver, pancreas, lung, kidney, testis, ovary, spinal cord.</li> <li>T.S. of endocrine glands of a mammal (pituitary, thyroid, parathyroid, adrenal).</li> </ol> </li> <li>Study of museum specimens: <ol style="list-style-type: none"> <li>Cyclostomata: Amnocoete larva, <i>Petromyzon</i>, <i>Myxine</i> and <i>Bdellostoma</i>.</li> <li>Pisces: <i>Sphyrna</i>, <i>Torpedo</i>, <i>Pristis</i>, Stingray, <i>Chimaera</i>, <i>Acipensor</i>, <i>Amia</i>, <i>Labeo</i>, <i>Wallago</i>, <i>Saccobranclus</i>, <i>Anguilla</i>, <i>Exocoetus</i>, <i>Belone</i>, <i>Hippocampus</i>, <i>Syngnathus</i>, <i>Echeries</i>, <i>Porcupine</i> and <i>Protopterus</i>.</li> <li>Amphibia: <i>Ichthyophis</i>, <i>Ambystoma</i>, Axolotal larva, <i>Salamandra</i>, <i>Necturus</i>, <i>Siren</i>, <i>Alytes</i>, <i>Pipa</i>, <i>Hyla</i> and <i>Rhacophorus</i>.</li> <li>Reptilia: <i>Chelone</i>, Turtle, <i>Testudo</i>, <i>Sphenodon</i>, <i>Phrynosoma</i>, <i>Chaemeleon</i>, <i>Calotes</i>, <i>Hemidactylus</i>, <i>Draco</i>, <i>Hydrophis</i>, <i>Eryx</i>, <i>Python</i>, <i>Naja</i>, <i>Viper</i>, <i>Bungarus</i> and <i>Crocodilus</i>.</li> <li>Aves: <i>Archaeopteryx</i>, <i>Psittaculla</i>, <i>Passer</i>, <i>Columba</i> and <i>Pavo</i>.</li> <li>Mammalia: <i>Ornithorynchus</i>, <i>Tachyglossus</i>,</li> </ol> </li> </ol> |         |

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|  |   |  | (vi) Mammalia: <i>Ornithorynchus</i> , <i>Tachyglossus</i> , <i>Pteropus</i> , <i>Funambulus</i> , Hedgehog, Mongoose and <i>Oryctolagus</i> .<br>• Development of Chordates :<br>(i) Study of the development and metamorphosis of Frog with the aid of permanent prepared slides.<br>(ii) W.M. of Primitive steak, head folds, 18hrs, 24 hrs 33hrs and of chick embryo, T.S. of chick embryo through various regions upto 4th somite state with aid of permanent prepared slides.  | <i>Pteropus</i> , <i>Funambulus</i> , <i>Hedgehog</i> , Mongoose and <i>Oryctolagus</i> .<br>5. Development of Chordates:<br>(i) Study of the development and metamorphosis of frog with the aid of permanent prepared slides.<br>(ii) W.M. of primitive steak, head folds, 18hrs, 24hrs and 33hrs of chick embryo, T.S. of chick embryo through various regions upto 4th somite state with aid of permanent prepared slides.<br><b>Suggested Books:</b><br>➤ Ghose, K., & Manna, B. (2016). <i>Practical Zoology</i> (4 <sup>th</sup> ed.). Kolkata: New Central Book Agency.<br>➤ Lal, S.S. (2015). <i>Practical Zoology: Vertebrates</i> (11 <sup>th</sup> ed.). Meerut: Rastogi Publication.<br>➤ Poddar, T., Mukhopadhyay, S., & Das, S.K. (2003). <i>An advanced Laboratory Manual of Zoology</i> . Kolkata: Macmillan India Limited.<br>➤ Verma, P.S. (2010). <i>A Manual of Practical Zoology: Chordates</i> (11 <sup>th</sup> ed.). New Delhi: S Chand Publishing. |         |
| <b>B.Sc. Biotechnology V &amp; VI Semester</b> |   |  |  |   |         |
| <b>Botany Discipline Electives-I &amp; II</b>  |   |  |  |   |         |
| 1)   | <b>Discipline Elective:-6.1:</b> Introduction to Genetics and Genetic Engineering | On completion of the course, students will be able to:<br>• Acquire knowledge of the structure and arrangement of the genome in living organisms.<br>• Understand the biochemical nature of nucleic acids, their role in living systems.<br>• Impart basic genetic | <b>Unit 1</b> <ul style="list-style-type: none"> <li>• Organization of Eukaryotic Chromosomes.</li> <li>• Bacterial Genetics.</li> <li>• Cell cycle, Mitosis and Meiosis.</li> <li>• Eugenics and Genetic Counseling.</li> </ul> <b>Unit 2</b> <ul style="list-style-type: none"> <li>• Mendel's experiments: Laws of inheritance, interaction of factors (Modified dihybrid ratios).</li> <li>• Quantitative inheritance, Linkage, crossing over, multiple alleles, Sex determination, Sex Linked inheritance.</li> <li>• Extra chromosomal inheritance.</li> </ul> | <b>Discipline Elective:</b><br><b>BOT 302: Introduction to Genetics and Genetic Engineering</b><br><b>Unit 1</b> <ul style="list-style-type: none"> <li>• Organization of eukaryotic chromosomes.</li> <li>• Bacterial genetics.</li> <li>• Cell cycle, mitosis and meiosis.</li> <li>• Eugenics and genetic counseling.</li> </ul> <b>Unit 2</b> <ul style="list-style-type: none"> <li>• Genetic terminology, Mendel's experiments: Laws of inheritance, interaction of factors (Modified dihybrid ratios).</li> <li>• Quantitative inheritance, linkage, crossing over, multiple alleles.</li> </ul>   |         |

| S No. | Course List | Learning Outcomes  | Existing Syllabus   | Suggested Syllabus  | Remarks |
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|       |             | <p>manipulation techniques and their application for human welfare.</p> <ul style="list-style-type: none"> <li>• Translate concepts in genetic engineering to their own research.</li> </ul> | <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>• Chromosomal aberrations- structural and numerical</li> <li>• Mutations</li> <li>• Gene: Basic concept</li> <li>• Isolation of eukaryotic mRNA, cDNA synthesis and library</li> <li>• Genomic library</li> </ul> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>• Restriction enzymes</li> <li>• Vectors- plasmids, phages, cosmids</li> <li>• Construction of recombinant DNA</li> <li>• Screening and selection of recombinant clones</li> </ul> <p><b>Unit 5</b></p> <ul style="list-style-type: none"> <li>• Isolation of DNA- plasmid, plant genomic DNA, phage DNA</li> <li>• General idea of Patents and Bio safety Guidelines.</li> <li>• Biotechnology: Definition, Application of Biotechnology, Basic concept of Biotechnological processes</li> <li>• Edible vaccines</li> </ul> <p><b>Books recommended:</b></p> <ul style="list-style-type: none"> <li>➤ Genetics: Stirckberger Prentice Hall of India.</li> <li>➤ Principles of Genetics 9th Ed: Gardner, Simmons, Snustad, John Wiley &amp; Sons.</li> <li>➤ Genetics: P.K. Gupta, Rastogi Publications Meerut.</li> <li>➤ Genetics –A molecular approach: T.A. Brown, Chapman and Hall.</li> <li>➤ Concepts of Genetics 7th Ed.: William S. Klug, Pearson Education.</li> <li>➤ Principles of Genetics: R.H. Tamarin, Tata McGraw Hill.</li> <li>➤ Genetics-From Genes to Genomes: Hartwell, McGraw Hill.</li> <li>➤ Genetics 5th Ed.: D.L. Hartl and E.W. Jones, Jones and</li> </ul> | <ul style="list-style-type: none"> <li>• Sex determination and sex linked inheritance.</li> <li>• Extra chromosomal inheritance.</li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>• Chromosomal aberrations- structural and numerical.</li> <li>• Mutations.</li> <li>• Gene: Basic concept.</li> <li>• Isolation of eukaryotic mRNA, cDNA synthesis and library.</li> <li>• Genomic library.</li> </ul> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>• Restriction enzymes.</li> <li>• Vectors- plasmids, phages, cosmids.</li> <li>• Construction of recombinant DNA.</li> <li>• Screening and selection of recombinant clones.</li> </ul> <p><b>Unit 5</b></p> <ul style="list-style-type: none"> <li>• Isolation of DNA- plasmid, plant genomic DNA, phage DNA.</li> <li>• General idea of patents and bio safety guidelines.</li> <li>• Biotechnology: Definition, application of biotechnology, basic concept of biotechnological processes.</li> <li>• Edible vaccines.</li> </ul> <p><b>Suggested Books:</b></p> <ul style="list-style-type: none"> <li>➤ Borem, A., Santos, F.R., &amp; Bowen, D.E. (2003). <i>Understanding Biotechnology</i> (1<sup>st</sup> d.). USA: Prentice Hall.</li> <li>➤ Brown, T. (2011). <i>Introduction to Genetics –A molecular approach</i> (1<sup>st</sup> ed.). USA: Garland Science.</li> <li>➤ Brown, T.A. (2010). <i>Gene Cloning and DNA Analysis: An Introduction</i> (6<sup>th</sup> ed.). USA: Wiley-Blackwell.</li> <li>➤ Gardner, E.J., Simmons, M.J., &amp; Snustad, D.P. (2005). <i>Principles of Genetics</i> (8<sup>th</sup> ed.). New Jersey, USA: John Wiley &amp; Sons Ltd.</li> </ul> |         |

| S No. | Course List | Learning Outcomes | Existing Syllabus   | Suggested Syllabus  | Remarks |
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|       |             |                   | <p>Barlett Publishers, Canada.</p> <ul style="list-style-type: none"> <li>➤ An Introduction to Genetic Analysis: Suzuki, Griffith, Miller &amp; Lewonith.</li> <li>➤ Microbial Genetics: D. Friefelder, Narosa Publications, New Delhi</li> <li>➤ Molecular Biology of Gene: J.D.Watson, Pearson Education.</li> <li>➤ Gene VIII: Lewin, Pearson Education.</li> <li>➤ Biotechnology by B.D. Singh.</li> <li>➤ Plant Biotechnology by P.K. Gupta.</li> <li>➤ Principles of Gene Manipulation: Old &amp; Primrose, Blackwell Scientific Publications.</li> <li>➤ Understanding Biotechnology: Aluizo Borem, Pearson Education.</li> <li>➤ Molecular Biotechnology: B.R. Glick and J.J. Pasternak, ASM Press, Washington, USA.</li> <li>➤ An Introduction to Gene Technology-From genes to clones: Winnacker, VCH.</li> </ul> | <ul style="list-style-type: none"> <li>➤ Glick, B.R., &amp; Patten, C.L. (2017). <i>Molecular Biotechnology: Principles and Applications of Recombinant DNA</i> (5<sup>th</sup> ed.). USA: American Society for Microbiology Press.</li> <li>➤ Griffiths, A.J.F., Miller, J.H., Suzuki, D.T., Lewonith, R.C. &amp; Gelbert, W.M. (2000). <i>An Introduction to Genetic Analysis</i> (7<sup>th</sup> ed.). New York, U.S.: W. H. Freeman.</li> <li>➤ Gupta, P.K. (2009). <i>Genetics</i>. Meerut: Rastogi Publications.</li> <li>➤ Gupta, P.K. (2010). <i>Plant biotechnology</i>. Meerut: Rastogi Publications.</li> <li>➤ Hartl, D.L. &amp; Jones, E.W. (1997). <i>Genetics: Analysis of Genes and Genome</i> (9<sup>th</sup> ed.). Canada: Jones and Barlett Publishers.</li> <li>➤ Hartwell, L., Hood, M., Goldberg, M., Reynolds, A.E., &amp; Silver, L. (2010). <i>Genetics: From Genes to Genomes</i> (4<sup>th</sup> ed.). New York: McGraw-Hill Education.</li> <li>➤ Klug, W.S., Cummings, M.R., Spencer, C.A., Palladino, M.A., Killian, D. (2018). <i>Concepts of Genetics</i> (12<sup>th</sup> ed.). USA: Pearson Education.</li> <li>➤ Krebs, J.E., Goldstein, E.S., &amp; Kilpatrick, S.T. (2012). <i>Lewin's Genes XI</i> (11<sup>th</sup> ed.). USA: Jones and Bartlett Publishers.</li> <li>➤ Maloy, S.R., Cronan, J.E., &amp; Friefelder, D. (1994). <i>Microbial Genetics</i> (2<sup>nd</sup> ed.). USA: Jones and Bartlett.</li> <li>➤ Primrose, S.B., &amp; Twyman, R. (2006). <i>Principles of Gene Manipulation and Genomics</i> (7<sup>th</sup> ed.) UK: Oxford University Press.</li> <li>➤ Singh, B.D. (2015). <i>Biotechnology</i>. New Delhi: Kalyani Publishers.</li> <li>➤ Strickberger, M.W. (1995). <i>Genetics</i> (3<sup>rd</sup> ed.). New Delhi: Prentice Hall India Learning Private Limited.</li> <li>➤ Tamarin, R.H. (2004). <i>Principles of Genetics</i> (7<sup>th</sup> ed.). USA: McGraw-Hill Higher Education.</li> </ul> |         |

| S No. | Course List  | Learning Outcomes  | Existing Syllabus   | Suggested Syllabus  | Remarks |
|-------|--|--|---|---|---------|
|       |  |  |   | <ul style="list-style-type: none"> <li>➤ Watson, J.D., Tania, A.B., &amp; Stephen, P.B. (2017). <i>Molecular Biology of the Gene</i> (7<sup>th</sup> ed.). USA: Pearson Education.</li> <li>➤ Winnacker, E.L. (1987). <i>From Genes to Clones: Introduction to Gene Technology</i>. Germany: Wiley VCH.</li> </ul> <p><b>Suggested e- Resources:</b></p> <ul style="list-style-type: none"> <li>➤ <b>Genetics</b><br/><a href="https://www.britannica.com/science/genetics">https://www.britannica.com/science/genetics</a></li> <li>➤ <b>Recombinant-DNA-technology</b><br/><a href="https://www.britannica.com/science/recombinant-DNA-technology">https://www.britannica.com/science/recombinant-DNA-technology</a><br/><a href="https://nptel.ac.in/courses/102103013/4">https://nptel.ac.in/courses/102103013/4</a><br/><a href="http://www.agbioworld.org/biotech-info/topics/dev-world/policies4.html">http://www.agbioworld.org/biotech-info/topics/dev-world/policies4.html</a></li> <li>➤ <b>Principles &amp; processes of recombinant-DNA-technology</b><br/><a href="https://www.toppr.com/guides/biology/biotechnology-principles-and-process/processes-of-recombinant-dna-technology/">https://www.toppr.com/guides/biology/biotechnology-principles-and-process/processes-of-recombinant-dna-technology/</a></li> <li>➤ <b>Vectors used in genetic engineering</b><br/><a href="http://www.biologydiscussion.com/genetic-engineering/vectors-used-in-genetic-engineering-biotechnology/61382">http://www.biologydiscussion.com/genetic-engineering/vectors-used-in-genetic-engineering-biotechnology/61382</a></li> <li>➤ <b>Patent rights in India</b><br/><a href="https://www.hg.org/legal-articles/patent-rights-in-india-4995">https://www.hg.org/legal-articles/patent-rights-in-india-4995</a></li> </ul> |         |
| 2)    | <b>Discipline Elective:</b><br><del>6.2:</del> Genetic and Genetic Engineering Lab | On completion of the course, students will be able to:<br><ul style="list-style-type: none"> <li>• Develop skills and understanding about different techniques used in genetics and genetic engineering</li> </ul> | <ol style="list-style-type: none"> <li>1. Problems of Genetics</li> <li>2. Models based on Mendel's law</li> <li>3. Human Genetics: Tongue rolling, Widow's peak, Ear lobes, Little finger.</li> <li>4. Estimation of standard DNA.</li> <li>5. Determination of purity of standard DNA</li> <li>6. Determination of <math>\lambda_{\max}</math> of standard DNA.</li> <li>7. Isolation of DNA from plant cells.</li> </ol> | <p><b>Discipline Elective:</b><br/><b>BOT 302L: Genetic and Genetic Engineering Lab</b></p> <ol style="list-style-type: none"> <li>1. Problems of genetics.</li> <li>1. Models based on Mendel's law.</li> <li>2. Human genetics: Tongue rolling, widow's peak, ear lobes, little finger.</li> <li>3. Estimation of standard DNA by DPA method.</li> <li>4. Determination of purity of standard DNA.</li> </ol>   |         |



