| | | |
|---|---|---|
| **6.5.1**<br><br>**$Q_lM$** | ***Internal Quality Assurance Cell (IQAC) has contributed significantly for institutionalizing the quality assurance strategies and processes, by constantly reviewing the teaching-learning process, structures & methodologies of operations and learning outcomes, at periodic intervals***<br>Describe two practices institutionalized as a result of IQAC initiatives within a maximum of 500 