| S No. | Course List  | Learning Outcomes  | Existing Syllabus   | Suggested Syllabus  | Remarks |
|-------|--|--|---|---|---------|
|       |  | <ul style="list-style-type: none"> <li>Critically analyze and interpret data generated from each practical</li> <li>Develop knowledge about genetic problems such as genetic mapping, test cross etc.</li> </ul>   |   | 5. Determination of $\lambda_{\max}$ of standard DNA.<br>6. Isolation of DNA from plant cells.<br>7. Restriction digestion of DNA.<br>8. Agarose gel electrophoresis of DNA.<br>9. Basic biosafety guidelines in the laboratory.<br><b>Suggested Books:</b><br>➤ Purohit, S.D. (2007). <i>Molecular Biology and Biotechnology: A Practical Manual</i> . Udaipur: Apex Publishing House.<br>➤ Vats, S. (2015). <i>A Laboratory Textbook of Biochemistry, Molecular biology and Microbiology</i> . GRIN Verlag.   |         |
| 3)    | <b>Discipline Elective</b><br><del>5.1:</del> Plant Physiology and Ecology | On completion of the course, students will be able to: <ul style="list-style-type: none"> <li>Comprehend about life processes happening inside plants and how they cope with varied biotic and abiotic factors.</li> <li>Understand maintenance of ecological balance and role of man in the degradation of the environment and to suggest remedies.</li> <li>Highlight the potential of these studies to become an entrepreneur.</li> </ul> | <b>Unit 1</b> <ul style="list-style-type: none"> <li>Plant water relations: Importance of water to plant life; movement of water across the membranes, ascent of sap; transpiration.</li> <li>Mineral nutrition: Methods to study the availability of macro and micro elements, uptake and roles of mineral elements.</li> <li>Translocation of organic substances: General principle and mechanism.</li> </ul> <b>Unit 2</b> <ul style="list-style-type: none"> <li>Photosynthesis: Photosynthetic pigments, factors affecting photosynthesis, mechanism of photosynthesis, role of light, carbon fixation in plants, Photophosphorylation.</li> <li>Respiration: Significance and mechanism, factors affecting respiration, release and utilization of biochemical energy, ATP synthesis.</li> </ul> <b>Unit 3</b> <ul style="list-style-type: none"> <li>Fat Metabolism: Mechanism of synthesis and break down of fats.</li> <li>Nitrogen metabolism: Nitrate assimilation, nitrogen fixation, amino acid synthesis and nitrogen cycle.</li> <li>Growth and Development: Physiology of dormancy and</li> </ul> | <b>Discipline Elective</b><br><b>BOT 303: Plant Physiology and Ecology</b><br><b>Unit 1</b> <ul style="list-style-type: none"> <li>Plant water relations: Importance of water to plant life; movement of water across the membranes, ascent of sap; transpiration.</li> <li>Mineral nutrition: Methods to study the availability of macro and micro elements, uptake and roles of mineral elements.</li> <li>Translocation of organic substances: General principle and mechanism.</li> </ul> <b>Unit 2</b> <ul style="list-style-type: none"> <li>Photosynthesis: Photosynthetic pigments, factors affecting photosynthesis, mechanism of photosynthesis, role of light, carbon fixation in plants, Photophosphorylation.</li> <li>Respiration: Significance and mechanism, factors affecting respiration, release and utilization of biochemical energy, ATP synthesis.</li> </ul> <b>Unit 3</b> <ul style="list-style-type: none"> <li>Fat Metabolism: Mechanism of synthesis and break down of fats.</li> <li>Nitrogen metabolism: Nitrate assimilation, nitrogen fixation, amino acid synthesis and nitrogen cycle.</li> </ul> |         |

| S No. | Course List | Learning Outcomes | Existing Syllabus  | Suggested Syllabus  | Remarks |
|-------|-------------|-------------------|--|---|---------|
|       |             |                   | <p>seed germination, vegetative and reproductive growth, Vernalization and Photoperiodism.</p> <ul style="list-style-type: none"> <li>Growth regulators: Auxins, gibberellins, cytokinins, ethylene and abscissic acid, their physiological importance.</li> </ul> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>Ecology.</li> <li>Plant environment: Climatic, edaphic, topographic and biotic factors.</li> <li>Ecosystem: Brief concept, food chains, ecological pyramids (Pyramids of number, mass and energy), energetics, biochemical cycling.</li> </ul> <p><b>Unit 5</b></p> <ul style="list-style-type: none"> <li>Plant communities: Structure, classification, diversity, dynamics.</li> <li>Applied ecology: Introduction to restoration ecology.</li> <li>Environmental pollution (Air, Water and Radioactive), Conservation, Plant indicators.</li> </ul> <p><b>Books Recommended:</b></p> <ul style="list-style-type: none"> <li>➤ Plant Physiology: Devlin &amp; Witham, Van Narst, New Delhi: East West Press, 1974.</li> <li>➤ Plant Physiology: Salisbury &amp; Ross, Prentice Hall of India.</li> <li>➤ Introductory Plant Physiology: Noggle &amp; Fritz, Prentice Hall of India.</li> <li>➤ Plant Physiology: Taiz and Zeiger.</li> <li>➤ Introduction to Plant Physiology: W.G. Hopkins and Hunner John Wiley and Sons Inc.</li> <li>➤ Plant Physiology: Pandey &amp; Sinha.</li> <li>➤ Ecology &amp; Environment: P.D. Sharma, Rastogi Publications, Meerut.</li> <li>➤ Fundamentals of Ecology: E.P. Odum, Natraj Publishers, Dehradun, India.</li> <li>➤ Plant Physiology: H.N. Srivastava, Vikas Publishing House.</li> </ul> | <ul style="list-style-type: none"> <li>Growth and development: Physiology of dormancy and seed germination, vegetative and reproductive growth, vernalization and photoperiodism.</li> <li>Growth regulators: Auxins, gibberellins, cytokinins, ethylene and abscissic acid, their physiological importance.</li> </ul> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>Ecology.</li> <li>Plant environment: Climatic, edaphic, topographic and biotic factors.</li> <li>Ecosystem: Brief concept, food chains, ecological pyramids (pyramids of number, mass and energy), energetics, biochemical cycling.</li> </ul> <p><b>Unit 5</b></p> <ul style="list-style-type: none"> <li>Plant communities: Structure, classification, diversity, dynamics.</li> <li>Applied ecology: Introduction to restoration ecology.</li> <li>Environmental pollution (air, water, noise and radioactive), Conservation, plant indicators.</li> </ul> <p><b>Suggested Books:</b></p> <ul style="list-style-type: none"> <li>➤ Ambhast, R.S. (2008). <i>Plant Ecology</i>. New Delhi: CBS.</li> <li>➤ Dutta, S.C. (2012). <i>Plant Physiology</i>. New Delhi: New age International Publishers.</li> <li>➤ Hopkins, W.G. &amp; Huner, N.P.A. (2008). <i>Introduction to Plant Physiology</i>. New Jersey: John Wiley and Sons Inc.</li> <li>➤ Narst, V., Devlin &amp; Witham. (1974). <i>Plant Physiology</i>. New Delhi: East West Press.</li> <li>➤ Noggle, G.R. &amp; Fritz, G.J. (1992). <i>Introductory Plant Physiology</i>. New Delhi: Prentice Hall of India.</li> <li>➤ Odum, E.P. (2004). <i>Fundamentals of Ecology</i>. Dehradun: Natraj Publishers.</li> <li>➤ Pandey, S.N. &amp; Sinha, B.K. (2015). <i>Plant Physiology</i>. New Delhi: Vikas Publishing House.</li> <li>➤ Salisbury &amp; Ross. (2012). <i>Plant Physiology</i>. New Delhi:</li> </ul> |         |

| S No. | Course List  | Learning Outcomes  | Existing Syllabus  | Suggested Syllabus   | Remarks |
|-------|--|--|--|--|---------|
|       |  |  | <ul style="list-style-type: none"> <li>➤ Plant Physiology: S. C. Dutta.</li> <li>➤ Plant Ecology: Ambast and Ambast.</li> </ul>  | Prentice Hall of India.<br><ul style="list-style-type: none"> <li>➤ Sharma, P.D. (2003). <i>Ecology &amp; Environment</i>. Meerut: Rastogi Publications.</li> <li>➤ Srivastava, H.S. (2005). <i>Plant Physiology</i>: Meerut: Rastogi Publications.</li> <li>➤ Taiz, L., &amp; Zeiger, E. (2010). <i>Plant Physiology</i>. London: Sinauer Associates.</li> </ul> <b>Suggested e-Resources:</b> <ul style="list-style-type: none"> <li>➤ <b>Plant Physiology</b><br/> <a href="https://www.udemy.com/plant-physiology/?siteID=zOCYiUhWwNM-1RExiYvhsJfnMd_rZR_ivg&amp;LSNPUBID=zOCYiUhWwNM">https://www.udemy.com/plant-physiology/?siteID=zOCYiUhWwNM-1RExiYvhsJfnMd_rZR_ivg&amp;LSNPUBID=zOCYiUhWwNM</a></li> <li>➤ <b>Ecological communities</b><br/> <a href="http://www-plb.ucdavis.edu/courses/bis/1c/text/Chapter27nf.pdf">http://www-plb.ucdavis.edu/courses/bis/1c/text/Chapter27nf.pdf</a></li> </ul>   |         |
| 4)    | <b>Discipline Elective</b><br><del>5.2:</del> Plant Physiology and Ecology Lab | On completion of the course, students will be able to: <ul style="list-style-type: none"> <li>• Understand the physiological details of photosynthesis and respiration.</li> <li>• Design experiments, collect and analyze data, critically evaluate and present the data produced in physiology or ecology.</li> <li>• Demonstrate skills related to</li> </ul> | A. List of Physiology experiments <ol style="list-style-type: none"> <li>1. Osmosis               <ol style="list-style-type: none"> <li>a. Grapes and dried raisins.</li> <li>b. Potato osmoscope and semi permeable membrane.</li> <li>c. Plasmolysis and deplasmolysis.</li> </ol> </li> <li>2. Root pressure               <ol style="list-style-type: none"> <li>a. An experiment on root pressure.</li> </ol> </li> <li>3. Transpiration               <ol style="list-style-type: none"> <li>a. Ganong's potometer and Farmer's potometer</li> <li>b. Unequal transpiration from two surfaces of a leaf                   <ol style="list-style-type: none"> <li>i. Cobalt chloride paper method.</li> <li>ii. Four leaf method with greased surface.</li> </ol> </li> <li>c. Demonstration of water lifting power of transpiration (suction force).</li> <li>d. Ringing experiment.</li> <li>e. Study of stomata</li> </ol> </li> <li>4. Photosynthesis</li> </ol> | <b>Discipline Elective</b><br><b>BOT 303L: Plant Physiology and Ecology Lab</b> <ol style="list-style-type: none"> <li>A. List of physiology experiments               <ol style="list-style-type: none"> <li>1. Osmosis                   <ol style="list-style-type: none"> <li>a. Grapes and dried raisins.</li> <li>b. Potato osmoscope and semi permeable membrane.</li> <li>c. Plasmolysis and deplasmolysis.</li> </ol> </li> <li>2. Root pressure                   <ol style="list-style-type: none"> <li>a. An experiment on root pressure.</li> </ol> </li> <li>3. Transpiration                   <ol style="list-style-type: none"> <li>a. Ganong's potometer and Farmer's photometer.</li> <li>b. Unequal transpiration from two surfaces of a leaf                       <ol style="list-style-type: none"> <li>i. Cobalt chloride paper method.</li> <li>ii. Four leaf method with greased surface.</li> </ol> </li> <li>c. Demonstration of water lifting power of transpiration (suction force).</li> <li>d. Ringing experiment.</li> <li>e. Study of stomata.</li> </ol> </li> <li>4. Photosynthesis</li> </ol> </li> </ol> |         |

| S No. | Course List                             | Learning Outcomes                             | Existing Syllabus   | Suggested Syllabus  | Remarks |
|-------|---|---|---|---|---------|
|       |   | laboratory as well as field based studies.    | <p>a. Oxygen is given off during photosynthesis (Wilmott's bubbler apparatus).</p> <p>b. Light is necessary for photosynthesis.</p> <p>c. Chlorophyll is necessary for photosynthesis.</p> <p>d. CO<sub>2</sub> is necessary for photosynthesis.</p> <p><del>e. No oxygen liberation without CO<sub>2</sub>.</del></p> <p>f. RQ by Ganong's respirometer of <del>carbohydrate, fatty seeds and <i>Opuntia</i> phylloclade.</del></p> <p>5. Respiration</p> <p>a. CO<sub>2</sub> is produced during respiration.</p> <p>b. Loss of dry weight in respiration.</p> <p>c. Anaerobic respiration.</p> <p>B. List of Ecological experiments</p> <p>1. To determine the soil temperature by soil thermometer.</p> <p>2. To measure relative humidity of the atmosphere by wet and dry-bulb thermometer or psychrometer.</p> <p>3. To determine soil texture.</p> <p>4. To test the presence of carbonate, nitrate, pH value and base deficiency in soil.</p> <p>5. To measure the light intensity.</p> <p>6. To study the structure of the plant community of an area by quadrat method and to determine the plant density, abundance and frequency <del>(the density, abundance and frequency can be calculated from a given data in laboratory during practical examination).</del></p> <p>7. To determine the water holding capacity of different soils.</p> <p>8. <del>A record of the experiments done during the year is to be submitted by the candidates.</del></p> | <p>a. Oxygen is given off during photosynthesis (Wilmott's bubbler apparatus).</p> <p>b. Light is necessary for photosynthesis.</p> <p>c. Chlorophyll is necessary for photosynthesis.</p> <p>d. CO<sub>2</sub> is necessary for photosynthesis.</p> <p>e. RQ by Ganong's respirometer (demonstration).</p> <p>5. Respiration</p> <p>a. CO<sub>2</sub> is produced during respiration.</p> <p>b. Loss of dry weight in respiration.</p> <p>c. Anaerobic respiration.</p> <p>B. List of ecological experiments</p> <p>1. To determine the soil temperature by soil thermometer.</p> <p>2. To measure relative humidity of the atmosphere by wet and dry-bulb thermometer or psychrometer.</p> <p>3. To determine soil texture.</p> <p>4. To test the presence of carbonate, nitrate, pH value and base deficiency in soil.</p> <p>5. To measure the light intensity.</p> <p>6. To study the structure of the plant community of an area by quadrat method and to determine the plant density, abundance and frequency.</p> <p>7. To determine the water holding capacity of different soils.</p> <p><b>Suggested Books:</b></p> <p>➤ Bendre, A., &amp; Kumar, A. (1984). <i>A Textbook of Practical Botany-II</i>. Meerut: Rastogi Publications.</p> |         |
| 5)    | <b>Discipline Elective: Ethnobotany</b> | <b>Learning outcomes:</b><br>On completion of |   | <b>Discipline Elective: Ethnobotany</b><br><b>Unit 1: Ethnobotany</b><br>• Introduction, concept, scope and objectives;   |         |

| S No. | Course List | Learning Outcomes  | Existing Syllabus | Suggested Syllabus   | Remarks |
|-------|-------------|--|-------------------|--|---------|
|       |             | <p>the course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Understand the science of ethnobotany, its concept, scope and objectives</li> <li>• Know the types, distribution and life style of ethnic groups in India.</li> <li>• Know the importance of tribals in present era.</li> <li>• Know the various uses of plants by the ethnic people in their daily life.</li> <li>• Know the miscellaneous uses of plants</li> <li>• Understand the methodology of ethnobotanical work</li> <li>• Know the medicinal uses of plants in crude ways.</li> <li>• Aware about the legal aspects associated with ethnobotany.</li> </ul> |                   | <p>Ethnobotany as an interdisciplinary science.</p> <ul style="list-style-type: none"> <li>• The relevance of ethnobotany in the present context.</li> <li>• Major and minor ethnic groups or Tribals of India, and their life styles.</li> </ul> <p><b>Unit 2: Ethnobotanical Uses</b></p> <ul style="list-style-type: none"> <li>• Plants used by the tribals: a) Food plants b) Fodder c) intoxicants and beverages d) Resins and oils and miscellaneous uses.</li> <li>• Plants of mythological and religious.</li> <li>• Plants mentioned in Folklore and Folk songs.</li> <li>• Plants as totems, taboos and superstition.</li> </ul> <p><b>Unit 3: Methodology of Ethnobotanical studies</b></p> <ul style="list-style-type: none"> <li>• Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places.</li> <li>• Major centers of Ethnobotany in India.</li> </ul> <p><b>Unit 4: Role of ethnobotany in modern Medicine</b></p> <ul style="list-style-type: none"> <li>• Medico-ethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology):( a) <i>Azadirachta indica</i> (b) <i>Ocimum sanctum</i> (c) <i>Vitex negundo</i> (d) <i>Gloriosa superba</i> (e) <i>Tribulus terrestris</i> (f) <i>Pongamia pinnata</i> (g) <i>Cassia auriculata</i> (h) <i>Indigofera tinctoria</i>.</li> <li>• Role of ethnobotany in modern medicine with special example <i>Rauvolfia sepentina</i>, <i>Trichopus zeylanicus</i>, <i>Artemisia</i>, <i>Withania</i>.</li> <li>• Role of ethnic groups in conservation of plant genetic resources.</li> <li>• Endangered taxa and forest management (participatory forest management).</li> </ul> <p><b>Unit 5: Ethnobotany and legal aspects</b></p> <ul style="list-style-type: none"> <li>• Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India.</li> <li>• Biopiracy, Intellectual Property Rights and Traditional</li> </ul> |         |

| S No. | Course List                                 | Learning Outcomes | Existing Syllabus | Suggested Syllabus   | Remarks |
|-------|---|-------------------|-------------------|--|---------|
|       |   |                   |                   | <p><b>Knowledge.</b></p> <p><b>Suggested Readings</b></p> <ul style="list-style-type: none"> <li>➤ Jain S.K. (1995). <i>Manual of Ethnobotany</i>, Scientific Publishers, Jodhpur, 1995.</li> <li>➤ Jain S.K. (1995). <i>Glimpses of Indian. Ethnobotny</i>, Oxford and I B H, New Delhi – 1981</li> <li>➤ Lone et al. (1980). <i>Palaeoethnobotany</i>, Oxford and I B H, New Delhi – 1981</li> <li>➤ Jain S.K. (ed.) (1989). <i>Methods and approaches in ethnobotany</i>. Society of ethnobotanists, Lucknow, India.</li> <li>➤ Jain S.K. (1990). Contributions of Indian ethnobotany. Scientific publishers, Jodhpur.</li> <li>➤ Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons, Chichester</li> <li>➤ Rama Ro, N and Henry A.N. (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah.</li> <li>➤ Rajiv K. Sinha (1996). Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur</li> <li>➤ Ethnobotany: Vinay Sharma and Afroz Alam, Rastogi Publishing House, Meerut</li> <li>➤ Faulks, P.J. 1958. An introduction to Ethnobotany, Moredale pub. Ltd.</li> </ul> <p><b>Suggested e- Resources:</b></p> <p><a href="http://botanicaldimensions.org/what-is-ethnobotany/">http://botanicaldimensions.org/what-is-ethnobotany/</a><br/> <a href="https://www.plantsnap.com/blog/casual-ethnobotany/">https://www.plantsnap.com/blog/casual-ethnobotany/</a><br/> <a href="https://trove.nla.gov.au/work/36470887?selectedversion=NBD44743330">https://trove.nla.gov.au/work/36470887?selectedversion=NBD44743330</a></p> |         |
| 6)    | <b>Discipline Elective: Ethnobotany Lab</b> |                   |                   | <p><b>Discipline Elective: Ethnobotany Lab</b></p> <ol style="list-style-type: none"> <li>1. Study of wild plants of different families at taxonomical level.</li> <li>2. Collection of locally growing plants of ethnic importance.</li> </ol>  |         |

| S No. | Course List                            | Learning Outcomes   | Existing Syllabus | Suggested Syllabus   | Remarks |
|-------|--|---|-------------------|--|---------|
|       |  |   |                   | 3. Herbarium preparation.<br>4. Study of ethnic groups through photographs and available literature.<br>5. Preparation of plants' extract.<br>6. Analysis of phytochemicals.   |         |
| 7)    | <b>Disciple Elective: Horticulture</b> | After completion of the course students will be able to: <ul style="list-style-type: none"> <li>• Understand the basic technique of plant propagation.</li> <li>• Perform cutting, grafting, budding, layering etc.</li> <li>• Grow plants in the absence of soil medium</li> <li>• Start bonsai creation</li> <li>• Know various aspects of Green House Technology</li> <li>• Start commercial cultivation of fruits and vegetables</li> </ul> |                   | <b>Disciple Elective: Horticulture</b><br><b>Unit 1:</b> <ul style="list-style-type: none"> <li>• Basic horticultural techniques (soil preparation, bed preparation, transplantation &amp; pruning)</li> <li>• Vegetative propagation of plants (a) cutting (b) grafting (c) budding (d) layering (e) other special structures.</li> </ul> <b>Unit 2:</b> <ul style="list-style-type: none"> <li>• Soil less culture (hydroponic, Aeroponics).</li> <li>• Application of Coco peat, Perlite, Vermiculite and Peat moss in horticultural practices</li> <li>• Indoor and outdoor plants.</li> <li>• Bonsai: Types, forms, structure and styles.</li> </ul> <b>Unit 3:</b> <ul style="list-style-type: none"> <li>• Greenhouse Technology: Importance, types and operation techniques.</li> <li>• Commercial uses of Green House Technology.</li> <li>• Benefits and Risks associated with Green House Technology.</li> </ul> <b>Unit 4:</b> <ul style="list-style-type: none"> <li>• Commercial cultivation of cut flowers (Roses, Gerberas &amp; Carnations).</li> <li>• Study of foliage plants (<i>Ficus</i>, <i>Croton</i> &amp; <i>Coleus</i>).</li> <li>• Study of one locally available vegetables (root, leafy, cole crops).</li> </ul> <b>Unit 5:</b> <ul style="list-style-type: none"> <li>• Study of tropical fruits (Mango, Amla, Date palm).</li> <li>• Study of temperate fruits (Apple).</li> <li>• Commercial cultivation of exotic fruits.</li> </ul> |         |

| S No.   | Course List  | Learning Outcomes   | Existing Syllabus  | Suggested Syllabus  | Remarks |
|---|--|---|--|---|---------|
|   |  |   |  | <p><b>Suggested Readings</b></p> <ul style="list-style-type: none"> <li>➤ Chalam, Venkateshwarlu, G.V.I. <i>Introduction to Agricultural Botany in India</i>. Asia Publishing House, New Delhi.</li> <li>➤ Ankur: (Magazine).</li> <li>➤ Jain, S.K. &amp; Rao, R.R. <i>A Hand book of Field &amp; Herbarium Methods</i>. Today &amp; Tomorrow's Printers &amp; Publications, New Delhi.</li> <li>➤ Hartmann and Kester. <i>Plant Propagation</i>.</li> <li>➤ Sandhu, M.K. <i>Plant Propagation</i>.</li> <li>➤ Bajaj, Y.P.S. &amp; Narosa. <i>Biotechnology in agriculture and forestry</i>.</li> </ul> <p><b>Suggested e- Resources:</b></p> <p><a href="https://icar.org.in/content/horticultural_division">https://icar.org.in/content/horticultural_division</a><br/> <a href="http://tnhorticulture.tn.gov.in/horti/">http://tnhorticulture.tn.gov.in/horti/</a><br/> <a href="https://www.onionseek.com/in/search/web/?pk=nQMhNzQd8g9IZLslSBEH6g&amp;q=Online%20Horticulture%20Degree%20Program&amp;id_event=5cc7d0693778ea7e85ea4bc6">https://www.onionseek.com/in/search/web/?pk=nQMhNzQd8g9IZLslSBEH6g&amp;q=Online%20Horticulture%20Degree%20Program&amp;id_event=5cc7d0693778ea7e85ea4bc6</a><br/> <a href="https://www.longdom.org/horticulture.html">https://www.longdom.org/horticulture.html</a></p> |         |
| 8)  | <b>Disciple Elective: Horticulture Lab</b>   |   |  | <p><b>Disciple Elective: Horticulture Lab</b></p> <ol style="list-style-type: none"> <li>1. Layout of kitchen garden.</li> <li>2. Vegetative propagation by cutting and grafting<br/>Herbarium preparation.</li> <li>3. Vegetative propagation by budding and layering (Gootee).</li> <li>4. To perform emasculation &amp; hybridization.</li> <li>5. Preparation of compost.</li> </ol>  |         |
| <b>Biotechnology Discipline Elective-I &amp; II</b> |  |   |  |   |         |
| 1)  | <b>Discipline elective</b><br><del>5.3:</del> Genetic Engineering, rDNA Technology | On completion of the course, students will be able to:<br><ul style="list-style-type: none"> <li>• Understand the various tools of recombinant DNA</li> </ul> | <p><b>Unit 1</b></p> <ul style="list-style-type: none"> <li>• Introduction and historical background of genetic engineering.</li> <li>• Isolation and purification of DNA from bacterial, plant</li> </ul> | <p><b>Discipline elective</b><br/><b>BT 307: Genetic Engineering, rDNA Technology and Cell and Tissue Culture Technology</b></p> <p><b>Unit 1</b></p> <ul style="list-style-type: none"> <li>• Introduction and historical background of genetic engineering.</li> </ul>  |         |



| S No. | Course List                            | Learning Outcomes  | Existing Syllabus   | Suggested Syllabus  | Remarks |
|-------|--|--|---|---|---------|
|       | and Cell and Tissue Culture Technology | <p>technology and their applications in different fields.</p> <ul style="list-style-type: none"> <li>Describe the principles, process of gene cloning and generation of recombinant libraries.</li> <li>Learn theoretical aspects of different cell culture techniques and their uses in therapeutic applications.</li> <li>Gain basic knowledge of patents and biosafety guidelines.</li> </ul> | <p>and animal cells.</p> <ul style="list-style-type: none"> <li>Vectors: plasmids, cosmids and phages.</li> <li>Restriction enzymes, Ligases, S1 nucleases, DNA polymerases, Reverse transcriptase.</li> </ul> <p><b>Unit 2</b></p> <ul style="list-style-type: none"> <li>cDNA synthesis and cloning: mRNA enrichment, reverse transcription,</li> <li>cDNA library. DNA primers</li> <li>Linkers, Adaptors, Blunt end ligation, Homopolymer tailing.</li> <li>Genomic library construction and screening.</li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>Molecular markers- RAPD, RFLP, AFLP, SNP.</li> <li>Techniques used in identification of recombinant DNA clones.</li> <li>Cloning and expression of foreign genes in prokaryotes (<i>E.coli</i>).</li> <li>Cloning and expression of foreign genes in eukaryotes (e.g. Yeast)</li> <li>Brief idea about gene cloning in plant and mammalian cells.</li> <li>Application of transposons in gene tagging.</li> </ul> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>Introduction, Historical background and terminology used in cell culture, Tissue culture lab: Basic requirements, Sterilization techniques.</li> <li>Media: Types, preparation and composition.</li> <li>Clonal propagation in plants.</li> <li>Somatic embryogenesis, Protoplast isolation and culture, viability tests.</li> </ul> <p><b>Unit 5</b></p> <ul style="list-style-type: none"> <li>Primary and established (including discontinuous and</li> </ul> | <ul style="list-style-type: none"> <li>Isolation and purification of DNA from bacterial, plant and animal cells.</li> <li>Vectors: plasmids, cosmids and phages.</li> <li>Restriction enzymes, ligases, S1 nucleases, DNA polymerases, reverse transcriptase.</li> </ul> <p><b>Unit 2</b></p> <ul style="list-style-type: none"> <li>DNA primers, cDNA synthesis and cloning: mRNA enrichment, reverse transcription.</li> <li>cDNA library.</li> <li>Linkers, adaptors, blunt end ligation, homopolymer tailing.</li> <li>Genomic library construction and screening.</li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>Molecular markers- RAPD, RFLP, AFLP, SNP.</li> <li>Techniques used in identification of recombinant DNA clones.</li> <li>Cloning and expression of foreign genes in prokaryotes (<i>E. coli</i>).</li> <li>Cloning and expression of foreign genes in eukaryotes (e.g. yeast).</li> <li>Brief idea about gene cloning in plant and mammalian cells.</li> <li>Transposon mediated gene tagging.</li> </ul> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>Introduction, historical background and terminology used in cell culture, tissue culture lab: basic requirements, sterilization techniques.</li> <li>Media: Types, preparation and composition.</li> <li>Primary and established (including discontinuous and continuous) cell lines.</li> <li>Cytotoxicity and transformation/transfection of cells.</li> <li>Animal cell products.</li> <li>Patents and biosafety guidelines.</li> </ul> <p><b>Unit 5</b></p> |         |

| S No. | Course List | Learning Outcomes | Existing Syllabus   | Suggested Syllabus   | Remarks |
|-------|-------------|-------------------|---|--|---------|
|       |             |                   | <p>continuous) cell lines.</p> <ul style="list-style-type: none"> <li>● Cytotoxicity and transformation/transfection of cells.</li> <li>● Production of haploids and their applications.</li> <li>● Zygotic Embryo culture.</li> <li>● Animal cell products.</li> <li>● Somaclonal variations</li> <li>● Patents and Biosafety guidelines.</li> </ul> <p><b>Books recommended:</b></p> <ul style="list-style-type: none"> <li>➤ Molecular Biology of Gene: J.D. Watson, Pearson Education.</li> <li>➤ An introduction to Gene Technology-From genes to clones: Winnacker.</li> <li>➤ Principles of Gene Manipulation: Old and Primrose.</li> <li>➤ Molecular Biotechnology: B.R. Glick and J.J. Pasternak, ASM Press, Washington, USA.</li> <li>➤ Plant Tissue Culture: S.S. Bhojwani and M.K. Razdan, Elsevier Science, The Netherlands.</li> <li>➤ An Introduction to Plant Tissue Culture: M.K. Razdan.</li> <li>➤ Genetic Engineering: Science and ethics on new frontier: Michael Boylan, Pearson Education.</li> <li>➤ An Introduction to Genetic Engineering: S.T. Nicholl, Cambridge University Press.</li> <li>➤ Principles of Gene Manipulations and Genomics, S. B. Primrose and R. M. Twyman.</li> <li>➤ Biotechnology and Genomics: P. K. Gupta, Rastogi Publication.</li> <li>➤ Introduction to plant Biotechnology: H.S. Chawla, Science Publishers.</li> <li>➤ Gene Cloning and DNA analysis: T. A. Brown.</li> </ul> | <ul style="list-style-type: none"> <li>● Clonal propagation in plants.</li> <li>● Somatic embryogenesis, protoplast isolation and culture, viability tests.</li> <li>● Production of haploids and their applications.</li> <li>● Zygotic embryo culture.</li> <li>● Somaclonal variations.</li> </ul> <p><b>Suggested Books:</b></p> <ul style="list-style-type: none"> <li>➤ Bhojwani, S.S., &amp; Razdan, M.K. (1996). <i>Plant Tissue Culture: Theory and Practice</i>. Netherlands: Elsevier Science.</li> <li>➤ Boylan, M., &amp; Brown, K.E. <i>Genetic Engineering: Science And Ethics On The New Frontier</i>.</li> <li>➤ Brown, T.A. (2010). <i>Gene Cloning and DNA Analysis: An Introduction</i> (6<sup>th</sup> ed.). USA: Wiley-Blackwell.</li> <li>➤ Chawla, H.S. (2009). <i>Introduction to Plant Biotechnology</i> (3<sup>rd</sup> ed.). USA: CRC Press.</li> <li>➤ Glick, B.R., &amp; Patten, C.L. (2017). <i>Molecular Biotechnology: Principles and Applications of Recombinant DNA</i> (5<sup>th</sup> ed.). USA: American Society for Microbiology Press.</li> <li>➤ Gupta, P.K. (2005). <i>Biotechnology and Genomics</i>. Meerut: Rastogi Publication.</li> <li>➤ Gupta, P.K. (2017). <i>Animal Biotechnology</i>. Meerut: Rastogi Publication.</li> <li>➤ Howe, C. (2007). <i>Gene Cloning &amp; Manipulation</i> (2<sup>nd</sup> ed.). New Delhi: Cambridge University Press.</li> <li>➤ Primrose, S.B., &amp; Twyman, R. (2006). <i>Principles of Gene Manipulation and Genomics</i> (7<sup>th</sup> ed.) UK: Oxford University Press.</li> <li>➤ Razdan, M.K. (2003). <i>Introduction to Plant Tissue Culture</i> (2<sup>nd</sup> ed.). USA: Science Pub Inc.</li> <li>➤ Shrivastava, S. (2012). <i>Molecular Techniques in Biochemistry &amp; Biotechnology</i>. Kolkata: New Central</li> </ul> |         |

| S No. | Course List   | Learning Outcomes  | Existing Syllabus   | Suggested Syllabus   | Remarks |
|-------|---|--|---|--|---------|
|       |   |  |   | <p>Book Agency.</p> <ul style="list-style-type: none"> <li>➤ Watson, J.D., Tania, A.B., &amp; Stephen, P.B. (2017). <i>Molecular Biology of the Gene</i> (7<sup>th</sup> ed.). USA: Pearson Education.</li> <li>➤ Winnacker, E.L. (1987). <i>From Genes to Clones: Introduction to Gene Technology</i>. Germany: Wiley VCH.</li> </ul> <p><b>Suggested e-Resources:</b></p> <ul style="list-style-type: none"> <li>➤ <b>Cloning</b><br/><a href="https://nptel.ac.in/courses/102103045/">https://nptel.ac.in/courses/102103045/</a></li> <li>➤ <b>Molecular markers</b><br/><a href="http://www.biologydiscussion.com/plants/molecular-marker-study-notes/10883">http://www.biologydiscussion.com/plants/molecular-marker-study-notes/10883</a></li> <li>➤ <b>Plant biotechnology</b><br/><a href="https://nptel.ac.in/courses/102103016/12">https://nptel.ac.in/courses/102103016/12</a></li> <li>➤ <b>cDNA library</b><br/><a href="http://www.biotechnologynotes.com/dna-libraries/notes-on-cdna-library-dna-libraries/517">http://www.biotechnologynotes.com/dna-libraries/notes-on-cdna-library-dna-libraries/517</a></li> <li>➤ <b>Genetic engineering</b><br/><a href="https://nptel.ac.in/courses/102103013/">https://nptel.ac.in/courses/102103013/</a></li> <li>➤ <b>Enzymes of genetic engineering</b><br/><a href="http://cec.nic.in/wpresources/module/Zoology/Paper-12/49/content/downloads/file1.pdf">http://cec.nic.in/wpresources/module/Zoology/Paper-12/49/content/downloads/file1.pdf</a></li> <li>➤ <b>Animal cell culture</b><br/><a href="https://nptel.ac.in/courses/102104059/">https://nptel.ac.in/courses/102104059/</a></li> </ul> |         |
| 2)    | <b>Discipline Elective</b><br><b>5.4:</b> Genetic Engineering, rDNA Technology and Cell and Tissue Culture Technology Lab | On completion of the course, students will be able to:<br><ul style="list-style-type: none"> <li>• Learn all technicalities of setting up a plant tissue culture laboratory.</li> <li>• Learn the techniques of</li> </ul> | <ol style="list-style-type: none"> <li>1. Tissue culture, media preparation-MS/White media, Slant preparation</li> <li>2. <del>Sterilization techniques</del></li> <li>3. Excision of embryo/ovule/anther from the provided material and its inoculation.</li> <li>4. Encapsulation of zygotic embryo.</li> <li>5. Demonstration of column chromatography.</li> <li>6. Extraction of proteins by phenol extraction.</li> <li>7. Estimation of proteins by Popov's method.</li> <li>8. To determine the melting curve of DNA.</li> </ol> | <p><b>Discipline Elective:</b><br/><b>BT 307L: Genetic Engineering, rDNA Technology and Cell and Tissue Culture Technology Lab</b></p> <ol style="list-style-type: none"> <li>1. Tissue culture, media preparation-MS/White media, slant preparation.</li> <li>2. Aseptic techniques.</li> <li>3. Excision of embryo/ovule/anther from the provided material and its inoculation.</li> <li>4. Encapsulation of zygotic embryo.</li> <li>5. Demonstration of column chromatography.</li> </ol>  |         |

| S No. | Course List  | Learning Outcomes   | Existing Syllabus   | Suggested Syllabus   | Remarks |
|-------|--|---|---|--|---------|
|       |  | isolation and estimation of nucleic acids.<br>• Gain practical knowledge about chromatographic purification of proteins   | 9. <del>Determination</del> of base composition of DNA.<br>10. Estimation of RNA by orcinol method.<br>11. Isolation of plasmid.<br>12. Setting of a biotechnology laboratory e.g. Tissue culture, Fermentation, Molecular Biology, rDNA Technology, Biochemistry etc. (at least one).  | 6. Extraction of proteins by phenol extraction.<br>7. Estimation of proteins by Popov's method.<br>8. To determine the melting curve and base composition of DNA.<br>9. Estimation of RNA content by orcinol method.<br>10. Isolation of plasmid from bacterial cell and determination of purity.<br>11. Cell immobilization (yeast).<br>12. Setting of a biotechnology laboratory, viz., tissue culture, fermentation, molecular biology, rDNA technology, biochemistry etc. (at least one).<br><b>Suggested Books:</b><br>➤ Saxena, J., Baunthiyal., & Ravi, I. (2015). <i>Laboratory Manual of Microbiology, Biochemistry and Molecular Biology</i> . Jodhpur: Scientific Publishers.<br>➤ Sharma, R.K., & Sangha, S.P.S. (2009). <i>Basic Techniques in Biochemistry &amp; Molecular Biology</i> . New Delhi: I.K. International Publisher.<br>➤ Swamy, P.M. (2008). <i>Laboratory Manual on Biotechnology</i> (1 <sup>st</sup> ed.). Meerut: Rastogi Publication. |         |
| 3)    | <b>Discipline Elective:</b><br><del>6-1:</del> Advances in Biotechnology | On completion of the course, students will be able to:<br>• Understand the different techniques of DNA sequencing, gene synthesis, gene silencing, PCR and blotting.<br>• Describe the industrial production of biopesticides, biopolymer and | <b>Unit 1</b><br>• Techniques in Molecular Biology: Gene sequencing, solid phase automated synthesis of DNA, PCR, Northern, Southern and Western blotting, Hybridization.<br>• Molecular probes and their applications,<br>• Drug designing<br>• Gene Therapy<br><b>Unit 2</b><br>• Fermentation processes, Batch, Fed batch and Continuous.<br>• Bioreactor: components, types of bioreactor-CSTR, Loop reactor, Fluidized bed reactor | <b>Discipline Elective</b><br><b>BT 301: Advances in Biotechnology</b><br><b>Unit 1</b><br>• Techniques in molecular biology: Gene sequencing, solid phase automated synthesis of DNA.<br>• PCR and its variants: nested, inverse, real time, touch down and hot start.<br>• Northern, Southern and Western blotting, hybridization.<br>• Molecular probes and their applications.<br>• An overview of drug designing.<br>• Gene therapy: An overview of its types and vectors used.<br><b>Unit 2</b><br>• Fermentation processes, batch, fed batch and continuous.  |         |

| S No. | Course List | Learning Outcomes   | Existing Syllabus  | Suggested Syllabus  | Remarks |
|-------|-------------|---|--|---|---------|
|       |             | <p>biopolysaccharides using fermentation techniques.</p> <ul style="list-style-type: none"> <li>Gain theoretical knowledge of cryopreservation, artificial insemination, IVF-ET technique, transgenic plants and transgenic animals.</li> </ul> | <ul style="list-style-type: none"> <li>Biopesticides – (Bt genes)</li> <li>Biopolymers (<math>\beta</math>-hydroxy butyrate)</li> <li>Biopolysaccharide (Xanthum gum)</li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>Human genome project: History and salient features.</li> <li><i>Arabidopsis</i> as a model plant for genetic engineering.</li> <li>Stem cells: current status.</li> <li>Antisense RNA Technology, RNAi</li> <li>Cassette vectors.</li> <li>Edible Vaccines</li> <li>DNA Chips</li> </ul> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>Chloroplast Engineering</li> <li>Proteomics and metabolomics.</li> <li>Terminator seed technology.</li> <li>Seed storage proteins.</li> <li>Therapeutic proteins.</li> <li>Biosensor.</li> </ul> <p><b>Unit 5</b></p> <ul style="list-style-type: none"> <li>Cryopreservation, transport of germplasm (semen, ovum, embryo).</li> <li>Artificial insemination, in vitro fertilization and embryo transfer.</li> <li>Transgenic Plants: Resistance to herbicides, fungal and viral pathogens, environmental stress, Plants suitable for food processing, male sterility, molecular farming, <del>to study regulated gene expression.</del></li> <li>Biotechnology of nitrogen fixation.</li> <li>Transgenic animals</li> </ul> <p><b>Books recommended:</b></p> <ul style="list-style-type: none"> <li>➤ Gene Cloning: TA Brown, Pearson Education.</li> <li>➤ Human Molecular Genetics: Peter Sudbery, prentice Hall (Pearson Education).</li> </ul> | <ul style="list-style-type: none"> <li>Bioreactor: Components, types of bioreactor-CSTR, loop reactor, fluidized bed reactor.</li> <li>Biopesticides-(Bt genes).</li> <li>Biopolymers (<math>\beta</math>-hydroxy butyrate).</li> <li>Biopolysaccharide (xanthum gum).</li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>Human genome project: History and salient features.</li> <li><i>Arabidopsis</i> as a model plant for genetic engineering.</li> <li>Stem cells: Current status.</li> <li><b>Gene silencing:</b> Antisense RNA technology and RNAi.</li> <li>Cassette vectors.</li> <li>Edible vaccines.</li> <li>DNA chips.</li> </ul> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>Chloroplast engineering.</li> <li><b>A brief introduction of</b> proteomics and metabolomics.</li> <li>Terminator seed technology.</li> <li>Seed storage proteins.</li> <li>Therapeutic proteins.</li> <li>Biosensor.</li> </ul> <p><b>Unit 5</b></p> <ul style="list-style-type: none"> <li>Cryopreservation, transport of germplasm (semen, ovum, embryo).</li> <li>Artificial insemination, <i>in vitro</i> fertilization and embryo transfer.</li> <li>Transgenic plants: Resistance to herbicides, fungal and viral pathogens, environmental stress, male sterility, <b>regulation of transgene expression</b>, plants suitable for food processing, molecular farming.</li> <li>Biological nitrogen fixation <b>and its genetic engineering.</b></li> <li>Transgenic animals.</li> </ul> <p><b>Suggested Books:</b></p> <ul style="list-style-type: none"> <li>➤ Balasubramanian, D., Bryce, C.F.A., Dharmalingam, K., Green, J., &amp; Jayaraman, K. (2004). <i>Concepts in</i></li> </ul> |         |

| S No. | Course List | Learning Outcomes | Existing Syllabus  | Suggested Syllabus   | Remarks |
|-------|-------------|-------------------|--|--|---------|
|       |             |                   | <ul style="list-style-type: none"> <li>➤ Understanding Biotechnology: Aluizo Borem, Pearson Education.</li> <li>➤ Biotechnology and Genomics: P.K. Gupta, Rastogi Publications, Meerut.</li> <li>➤ Modern Concepts of Biotechnology: H.D. Kumar, Vikas Publishing House, Pvt. Ltd., New Delhi.</li> <li>➤ Concepts in Biotechnology: Balasubramanian et al.</li> <li>➤ Immunology: Janis Kuby, John Wiley &amp; Sons.</li> <li>➤ Biotechnology: A handbook of Industrial Microbiology: Crueger and Crueger.</li> </ul> | <p><i>Biotechnology</i>. Hyderabad: University Press.</p> <ul style="list-style-type: none"> <li>➤ Borem, A., Santos, F.R., &amp; Bowen, D.E. (2003). <i>Understanding Biotechnology</i> (1<sup>st</sup> ed.). USA: Prentice Hall.</li> <li>➤ Brown, T.A. (2010). <i>Gene Cloning and DNA Analysis: An Introduction</i> (VI Ed.). USA: Wiley-Blackwell.</li> <li>➤ Crueger, W., &amp; Crueger, A. (2017). <i>Biotechnology: A Textbook of Industrial Microbiology</i> (3<sup>rd</sup> ed.). New York: Medtech.</li> <li>➤ Gupta, P.K. (2005). <i>Biotechnology and Genomics</i>. Meerut: Rastogi Publication.</li> <li>➤ Kumar, H.D. (1998). <i>Modern Concept of Biotechnology</i>. New Delhi: Vikas Publishing House.</li> <li>➤ Owen, J., Punt, J., Stranford, S., &amp; Jones, P. (2018). <i>Kuby Immunology</i> (8<sup>th</sup> ed.). USA: W. H. Freeman and Company.</li> <li>➤ Shrivastava, S. (2012). <i>Molecular Techniques in Biochemistry &amp; Biotechnology</i>. Kolkata: New Central Book Agency.</li> <li>➤ Sudbery, P. (2010). <i>Human Molecular Genetics</i> (3<sup>rd</sup> ed.). USA: Pearson Education.</li> </ul> <p><b>Suggested e-Resources:</b></p> <ul style="list-style-type: none"> <li>➤ <b>Gene therapy</b><br/><a href="https://nptel.ac.in/courses/102103041/">https://nptel.ac.in/courses/102103041/</a></li> <li>➤ <b>Bioreactors</b><br/><a href="https://nptel.ac.in/courses/102106053/">https://nptel.ac.in/courses/102106053/</a></li> <li>➤ <b>PCR, hybridization &amp; blotting technique</b><br/><a href="http://www.tulane.edu/~wiser/methods/notes.pdf">http://www.tulane.edu/~wiser/methods/notes.pdf</a></li> <li>➤ <b>IVF-ET</b><br/><a href="https://www.urmc.rochester.edu/MediaLibraries/URMCMedia/fertility-center/documents/In-Vito-Fertilization-4-29-15-updated.pdf">https://www.urmc.rochester.edu/MediaLibraries/URMCMedia/fertility-center/documents/In-Vito-Fertilization-4-29-15-updated.pdf</a></li> <li>➤ <b>Transgenic plants</b><br/><a href="https://popups.uliege.be/1780-4507/index.php?id=11844">https://popups.uliege.be/1780-4507/index.php?id=11844</a></li> </ul> |         |

| S No. | Course List  | Learning Outcomes   | Existing Syllabus  | Suggested Syllabus   | Remarks |
|-------|--|---|--|--|---------|
|       |  |   |  | ➤ <b>RNAi</b><br><a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC309050/">https://www.ncbi.nlm.nih.gov/pmc/articles/PMC309050/</a>   |         |
| 4)    | <b>Discipline Elective:</b><br><del>6.2:</del> Advances in Biotechnology Lab | On completion of the course, students will be able to:<br><ul style="list-style-type: none"> <li>• Demonstrate the skills required for basic laboratory procedures and principles of reagent preparation.</li> <li>• Design, conduct experiments, analyze and interpret data for investigating problems in biotechnology and allied fields.</li> <li>• Understand the importance of the practical aspects of different techniques like electrophoresis, fermentation, and spectroscopy etc, currently used in biomedical research.</li> </ul> | <ol style="list-style-type: none"> <li>1. Isolation and estimation of genomic DNA from <i>E. coli</i>.</li> <li>2. Agarose gel electrophoresis of DNA.</li> <li>3. Seed germination under stress condition.</li> <li>4. <del>DO estimation</del></li> <li>5. To determine the hardness of water</li> <li>6. To find out absorption spectrum of the oxidized and reduced form of a molecular species (NAD and NADH).</li> <li>7. To determine the LD50 value of pesticide / weedicide.</li> <li>8. Chlorophyll estimation from the given samples.</li> <li>9. Extraction and estimation of phenol based secondary metabolites.</li> <li>2. Demonstration of fermenter.</li> <li>3. <del>Bioinformatics exercise 1.</del></li> <li>4. <del>Bioinformatics exercise 2.</del></li> <li>5. Submission of project report based on any topic related to Biotechnology.</li> </ol> | <p>➤ <b>Discipline Elective:</b><br/><b>BT 301L: Advances in Biotechnology Lab</b></p> <ol style="list-style-type: none"> <li>1. Isolation and estimation of genomic DNA from <i>E. coli</i>.</li> <li>2. Agarose gel electrophoresis of DNA.</li> <li>3. Seed germination under stress condition.</li> <li>4. To find out absorption spectrum of the oxidized and reduced form of a molecular species (NAD and NADH).</li> <li>5. To determine the LD<sub>50</sub> value of pesticide / weedicide.</li> <li>6. Chlorophyll estimation from the given samples.</li> <li>7. Extraction and estimation of total phenolic content using standard curve of gallic acid.</li> <li>8. Isolation of protoplast and its culture using microchamber technique.</li> <li>9. Demonstration of fermenter.</li> <li>10. Determination of total hardness of water.</li> <li>11. Submission of project report based on any topic related to Biotechnology.</li> </ol> <p><b>Suggested Books:</b></p> <ul style="list-style-type: none"> <li>➤ Saxena, J., Baunthiyal., &amp; Ravi, I. (2015). <i>Laboratory Manual of Microbiology, Biochemistry and Molecular Biology</i>. Jodhpur: Scientific Publishers.</li> <li>➤ Sharma, R.K., &amp; Sangha, S.P.S. (2009). <i>Basic Techniques in Biochemistry &amp; Molecular Biology</i>. New Delhi: I.K. International Publisher.</li> <li>➤ Swamy, P.M. (2008). <i>Laboratory Manual on Biotechnology</i> (1<sup>st</sup> ed.). Meerut: Rastogi Publication.</li> <li>➤ Vats, S. (2015). <i>A laboratory Text book of Biochemistry, Molecular Biology and Microbiology</i>. Germany: GRIN Verlag.</li> </ul> |         |
| 5)    | <b>Discipline Elective:</b>  | On completion of the course, students   |  | <b>Discipline Elective:</b><br><b>Animal and Plant Biotechnology</b>   |         |

| S No. | Course List                           | Learning Outcomes  | Existing Syllabus | Suggested Syllabus  | Remarks |
|-------|---------------------------------------|--|-------------------|---|---------|
|       | <b>Animal and Plant Biotechnology</b> | <p>will be able to</p> <ul style="list-style-type: none"> <li>• Gain knowledge of assisted reproductive technology, transgenic animal production and applications.</li> <li>• Gain an understanding of current scenario of stem cells and their applications.</li> <li>• Explain applications of tissue engineering in bioartificial organs development and transplantation.</li> <li>• Explain various techniques used in plant biotechnology.</li> </ul> |                   | <p><b>Unit-I</b></p> <ul style="list-style-type: none"> <li>• Animal propagation: Induction of superovulation, embryo collection and evaluation, embryo splitting, embryo sexing, artificial insemination (IUI, ICSI) and embryo transfer techniques in cattle.</li> <li>• Animal clones, nuclear transplantation, cloning for conservation of endangered species</li> <li>• <i>In vitro</i> fertilization and embryo transfer: Composition of IVF media, steps involved in IVF.</li> </ul> <p><b>Unit-II</b></p> <ul style="list-style-type: none"> <li>• Gene transfer methods in animals: Calcium phosphate, DEAE-dextran, lipofection, electroporation, microinjection, embryonic stem cell transfer, retrovirus.</li> <li>• Transgenic animals and their applications with reference to transgenic mice, cattle, sheep, goats, pigs, chicken and fish.</li> <li>• Stem cells: Definition, classification, characteristics and therapeutic applications.</li> </ul> <p><b>Unit-III</b></p> <ul style="list-style-type: none"> <li>• Recombinant protein vaccine production by cultured animal cells.</li> <li>• Basics of tissue engineering: Cell-ECM interaction, Biomaterials in tissue engineering. Bioartificial organs-sources of cells, scaffold material, mode of transplantation.</li> <li>• Shoot tip and meristem culture and production of virus-free plants.</li> <li>• Protoplast studies: Isolation, culture, fusion and selection of hybrid cells, somatic hybrids and cybrids and applications.</li> </ul> <p><b>Unit-IV</b></p> <ul style="list-style-type: none"> <li>• Artificial seeds: Production, applications and limitations.</li> <li>• Genetic transformation methods: Vector</li> </ul> |         |



| S No. | Course List | Learning Outcomes | Existing Syllabus | Suggested Syllabus  | Remarks |
|-------|-------------|-------------------|-------------------|---|---------|
|       |             |                   |                   | <p>(<i>Agrobacterium tumefaciens</i>) mediated genetic transformation. T-DNA transfer mechanism. Physical gene transfer methods: Particle bombardment, electroporation and microinjection.</p> <ul style="list-style-type: none"> <li>Genetic engineering of crops for improved nutritional quality: Vitamin-A, iron, zinc, protein quality.</li> </ul> <p><b>Unit-V</b></p> <ul style="list-style-type: none"> <li>Genetic engineering in plants: Selectable markers, reporter genes and promoters used in plant vectors.</li> <li>Genetic engineering of plants for disease resistance, pest and herbicide resistance.</li> <li>Molecular pharming: Concept of plants as biofactories, production of antibodies, viral antigens, peptide hormones and biodegradable plastics.</li> </ul> <p><b>Suggested Books:</b></p> <ul style="list-style-type: none"> <li>➤ Chawla, H.S. (2009). <i>Plant Biotechnology</i> (3<sup>rd</sup> ed.). New Delhi, India: Oxford &amp; IBH Publishing Co. Pvt. Ltd.</li> <li>➤ Kumaresan, V. (2008). <i>Applied animal biotechnology</i>. Tamil Nadu, India: Saras Publication.</li> <li>➤ Lanza, R., Gearhart, J., &amp; Hogan, B. <i>Essentials of stem cell biology</i> (2<sup>nd</sup> ed.). London, UK: Academic Press.</li> <li>➤ Lanza, R., Langer, R., &amp; Vacanti, J. <i>Principles of tissue engineering</i> (4<sup>th</sup> ed.). London, UK: Academic Press.</li> <li>➤ Peter, K.V., &amp; Keshavachandran, R. (2008). <i>Plant Biotechnology: Methods in Tissue Culture and Gene Transfer</i>. India: Universities Press.</li> <li>➤ Singh, B., Gautam, S.K., &amp; Chauhan, M.S. (2015). <i>Textbook of animal biotechnology</i>. New Delhi, India: Teri Publication.</li> </ul> |         |

| S No. | Course List  | Learning Outcomes  | Existing Syllabus | Suggested Syllabus  | Remarks |
|-------|--|--|-------------------|---|---------|
|       |  |  |                   | <ul style="list-style-type: none"> <li>➤ Singh, B.D. (2011). <i>Plant Biotechnology</i> (2<sup>nd</sup> ed.). New Delhi, India: Kalyani Publisher.</li> <li>➤ Singh, B.S. (2007). <i>Fundamentals of Plant Biotechnology</i>. New Delhi, India: Satish Serial Publishing House.</li> <li>➤ Slater, A. (2008). <i>Plant Biotechnology: The Genetic Manipulation of Plants</i> (2<sup>nd</sup>ed.). Oxford, UK: Oxford Publisher.</li> </ul> <p><b>Suggested e- resources</b></p> <p><b>Plant Biotechnology</b></p> <ul style="list-style-type: none"> <li>➤ <a href="https://nptel.ac.in/courses/102103016/">https://nptel.ac.in/courses/102103016/</a></li> </ul> <p><b>Tissue engineering</b></p> <ul style="list-style-type: none"> <li>➤ <a href="https://nptel.ac.in/courses/102106036/">https://nptel.ac.in/courses/102106036/</a></li> </ul>  |         |
| 6)    | <b>Discipline Elective:<br/>Animal and Plant Biotechnology Lab</b> | <p>On completion of the course, students will be able to</p> <ul style="list-style-type: none"> <li>• Gain hands on training on plant &amp; animal tissue culture and biotechnology.</li> <li>• Learn the technique of genomic DNA isolation, its electrophoresis and SDS-PAGE.</li> </ul> |                   | <p><b>Discipline Elective:<br/>Animal and Plant Biotechnology Lab</b></p> <ol style="list-style-type: none"> <li>1. Introduction to the laboratory and general safety practices for plant and animal cell culture.</li> <li>2. Aseptic culture techniques for establishment and maintenance of cultures.</li> <li>3. Prepare culture media with various supplements for plant and animal tissue culture.</li> <li>4. To select, prune, sterilize and prepare an explant for culture.</li> <li>5. Establishment of callus cultures.</li> <li>6. Cell suspension cultures.</li> <li>7. Isolation and culture of protoplast.</li> <li>8. Isolation of plant genomic DNA by modified CTAB method.</li> <li>9. Isolation of DNA from animal tissue.</li> <li>10. Quantification of DNA by spectrophotometric method.</li> <li>11. Size analysis of DNA by agarose electrophoresis.</li> <li>12. Effect of different light wavelengths and temperature on germinating embryos.</li> <li>13. Separation of plant proteins by SDS-gel electrophoresis.</li> </ol> |         |

| S No. | Course List  | Learning Outcomes   | Existing Syllabus | Suggested Syllabus   | Remarks |
|-------|--|---|-------------------|--|---------|
|       |  |   |                   | <b>Suggested Books:</b> <ul style="list-style-type: none"> <li>➤ Green, M. R., &amp; Sambrook, J. (2012). <i>Molecular Cloning: a Laboratory Manual</i>. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.</li> <li>➤ Saxena, J., Baunthiyal., &amp; Ravi, I. (2015). <i>Laboratory Manual of Microbiology, Biochemistry and Molecular Biology</i>. Jodhpur: Scientific Publishers.</li> <li>➤ Swamy, P.M. (2008). <i>Laboratory Manual on Biotechnology</i> (1<sup>st</sup> ed.). Meerut: Rastogi Publication.</li> </ul>  |         |
| 7)    | <b>Discipline Elective-I Environmental Biotechnology</b> | <p>On completion of the course, students will be able to:</p> <ul style="list-style-type: none"> <li>• Understand the importance of microorganisms as pesticides.</li> <li>• Understand the basic concept of bioleaching, biodesulphurization, bioplastics, biosurfactants and bioemulsifiers.</li> <li>• Understand different waste management processes and generation of energy from waste.</li> <li>• Describe various roles played by microbes in biodegradation,</li> </ul> |                   | <b>Discipline Elective-I:</b><br><b>Environmental Biotechnology</b><br><b>Unit-I</b> <ul style="list-style-type: none"> <li>• Solid waste management: Waste generation, handling, storage, processing, transport, bailing, composting-incineration, pyrolysis, land farming – waste disposal by sanitary land filling (aerobic and anaerobic degradation), recycling and product re-use.</li> <li>• Microbial leaching and biomining: Types and methods of bioleaching, chemistry and microbiology of bioleaching, <i>in situ</i> and <i>ex situ</i> leaching process of copper and uranium, plasmids and genes in biomining.</li> </ul> <b>Unit-II</b> <ul style="list-style-type: none"> <li>• Bioremediation of soil and water contaminated with oil spills, heavy metals and detergents.</li> <li>• Microbial degradation of pesticides and xenobiotic compounds, metabolism and mechanism of degradation, degradative plasmids, microbes and cloning strategies.</li> <li>• Phyto-remediation: Basic concept, types (phytoaccumulation, phytovolatilization, rhizofiltration and phytostabilization) and applications.</li> </ul> |         |

| S No. | Course List       | Learning Outcomes                          | Existing Syllabus | Suggested Syllabus  | Remarks |
|-------|-------------------|--|-------------------|---|---------|
|       |                   | bioremediation and plant growth promotion. |                   | <p><b>Unit-III</b></p> <ul style="list-style-type: none"> <li>• Bioinsecticides: <i>Bacillus thuringiensis</i>, baculoviruses, genetic modifications and aspects of safety in their use. Biofungicides: Mode of actions and mechanism (<i>Trichoderma</i>).</li> <li>• Biofertilizers: Algal fertilizers, nitrogen fixing bacteria, phosphate solubilising microbes, VAM, plant growth promoting rhizobacteria (PGPR).</li> <li>• Earthworm as biofertilizer.</li> </ul> <p><b>Unit-IV</b></p> <ul style="list-style-type: none"> <li>• Biodesulphurization of coal/petroleum/diesel: Bioprocessing of coal, mechanism of inorganic sulphur removal, organic sulphur removal by Kodama pathway and 4 S pathways.</li> <li>• Sewage treatment: Primary, secondary (Aerobic and anaerobic treatment) and tertiary.</li> <li>• An introduction of biodelignification.</li> </ul> <p><b>Unit-V</b></p> <ul style="list-style-type: none"> <li>• Bioindicators and biosensors for detection of environmental pollution.</li> <li>• Biofuels: Biogas, bioethanol, biodiesel, biohydrogen.</li> <li>• A brief introduction of bioplastics, biosurfactants and bioemulsifiers.</li> </ul> <p><b>Suggested Books:</b></p> <ul style="list-style-type: none"> <li>➤ Allen, K. (2016). <i>Environmental Biotechnology</i>. New Delhi, India: CBS Publishers.</li> <li>➤ Evans, G.M. &amp; Furlong, J.C. (2003). <i>Environmental Biotechnology: Theory and Applications</i>. Wiley Publishers.</li> <li>➤ Milton, W. (Ed.). (1999). <i>An Introduction to Environmental Biotechnology</i>. USA: Springer.</li> <li>➤ Scragg A. (2005). <i>Environmental Biotechnology</i>. Pearson Education Limited.</li> </ul> |         |
| 8)    | <b>Discipline</b> | On completion of                           |                   | <b>Discipline Elective:</b>   |         |

| S No.   | Course List  | Learning Outcomes  | Existing Syllabus   | Suggested Syllabus   | Remarks |
|---|--|--|---|--|---------|
|   | <b>Elective:<br/>Environmental<br/>Biotechnology<br/>Lab</b> | the course, students will be able to: <ul style="list-style-type: none"> <li>Gain practical experience in quality determination of water with easy to run experiments such as dissolved oxygen, hardness and alkalinity.</li> <li>Gain practical understanding in the role of biofertilizers and biopesticides in the cleaning of environment.</li> <li>Gain practical experience in quality determination of water with easy to run experiments such as dissolved oxygen, hardness and alkalinity.</li> </ul> |   | <b>Environmental Biotechnology Lab</b> <ol style="list-style-type: none"> <li>Isolation of biofertilizer microbes by biological enrichment method.</li> <li>Estimation of BOD in water sample.</li> <li>Estimation of COD in water sample.</li> <li>Determination of total hardness of water.</li> <li>Determination of total alkalinity of water.</li> <li>Production of microbial biofertilizers.</li> <li>Efficacy testing for biofertilizers.</li> <li>Testing for microbiological quality of potable water (Coli form test).</li> <li>Microbial degradation of heavy metals.</li> <li>Effect of heavy metal toxicity on seed germination and plant growth.</li> <li>Alcohol fermentation by using Baker's yeast and its quantification by dichromate method.</li> </ol> |         |
| <b>Zoology Discipline Elective-I &amp; II</b> |  |  |   |  |         |
| 1)  | <b>Discipline Elective 6.3:</b> Animal Physiology            | On completion of the course, students will be able to: <ul style="list-style-type: none"> <li>Gain basic understanding of structure and</li> </ul>   | <b>Unit 1</b> <ul style="list-style-type: none"> <li>Physiology of Digestion: Various kinds of digestive enzymes (Carbohydases, Proteinases and Lipases) and their digestive action to corresponding food stuffs in the alimentary canal of mammals; Hormonal control of</li> </ul> | <b>Discipline Elective ZOO 301: Animal Physiology</b> <b>Unit 1</b> <ul style="list-style-type: none"> <li>Physiology of digestion: Various kinds of digestive enzymes (carbohydases, proteinases and lipases) and their digestive action to corresponding food stuffs in the</li> </ul>   |         |

| S No. | Course List | Learning Outcomes  | Existing Syllabus   | Suggested Syllabus  | Remarks   |
|-------|-------------|--|---|---|---|
|       |             | <p>functions of each physiological system of human.</p> <ul style="list-style-type: none"> <li>Describe principles and pathway of metabolism of carbohydrate, protein and lipids.</li> <li>Develop an understanding about principles of human anatomy and physiology.</li> </ul> | <p>digestive functions; Mechanism of absorption of various end-products of digestion and other materials such as vitamins, minerals and trace elements.</p> <ul style="list-style-type: none"> <li>Physiology of Respiration in mammals: Mechanism and control of breathing; Transport of oxygen and carbon dioxide; oxygen dissociation curves of Hemoglobin, Bohr's effect, Chloride shift, Respiration at cellular level.</li> </ul> <p><b>Unit 2</b></p> <ul style="list-style-type: none"> <li>Metabolism: (Structure formula of metabolites not essential) Carbohydrate metabolism oxidation of glucose (glycolysis); The Embden–Meyerhof Parnas pathway, Tricarboxylic Acid Cycle (TCA) and Oxidative phosphorylation Glycogenolysis and Glycogenesis; Gluconeogenesis and the role of dicarboxylic acid Shuttle, role of insulin and glucagons on carbohydrate metabolism.</li> <li>Protein metabolism: Essential and non-essential amino-acids, oxidative deamination, transamination and decarboxylation of amino acids, fate of glucogenic and ketogenic amino acids, Role of hormones in protein metabolism.</li> <li>Fat metabolism: -oxidation of fatty acids, oxidation of glycerol and unsaturated fatty acids; fate of Acetyl CoA; Synthesis of lipids; Role of hormones in fat metabolism.</li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>Physiology of Excretion: Kinds of nitrogenous excretory products, Role of liver in the formation of urea; <del>Relationship between the nature of excretory products to the habitat (Fresh water, Marine water and Terrestrial);</del> Composition and formation of urine; Role of hormones.</li> <li>Physiology of Vascular system: Composition and</li> </ul> | <p>alimentary canal of mammals; hormonal control of digestive functions; mechanism of absorption of various end-products of digestion and other materials such as vitamins, minerals and trace elements.</p> <ul style="list-style-type: none"> <li>Physiology of respiration in mammals: Mechanism and control of breathing; transport of oxygen and carbon dioxide; oxygen dissociation curves of hemoglobin, Bohr effect, chloride shift, Haldane effect, lung volumes and capacities, regulation of respiration, respiration at cellular level.</li> </ul> <p><b>Unit 2</b></p> <ul style="list-style-type: none"> <li>Metabolism: (structure formula of metabolites not essential) Carbohydrate metabolism oxidation of glucose (glycolysis); Embden–Meyerhof-Parnas pathway, tricarboxylic acid cycle and oxidative phosphorylation, shuttle mechanisms (malate-aspartate and glycerol-phosphate), glycogenolysis and glycogenesis; gluconeogenesis and the role of dicarboxylic acid shuttle, role of insulin and glucagons on carbohydrate metabolism.</li> <li>Protein metabolism: Essential and non-essential amino-acids, oxidative deamination, transamination and decarboxylation of amino acids, fate of glucogenic and ketogenic amino acids, role of hormones in protein metabolism.</li> <li>Fat metabolism: Oxidation of fatty acids (<math>\beta</math>-oxidation), glycerol, and unsaturated fatty acids; fate of Acetyl CoA; synthesis of fatty acids &amp; lipids; role of hormones in fat metabolism.</li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>Physiology of excretion: Kinds of nitrogenous excretory products, structure of kidney, role of liver in the formation of urea; composition and formation of urine; role of hormones in urine formation; micturition.</li> <li>Physiology of vascular system: Composition and</li> </ul> | <p>The topic “Relationship between the nature of excretory products to the habitat (Fresh water, Marine water and Terrestrial)”</p> |

| S No. | Course List | Learning Outcomes | Existing Syllabus  | Suggested Syllabus   | Remarks   |
|-------|-------------|-------------------|--|--|---|
|       |             |                   | <p>functions of blood and lymph; Blood groups, Rh factor; Blood <del>Coagulation</del> (clotting) mechanism and its physiological significance; Structure and functions of Hemoglobin. Blood pressure; origin, conduction and regulation of heart beat; Nervous and hormonal regulation of heart beat; Cardiac cycle.</p> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>• Physiology of Muscle Contraction: Functional architecture of smooth, skeletal and cardiac muscles; mechanism of muscle contractions (skeletal muscle). Mechanical properties of muscle: simple muscle twitch; tetanus and muscle fatigue.</li> <li>• Physiology of nerve impulse and reflex action: Functional architecture of neuron, nature, origin and propagation of nerve impulse along a neuron, synapse; reflex arc, reflex action and its central control.</li> </ul> <p><b>Unit 5</b></p> <ul style="list-style-type: none"> <li>• Physiology of Endocrine Glands: Structure and functions of Hypothalamus; Pituitary; Thyroid; Parathyroid; Adrenal and Pancreas;</li> <li>• An elementary idea about neuro secretion.</li> <li>• Physiology of Reproduction: Structure and Physiology of human male and female reproductive system; reproductive cycles- Estrous and Menstrual cycle</li> <li>• Hormonal regulation of ovulation, fertilization, implantation, abortion, gestation, parturition and lactation</li> </ul> <p><b>Books Recommended:</b></p> <ul style="list-style-type: none"> <li>➤ Text book of Medical Physiology: A.C. Guyton, Saunders College Publications.</li> <li>➤ Text book of Animal Physiology: P.S. Verma.</li> </ul> | <p>functions of blood; lymph &amp; lymphatic system; blood groups, Rh factor; platelet plug formation; blood clotting mechanism and its significance; structure and functions of hemoglobin. Blood pressure &amp; its regulation; origin, conduction and regulation of heart beat; nervous and hormonal regulation of heart beat; cardiac cycle.</p> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>• Physiology of muscle contraction: Functional architecture of smooth, skeletal and cardiac muscles; mechanism of muscle contractions (skeletal muscle). Fuel for muscle contraction, mechanical properties of muscle: simple muscle twitch; wave summation, tetanus and muscle fatigue.</li> <li>• Physiology of nerve impulse and reflex action: Functional architecture and classification of neuron; nature, origin and propagation of nerve impulse along a neuron (myelinated and unmyelinated), synapse; reflex arc, reflex action and its central control.</li> </ul> <p><b>Unit 5</b></p> <ul style="list-style-type: none"> <li>• Physiology of endocrine glands: Structure and functions of hypothalamus; pituitary; thyroid; parathyroid; adrenal and pancreas.</li> <li>• An elementary idea about neuro-secretion.</li> <li>• Physiology of reproduction: Structure and physiology of human male and female reproductive system; spermatogenesis and oogenesis; reproductive cycles- estrous and menstrual cycle.</li> <li>• Hormonal regulation of ovulation, fertilization, implantation, abortion, gestation, parturition and lactation.</li> </ul> <p><b>Suggested Books:</b></p> <ul style="list-style-type: none"> <li>➤ Chaterjee, C.C. (2005). <i>Human Physiology</i> Vol-II (11<sup>th</sup> ed.).</li> <li>➤ Chaterjee, C.C. (2018). <i>Human Physiology</i> Vol-I (12<sup>th</sup></li> </ul> | <p>is proposed to be remove from existing syllabus because it is usually covered in the another topic i.e. Kinds of nitrogenous excretory products. This is important for the students to learn about structure of kidney, therefore this topic is proposed to be part of modified syllabus. It is important to learn about the different fuels available for muscular contraction. It is important for the students to learn about the classification of neuron based on their functionality and number of process emerges from cell body.</p> |

| S No. | Course List | Learning Outcomes | Existing Syllabus  | Suggested Syllabus   | Remarks |
|-------|-------------|-------------------|--|--|---------|
|       |             |                   | <ul style="list-style-type: none"> <li>➤ Text book of Human Physiology Vol. I &amp; II: C.C. Chaterjee.</li> <li>➤ A text book of Human Anatomy &amp; Physiology: G.M. Tortora.</li> <li>➤ Regulatory Mechanisms in Vertebrates: Pandey and Shukla Rastogi Publication, Meerut.</li> <li>➤ Text book of Animal Physiology – Eckert.</li> </ul> | <p>ed.). New Delhi: CBS Publishers &amp; Distributors.</p> <ul style="list-style-type: none"> <li>➤ Guyton, A.C., &amp; Hall, J.E. (2015). <i>Textbook of Medical Physiology</i> (13<sup>th</sup> ed.). USA: Saunders.</li> <li>➤ Jurd, R.D. (2003). <i>Instant notes in Animal Biology</i>. New Delhi: Viva Books Pvt. Ltd.</li> <li>➤ Kumar, N. (2016). <i>Animal Physiology</i>. Jaipur: RSBA Publishers.</li> <li>➤ Pandey, K., &amp; Shukla, J.P. (2005). <i>Regulatory Mechanism in Vertebrates</i>. Meerut: Rastogi Publications.</li> <li>➤ Randall, D., Burggren, W., &amp; French, K. (2001). <i>Eckert Animal Physiology</i> (5<sup>th</sup> ed.). W. H. Freeman.</li> <li>➤ Roy, R.N. (2018). <i>Textbook of Physiology: with Biochemistry &amp; Biophysics</i> Vol-I. Kolkata: New Central Book Agency.</li> <li>➤ Tortora, G.J., &amp; Grabowski. (2003). <i>Principles of Anatomy &amp; Physiology</i> (10<sup>th</sup> ed.). New Jersey, USA: John Wiley &amp; Sons.</li> <li>➤ Verma, P.S., Tyagi, B.S., &amp; Agarwal, V.K. (2000). <i>Animal Physiology</i>. New Delhi: S. Chand Publisher.</li> </ul> <p><b>Suggested e-Resources:</b></p> <ul style="list-style-type: none"> <li>➤ <b>Digestive system</b><br/><a href="https://www2.estrellamountain.edu/faculty/farabee/biobk/BioBookDIGEST.html">https://www2.estrellamountain.edu/faculty/farabee/biobk/BioBookDIGEST.html</a></li> <li>➤ <b>Unsaturated fatty acid oxidation</b><br/><a href="https://pharmaxchange.info/2013/10/oxidation-of-unsaturated-fatty-acids/">https://pharmaxchange.info/2013/10/oxidation-of-unsaturated-fatty-acids/</a></li> <li>➤ <b>Urine formation</b><br/><a href="http://medschool.slu.edu/gpbs/syllabus/2008/renal2/Kidney%20Lecture-2%20Core%202008.pdf">http://medschool.slu.edu/gpbs/syllabus/2008/renal2/Kidney%20Lecture-2%20Core%202008.pdf</a></li> <li>➤ <b>Muscles</b><br/><a href="http://www.onlinebiologynotes.com/muscular-tissue-skeletal-smooth-cardiac-muscle/">http://www.onlinebiologynotes.com/muscular-tissue-skeletal-smooth-cardiac-muscle/</a></li> <li>➤ <b>Endocrine glands</b><br/><a href="http://what-when-how.com/nursing/the-endocrine-">http://what-when-how.com/nursing/the-endocrine-</a></li> </ul> |         |



| S No. | Course List  | Learning Outcomes   | Existing Syllabus   | Suggested Syllabus  | Remarks  |
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|       |  |   |   | system-structure-and-function-nursing-part-1/<br>➤ <b>Physiological systems</b><br><a href="https://nptel.ac.in/courses/102104042/">https://nptel.ac.in/courses/102104042/</a><br><a href="https://nptel.ac.in/courses/122103039/18">https://nptel.ac.in/courses/122103039/18</a>   |  |
| 2)    | <b>Discipline Elective:</b><br><del>6.4:</del> Animal Physiology Lab | On completion of the course, students will be able to:<br>• Gain hands on experience in hematological tests such as counting of RBCs, WBCs, preparation of haemin crystals, determination of blood haemoglobin, calcium, cholesterol, sugar, protein, clotting time.<br>• Demonstrate the skills of pathological analysis of urine through the detection glucose and albumin. | 1. Preparation of haemin crystals.<br>2. Estimation of haemoglobin percentage by haemometer.<br>3. Enumeration of the total number of red blood corpuscles (RBC).<br>4. Enumeration of the total number of white blood corpuscles (WBC).<br>5. Determination of ABO blood groups and Rh factor.<br>6. Study of effect of isotonic, hypotonic and hypertonic solutions on RBC.<br>7. Determination of the presence of sugar and albumin in the urine sample.<br>8. Determination of blood sugar content.<br>9. Estimation of total protein from blood.<br>10. Estimation of total calcium from blood.<br>11. Estimation of total cholesterol from blood.<br>12. Determination of the clotting time of blood. | <b>Discipline Elective:</b><br><del>ZOO 301L:</del> Animal Physiology Lab<br><br>No change in the syllabus, suggested Books added.<br><br><b>Suggested Books:</b><br>➤ Poddar, T., Mukhopadhyay, S., & Das, S.K. (2003). <i>An advanced Laboratory Manual of Zoology</i> . Kolkata: Macmillan India Limited.<br>➤ Sharma, S. (2007). <i>Experiments and Techniques in Biochemistry</i> (1 <sup>st</sup> ed.). New Delhi: Galgotia Publication.<br>➤ Sharma, S., & Sharma, R. (2016). <i>Practical Manual of Biochemistry</i> (2 <sup>nd</sup> ed.). New Delhi: Medtech. |  |
| 3)    | <b>Discipline Elective:</b> <del>5.1 Environmental Biology</del>     | On completion of the course, students will be able to:<br>• Understand the physical and biological characters of the environment  | <del>5.1 Environmental Biology</del><br><b>Unit 1 • Terminology and scope of ecology.</b><br>Environment :<br>i. Biosphere – Lithosphere, Hydrosphere and Atmosphere.<br>ii. Physical factors – with special reference to temperature, light and water.   | <b>Discipline Elective:</b><br><del>ZOO 302:</del> Environmental Biology and Biostatistics<br><b>Unit 1 •</b><br>• Terminology and scope of ecology.<br>• Environment:<br>i. Biosphere -Lithosphere, hydrosphere and atmosphere.<br>ii. Physical factors-with special reference to temperature,   | Title of the paper is renamed as Environmental Biology and Biostatistics |

| S No. | Course List | Learning Outcomes   | Existing Syllabus  | Suggested Syllabus  | Remarks   |
|-------|-------------|---|--|---|---|
|       |             | <p>and the interrelationship between biotic and abiotic components of nature as well as relationship among the individuals of the biotic components.</p> <ul style="list-style-type: none"> <li>• Realize the importance of ecosystem and biodiversity for maintaining ecological balance.</li> <li>• Understand the basic principles of population and community ecology.</li> <li>• Understand the fundamental principles of biostatistics and its role in the data analysis generated by scientific research.</li> </ul> | <p>iii. Biotic factors – Intra and Inter specific relationship among animals.</p> <p>iv. Principles of limiting factors – Leibig’s law of minimum, Shelford’s Law of tolerance, combined concept of limiting factors.</p> <p>Biogeochemical Cycles: Carbon, Oxygen, Nitrogen and Phosphorus cycles.</p> <p><b>Unit 2</b></p> <ol style="list-style-type: none"> <li>1. Ecosystem Ecology: Structure and dynamics of the ecosystem including food chain, food webs trophic levels, productivity and energetics.</li> <li>2. Fresh Water Ecosystem: Physiochemical factors, Biotic communities and lake eutrophication.</li> <li>3. Marine Ecosystem: Zonation factors and biotic communities of deep sea only.</li> <li>4. Terrestrial Ecosystem: Salient features of grass land, forest and desert ecosystem.</li> </ol> <p><b>Unit 3</b></p> <ol style="list-style-type: none"> <li>5. <i>Population Ecology</i>. <ol style="list-style-type: none"> <li>i. Definition and attributes of animal population: Population density and its measurement, natality, mortality, growth form, age distribution, age pyramids, Sex ratio, dispersal and dispersion.</li> <li>ii. Regulation of Population density: Population fluctuations and interactions.</li> </ol> </li> <li>6. Community Ecology : <ol style="list-style-type: none"> <li>i. Definition of types of communities (micro and macro communities).</li> <li>ii. Community dominance and species diversity.</li> <li>iii. Ecotone, edge effect and ecological Niche.</li> <li>iv. Succession and Climax.</li> </ol> </li> </ol> <p><b>Unit 4</b></p> <p><del>7. <i>Pollution Ecology</i>:-</del></p> <ol style="list-style-type: none"> <li><del>i. Pollution, Biodegradable and non-biodegradable pollutants.</del></li> </ol> | <p>light and water.</p> <p>iii. Biotic factors -Intra and inter specific relationship among animals.</p> <p>iv. Principles of limiting factors-Leibig’s law of minimum, Shelford’s law of tolerance, combined concept of limiting factors.</p> <ul style="list-style-type: none"> <li>• Biogeochemical cycles: Carbon, oxygen, nitrogen and phosphorus cycles.</li> </ul> <p><b>Unit 2</b></p> <ul style="list-style-type: none"> <li>• Ecosystem ecology: Structure and dynamics of the ecosystem including food chain, food webs trophic levels, productivity and energetics.</li> <li>• Fresh water ecosystem: Physiochemical factors, biotic communities and lake eutrophication.</li> <li>• Marine ecosystem: Zonation factors and biotic communities of deep sea only.</li> <li>• Terrestrial ecosystem: Salient features of grass land, forest and desert ecosystem.</li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>• Population ecology: <ol style="list-style-type: none"> <li>i. Definition and attributes of animal population: Population density and its measurement, natality, mortality, growth form, age distribution, age pyramids, sex ratio, dispersal and dispersion.</li> <li>ii. Regulation of population density: Population fluctuations and interactions.</li> </ol> </li> <li>• Community ecology: <ol style="list-style-type: none"> <li>i. Definition of types of communities (micro and macro communities).</li> <li>ii. Community dominance and species diversity.</li> <li>iii. Ecotone, edge effect and ecological niche.</li> <li>iv. Succession and climax.</li> </ol> </li> </ul> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>• Applied ecology: <ol style="list-style-type: none"> <li>i. Conservation of natural resources.</li> </ol> </li> </ul> | <p>Unit-4 of this paper is already mentioned in</p> |

| S No. | Course List | Learning Outcomes | Existing Syllabus  | Suggested Syllabus   | Remarks  |
|-------|-------------|-------------------|--|--|--|
|       |             |                   | <p>ii. Air pollution: Sources, nature, prevention and control.</p> <p>iii. Water pollution: Source, nature abatement.</p> <p>iv. Noise pollution</p> <p>v. Radioactive pollution and effects of radioactive substance on living organisms.</p> <p>vi. Environmental health and welfare.</p> <p><b>Unit 5</b></p> <p>8. <b>Applied Ecology :</b></p> <p>i. Conservation of Natural resources.</p> <p>ii. Wild life management.</p> <p>iii. National parks and Wild life sanctuaries in India.</p> <p>iv. Extinction in animals.</p> <p>v. Zoogeographical regions of the world along with the boundaries and fauna</p> <p><b>Recommended Books :</b></p> <ul style="list-style-type: none"> <li>➤ Elements of Ecology: Clarke.</li> <li>➤ Ecology: E.P. Odum, New Delhi : Amerind Publishing, 1965.</li> <li>➤ Environmental Analysis: M.M. Saxena, Bikaner Agro Botanical Pub., 1990.</li> <li>➤ Ecology with special reference to animal and man : S. Charles Kendeigh.</li> <li>➤ Principles of Animal Ecology: Allee, Emeroon, Park and Schmidt.</li> <li>➤ Animal Ecology : S.P. Singh.</li> <li>➤ Ecology and Environment: P.D. Sharma, Rastogi Publications.</li> <li>➤ Ecology: C.V.S. Bahura.</li> <li>➤ Ecology: C.J. Krebs.</li> <li>➤ Ecology 2000: Edited by Edmand Hillary, London Michael Joseph, 1984.</li> </ul> | <p>ii. Wild life management.</p> <p>iii. National parks and wild life sanctuaries in India.</p> <p>iv. Extinction in animals.</p> <p>v. Zoogeographical regions of the world along with the boundaries and fauna.</p> <p><b>Unit 5</b></p> <ul style="list-style-type: none"> <li>• Biostatistics: <ul style="list-style-type: none"> <li>i. Introduction, scope and applications.</li> <li>ii. Sampling, data collection and presentation.</li> <li>iii. Types of data, methods of collection of primary and secondary data, data presentation-Histogram, polygon, bar diagram, pie diagram.</li> <li>iv. Frequency distribution. Measures of central tendency-Mean, median, mode.</li> <li>v. Measures of variability-Standard deviation, standard error.</li> </ul> </li> </ul> <p><b>Suggested Books :</b></p> <ul style="list-style-type: none"> <li>➤ Alllee W.C., Emerson, A.E., Park, O., Parl, T., &amp; Schmidt, K.P. (1967). <i>Principles of Animal Ecology</i>. USA: W.B. Saunders Company.</li> <li>➤ Banerjee, P.K. (2007). <i>Introduction to Biostatistics</i> (3<sup>rd</sup> ed.). New Delhi: S Chand and company Pvt. Ltd.</li> <li>➤ Bhuyan, K.C. (2017). <i>Advanced Biostatistics</i>. Kolkata: New Central Book Agency.</li> <li>➤ Chaudhary, B.L., &amp; Pandey, J. (2007). <i>Fundamentals of Ecology &amp; Environment</i>. Jaipur: Apex Publishing House.</li> <li>➤ Clarke, G.L. (1965). <i>Elements of Ecology</i>. New Jersey: John Wiley &amp; Sons Inc.</li> <li>➤ Datta, A.K. (2014). <i>Basic Biostatistics and Application</i>. Kolkata: New Central Book Agency.</li> <li>➤ Hillary, E. (1984). <i>Ecology 2000: The Changing Face of Earth</i>. Michael Joseph Ltd.</li> </ul> | <p>plant physiology and ecology paper, therefore contents of unit-V has shifted to Unit-IV and Introduction to biostatistics is proposed to be include in the Unit-V</p> |

| S No. | Course List | Learning Outcomes | Existing Syllabus | Suggested Syllabus   | Remarks |
|-------|-------------|-------------------|-------------------|--|---------|
|       |             |                   |                   | <ul style="list-style-type: none"> <li>➤ Kendeigh, S.C. (1974). <i>Ecology with special reference to animal and man</i>. New Jersey: Prentice Hall.</li> <li>➤ Krebs, C.J. (2001). <i>Ecology</i> (5<sup>th</sup> ed.). San Francisco, USA: Benjamin Cummings.</li> <li>➤ Kumar, A. (2015). <i>Biodiversity &amp; Conservation</i>. New Delhi: APH Publishing Corporation.</li> <li>➤ Miller, G.T. (2004). <i>Environmental Science: Working with the Earth</i> (10<sup>th</sup> ed.). Singapore: Thomson Asia.</li> <li>➤ Misra, S.P., &amp; Pandey, S.N. (2016). <i>Essentials of Environmental Sciences</i> (4<sup>th</sup> ed.). New Delhi: Ane Books Pvt. Ltd.</li> <li>➤ Odum, E.P. (1965). <i>Ecology</i>, New Delhi: Amerind Publishing.</li> <li>➤ Pandey, M. (2015). <i>Biostatistics: Basic and Advanced</i>. New Delhi: MV Learning.</li> <li>➤ Saxena, M.M. (1990). <i>Environmental Analysis</i>: Bikaner: Agro Botanical.</li> <li>➤ Sharma, P.D. (2011). <i>Ecology and Environment</i>. Meerut: Rastogi Publication.</li> <li>➤ Singh, S.P. (2005.). <i>Animal Ecology</i>. Meerut: Rastogi Publications.</li> <li>➤ Tripathi, G. (2002). <i>Modern Trends in Environmental Biology</i>. New Delhi: CBS Publishers &amp; Distributors.</li> </ul> <p><b>Suggested e-Resources:</b></p> <ul style="list-style-type: none"> <li>➤ <b>Aquatic ecology</b><br/><a href="https://nptel.ac.in/courses/120108002/">https://nptel.ac.in/courses/120108002/</a></li> <li>➤ <b>Ecosystem</b><br/><a href="https://nptel.ac.in/courses/122103039/38">https://nptel.ac.in/courses/122103039/38</a></li> <li>➤ <b>Biostatistics</b><br/><a href="https://nptel.ac.in/courses/102101056/">https://nptel.ac.in/courses/102101056/</a></li> <li>➤ <b>Measures of central tendency</b><br/><a href="https://www.tutorialspoint.com/statistics/arithmetic_mean.htm">https://www.tutorialspoint.com/statistics/arithmetic_mean.htm</a></li> <li>➤ <b>Population characteristics</b><br/><a href="http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.">http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.</a></li> </ul> |         |

| S No. | Course List  | Learning Outcomes  | Existing Syllabus  | Suggested Syllabus   | Remarks  |
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|       |  |  |  | 1.1.534.5462&rep=rep1&type=pdf   |  |
| 4)    | <b>5.2: Environmental Biology Lab</b><br><b>Discipline Elective:</b><br><b>ZOO 302L: Environmental Biology and Biostatistics Lab</b> | On completion of the course, students will be able to:<br><ul style="list-style-type: none"> <li>• Demonstrate skills in the quality assessment of water through testing of water for CO<sub>2</sub>, O<sub>2</sub>, chloride and hardness.</li> <li>• Gain an understanding of parasitic, aquatic, desert and aerial adaptations of animals with the help of charts and specimens.</li> <li>• Describe symbiosis, commensalism and socialization among organisms with the help of charts and specimens.</li> <li>• Understand analysis of data by solving biostatistical problems.</li> </ul> | <b>5.2: Environmental Biology Lab</b><br>1. To find the depth and visibility in a pond by Sachi disc method.<br>2. To determine the pH of water sample.<br>3. To determine the content of dissolved oxygen in the water sample.<br>4. To determine free CO <sub>2</sub> content in the water sample.<br>5. To determine the Chloride content of the water sample.<br>6. To determine the total hardness of water.<br>7. To study the effect of environmental stimulation on <i>paramecium</i> .<br>8. To study parasitic, desert, aquatic and aerial adaptations in animals<br>i. Parasite : <i>Hirudinaria, Taenia, Ascaris, Schistosoma, Fasciola, Head louse</i> .<br>ii. Desert : <i>Phrynosoma, Uromastix, Camel, Heloderma</i> , Rattle snake, Golden mole.<br>iii. Aquatic : <i>Pleuronectus, Exocoetus, Turtle, Hippocampus, Dolphin, Hydrophis, Duck, Crocodile</i> .<br>iv. Aerial: Any Bird, Draco, Bat.<br>9. To study different types of associations existing among living organisms.<br>i. Symbiosis: Chlorohydra, Termite and Aphid.<br>ii. Commensalism: Harmit-crab and Sea anemone and Gastropod shell, Euplectella and Shrimps.<br>iii. Socialization: Ants, Termites, Honey bees.<br>10. Draw a map of world and identify the Zoogeographical regions of the world along with their major fauna.<br>Report on any current topic related to Environmental Biology. | <b>Discipline Elective:</b><br><b>ZOO 302L: Environmental Biology and Biostatistics Lab</b><br>1. To find the depth and visibility in a pond by Sachi disc method.<br>2. To determine the pH of water sample.<br>3. To determine the content of dissolved oxygen in the water sample.<br>4. To determine the chemical oxygen demand in the water sample.<br>5. To determine free CO <sub>2</sub> content in the water sample.<br>6. To determine the chloride content of the water sample.<br>7. To determine the total hardness of water.<br>8. To study the effect of environmental stimulation on <i>Paramecium</i> .<br>9. To study parasitic, desert, aquatic and aerial adaptations in animals:<br>i. Parasite: <i>Hirudinaria, Taenia, Ascaris, Schistosoma, Fasciola, Pediculus</i> .<br>ii. Desert: <i>Phrynosoma, Uromastix, Camel, Heloderma</i> , Rattle snake, Golden mole.<br>iii. Aquatic: <i>Pleuronectus, Exocoetus, Turtle, Hippocampus, Dolphin, Hydrophis, Duck, Crocodile</i> .<br>iv. Aerial: Any bird, <i>Draco</i> , bat.<br>10. To study different types of associations existing among living organisms.<br>i. Symbiosis: <i>Chlorohydra</i> , termite and aphid.<br>ii. Commensalism: Harmit-crab, sea anemone and gastropod shell, <i>Euplectella</i> and shrimps.<br>iii. Socialization: Ants, termites and honey bees.<br>11. Draw a map of world and identify the Zoogeographical regions of the world along with their major fauna.<br>12. Biostatistics exercise-mean, median, mode, standard deviation and standard error.<br>13. Report on any current topic related to environmental | Exercise on biostatistics is introduced in the revised laboratory syllabus |

| S No. | Course List                                       | Learning Outcomes   | Existing Syllabus | Suggested Syllabus  | Remarks |
|-------|---|---|-------------------|---|---------|
|       |   |   |                   | biology.<br><b>Suggested books:</b> <ul style="list-style-type: none"> <li>➤ Lal, S.S. (2015). <i>Practical Zoology: Invertebrates</i> (11<sup>th</sup> ed.). Meerut: Rastogi Publication.</li> <li>➤ Lal, S.S. (2015). <i>Practical Zoology: Vertebrates</i> (11<sup>th</sup> ed.). Meerut: Rastogi Publication.</li> <li>➤ Lal, S.S. (2016). <i>A Textbook of Practical Zoology Vol-III</i> (2<sup>nd</sup> ed.). Meerut: Rastogi Publication.</li> <li>➤ Poddar, T., Mukhopadhyay, S., &amp; Das, S.K. (2003). <i>An advanced Laboratory Manual of Zoology</i>. Kolkata: Macmillan India Limited.</li> <li>➤ Verma, P.S. (2010). <i>A Manual of Practical Zoology: Chordates</i> (11<sup>th</sup> ed.). New Delhi: S Chand Publishing.</li> </ul>  |         |
| 5)    | <b>Discipline Elective: Developmental Biology</b> | <b>Learning Outcomes:</b><br>On completion of the course, students will be able to <ul style="list-style-type: none"> <li>• Gain expertise in explaining how a variety of interacting processes generate an organism's heterogeneous shapes, size and structural features that arise on the trajectory from embryo to adult or more generally throughout a life cycle.</li> <li>• Gain an understanding of</li> </ul> |                   | <b>Discipline Elective: Developmental Biology</b><br><b>Unit 1: Introduction to developmental biology</b> <ul style="list-style-type: none"> <li>• History, scope and applications of developmental biology.</li> <li>• Basic concepts: Phases of development, cell-cell interaction, pattern formation, differentiation and growth, differential gene expression, cytoplasmic determinants and asymmetric cell division.</li> <li>• Gametogenesis: spermatogenesis and oogenesis. Polarity and gradients.</li> <li>• Fertilization: Types, mechanism and theories.</li> </ul> <b>Unit 2: Early embryonic development</b> <ul style="list-style-type: none"> <li>• Cleavage: Definition, planes and patterns of cleavage, classification of cleavage based on distribution and amount of yolk.</li> <li>• Morulation, blastulation and gastrulation in ambhibia and birds.</li> <li>• Morphogenetic movements, embryonic induction and competence, primary organizers.</li> </ul> <b>Unit 3: Late embryonic development</b> <ul style="list-style-type: none"> <li>• Differentiation of germinal layers.</li> <li>• Method of organ formation: an overview of neural</li> </ul> |         |

| S No. | Course List | Learning Outcomes   | Existing Syllabus | Suggested Syllabus   | Remarks |
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|       |             | <p>systematic and organized learning about the knowledge and concepts of growth and development of organisms.</p> <ul style="list-style-type: none"> <li>• Demonstrate a rich array of material and conceptual practices that could be analysed to better understand the scientific reasoning exhibited in experimental life sciences.</li> </ul> |                   | <p>tube formation, types of mesoderm, somite formation, endoderm and its derivatives in amphibians and birds.</p> <ul style="list-style-type: none"> <li>• Extra-embryonic membranes in birds, their development and functions.</li> <li>• Paedogenesis and neoteny in amphibians.</li> </ul> <p><b>Unit 4: Post embryonic development</b></p> <ul style="list-style-type: none"> <li>• Metamorphic events and its hormonal regulations in amphibians.</li> <li>• Regeneration: types, regeneration of limbs in salamanders, regeneration of lost tail in lizard.</li> <li>• Introduction to senescence and apoptosis.</li> </ul> <p><b>Unit 5: Implications of developmental biology</b></p> <ul style="list-style-type: none"> <li>• Teratogenesis: Teratogenic agents and their effects on embryonic development.</li> <li>• Embryonic stem cells and their applications.</li> <li>• Cloning of animals: Nuclear transfer technique and embryo transfer technique.</li> <li>• <i>In vitro</i> fertilization, artificial insemination in cattle, amniocentesis.</li> </ul> <p><b>Suggested Books</b></p> <ul style="list-style-type: none"> <li>➤ Balinsky, B.I. &amp; Fabian, B.C. (1981). <i>An Introduction to Embryology</i> (5<sup>th</sup> ed.). International Thompson Computer Press.</li> <li>➤ Carlson, B.M. (1999). <i>Patten's foundations in embryology</i>. (6<sup>th</sup> ed.). New York, USA: McGraw Hill.</li> <li>➤ Chattopadhyay, S. (2017). <i>An introduction to developmental Biology</i>. Kolkata, India: Books and Allied.</li> <li>➤ Gilbert, S.F. (2010). <i>Developmental Biology</i> (9<sup>th</sup> ed.). Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.</li> <li>➤ Kalthoff (2008). <i>Analysis of Biological Development</i> (2<sup>nd</sup> ed.). McGraw-Hill Publishers.</li> </ul> |         |

| S No. | Course List   | Learning Outcomes   | Existing Syllabus | Suggested Syllabus  | Remarks |
|-------|---|---|-------------------|---|---------|
|       |   |   |                   | <ul style="list-style-type: none"> <li>➤ Lewis, Wolpert (2002). <i>Principles of Development</i> (2<sup>nd</sup> ed.). Oxford University Press.</li> <li>➤ Rastogi, V.B. &amp; Jayaraj, M.S. (2005). <i>Developmental Biology</i> (A Text book of embryology). Kedar Nath Ram Nath Publisher, Meerut.</li> </ul> <p><b>Suggested e-Resources:</b><br/> <b>Developmental Biology</b></p> <ul style="list-style-type: none"> <li>➤ <a href="https://nptel.ac.in/courses/nptel_download.php?subjectid=102101068">https://nptel.ac.in/courses/nptel_download.php?subjectid=102101068</a></li> <li>➤ <a href="http://cmb.learn.unito.it/mod/book/tool/print/index.php?id=3288">http://cmb.learn.unito.it/mod/book/tool/print/index.php?id=3288</a></li> </ul>  |         |
| 6)    | <b>Discipline Elective: Developmental Biology Lab</b> | <p>On completion of the course, students will be able to</p> <ul style="list-style-type: none"> <li>• Understand the different stages of development of frog and chick through microscopic slides.</li> <li>• Understand the development and life cycle of <i>Drosophila</i> through microscopic slides.</li> </ul> |                   | <p><b>Discipline Elective: Developmental Biology Lab</b></p> <ol style="list-style-type: none"> <li>1. Study of whole mounts and sections of developmental stages of frog through permanent slides/charts/models: Eggs, cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages).</li> <li>2. Study of whole mounts of developmental stages of chick through permanent slides/charts/models: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages).</li> <li>3. Study of the developmental stages and life cycle of <i>Drosophila</i> with the help of chart/specimen/models.</li> </ol> <p><b>Suggested Books</b></p> <ul style="list-style-type: none"> <li>➤ Lal, S.S. (2015). <i>Practical Zoology: Vertebrates</i> (11<sup>th</sup> ed.). Meerut: Rastogi Publication.</li> <li>➤ Verma, P.S. (2010). <i>A Manual of Practical Zoology: Chordates</i> (11<sup>th</sup> ed.). New Delhi: S Chand Publishing.</li> </ul> |         |
| 7)    | <b>Discipline Elective: Applied Zoology</b>           | <p>On completion of the course, students will be able to</p> <ul style="list-style-type: none"> <li>• Explore the important of</li> </ul>   |                   | <p><b>Discipline Elective Unit-1</b></p> <ul style="list-style-type: none"> <li>• <b>Parasitic protozoans:</b> Life history and pathogenicity of <i>Entamoeba histolytica</i>, <i>Plasmodium vivax</i>, <i>Giardia</i>, <i>Leishmania</i> and</li> </ul>  |         |



| S No. | Course List | Learning Outcomes  | Existing Syllabus | Suggested Syllabus  | Remarks |
|-------|-------------|--|-------------------|---|---------|
|       |             | <p>earthworms in agro-ecosystems and utilize gained knowledge for production of vermicompost in small scale for garden/household plant.</p> <ul style="list-style-type: none"> <li>• Demonstrate their knowledge for setting up poultry farm, sericulture, apiculture, lac culture plant.</li> <li>• Understand biology, life cycle and control measures of crop pests, stored grain pests and insects serve as vectors for human diseases.</li> </ul> |                   | <p><i>Trypanosoma gambiense</i>.</p> <ul style="list-style-type: none"> <li>• <b>Parasitic Helminthes:</b> Life history and pathogenicity of <i>Ancylostoma duodenale</i> and <i>Wuchereria bancrofti</i>.</li> </ul> <p><b>Unit-2</b></p> <ul style="list-style-type: none"> <li>• <b>Insects of agriculture importance:</b> Biology, control and damage caused by crop pests (<i>Helicoverpa armigera</i>, <i>Pyrilla perpusilla</i>, <i>Papilio demoleus</i>) and stored grain pests (<i>Callosobruchus chinensis</i>, <i>Sitophilus oryzae</i> and <i>Tribolium castaneum</i>).</li> <li>• <b>Insects of medical importance and their control:</b> <i>Pediculus humanus corporis</i>, <i>Anopheles</i>, <i>Culex</i>, <i>Aedes</i>, <i>Xenopsylla cheopis</i>.</li> </ul> <p><b>Unit 3</b></p> <ul style="list-style-type: none"> <li>• <b>Apiculture:</b> Different species of honey bees, pollen calendar, bee keeping and management practices, honey extraction techniques, bee products, pests of honey bees and their control.</li> <li>• <b>Sericulture:</b> Different silkworm species and their host plants, silkworm rearing and management practices, pests of silkworms and their control.</li> <li>• <b>Lac culture:</b> Lac insect, culture practices, pests of lac insect and their control.</li> </ul> <p><b>Unit 4</b></p> <ul style="list-style-type: none"> <li>• <b>Aquaculture:</b> Types of fishery: Marine, inland. Composite fish culture, induced breeding and hybridization. Transportation of fish seed. Fish diseases and their control.</li> <li>• <b>Prawn culture:</b> Culture practices of giant fresh water prawn (<i>Macrobrachium rosenbergii</i>), biology and life history.</li> <li>• Pearl culture, pearl formation, composition, colour, size and quality of pearl.</li> </ul> <p><b>Unit 5</b></p> |         |

| S No. | Course List | Learning Outcomes | Existing Syllabus | Suggested Syllabus  | Remarks |
|-------|-------------|-------------------|-------------------|---|---------|
|       |             |                   |                   | <ul style="list-style-type: none"> <li>• <b>Vermiculture:</b> Definition, scope and importance, culture methods: indoors and out door, monoculture and polyculture, vermicomposting.</li> <li>• <b>Poultry farming:</b> Principles of poultry breeding, management of breeding stock and broilers, processing and preservation of eggs, diseases of poultry and their control.</li> <li>• <b>Animal Husbandry:</b> Preservation and artificial insemination in cattle, induction of early puberty and synchronization of estrus in cattle.</li> </ul> <p><b>Suggested Books:</b></p> <ul style="list-style-type: none"> <li>➤ Arora, D.R &amp; Arora, B. (2001). <i>Medical Parasitology</i> (2<sup>nd</sup> ed.). CBS Publications and Distributors.</li> <li>➤ Atwal, A.S. (1986). <i>Agricultural Pests of India and South East Asia</i>, Kalyani Publishers.</li> <li>➤ Dennis, H. (2009). <i>Agricultural Entomology</i>. Timber Press (OR).</li> <li>➤ Dunham R.A. (2004). <i>Aquaculture and Fisheries Biotechnology Genetic Approaches</i>. CABI publications, U.K.</li> <li>➤ Hafez, E.S.E. (1962). <i>Reproduction in Farm Animals</i>. Lea &amp; Fabiger Publisher.</li> <li>➤ Kumar and Corton. <i>Pathological Basis of Diseases</i>.</li> <li>➤ Pedigo, L.P. (2002). <i>Entomology and Pest Management</i>, Prentice Hall.</li> <li>➤ Sarkar, S., Kundu, G. &amp; Chaki, K.K. (2014). <i>Introduction to Economic Zoology</i>. Kolkata: New Central Book Agency (P) Ltd.</li> <li>➤ Shukla &amp; Upadhyaya (1999-2000). <i>Economic Zoology</i>. Meerut: Rastogi Publishers.</li> <li>➤ Venkitaraman (1983). <i>Economic Zoology</i>. Sudarsana Publishers.</li> </ul> <p><b>Suggested e-Resources</b><br/><b>Sericulture</b></p> |         |

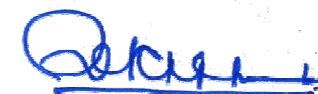
| S No. | Course List                                     | Learning Outcomes   | Existing Syllabus | Suggested Syllabus   | Remarks |
|-------|---|---|-------------------|--|---------|
|       |   |   |                   | ➤ <a href="https://swayam.gov.in/courses/152-silkworm-crop-protection">https://swayam.gov.in/courses/152-silkworm-crop-protection</a>  |         |
| 8)    | <b>Discipline Elective: Applied Zoology Lab</b> | On completion of the course, students will be able to <ul style="list-style-type: none"> <li>• Understand the life cycle of protozoan and helminthes parasites through microscopic slides.</li> <li>• Explore the knowledge of life cycle of honey bees, silk moths and lac insects for setting up apiculture, sericulture and lac culture farm.</li> <li>• Gain an understanding of biology, life cycle and control of stored grain pests, crop pests and insect of medical importance.</li> </ul> |                   | <b>Discipline Elective: Applied Zoology Lab</b> <ol style="list-style-type: none"> <li>1. Study of life cycle of <i>Plasmodium vivax</i>, <i>Entamoeba histolytica</i>, <i>Giardia</i>, <i>Leishmania</i>, <i>Trypanosoma gambiense</i>, <i>Ancylostoma duodenale</i> and <i>Wuchereria bancrofti</i> through permanent slides/photomicrographs or specimens.</li> <li>2. Study of different types of bees (Queens, drones and worker bees) permanent slides/photomicrographs or specimens.</li> <li>3. Study of different types of silk moths (<i>Bombyx</i>, <i>Samia</i> and <i>Antheraea</i>) through permanent slides/photomicrographs or specimens.</li> <li>4. Study of <i>Tachardia lacca</i> through permanent slides/photomicrographs or specimens.</li> <li>5. Study of different types of pearls through photomicrographs or specimens.</li> <li>6. Study of arthropod vectors associated with human diseases: <i>Pediculus</i>, <i>Culex</i>, <i>Anopheles</i>, <i>Aedes</i> and <i>Xenopsylla</i> through permanent slides/photomicrographs or specimens.</li> <li>7. Study of some stored grains insect pests through damaged products/photographs.</li> <li>8. Identifying feature and economic importance of <i>Helicoverpa (Heliothis) armigera</i>, <i>Papilio demoleus</i>, <i>Pyrilla perpusilla</i> and <i>Callosobruchus chinensis</i>.</li> <li>9. Aquarium design and maintenance.</li> </ol> |         |

\* 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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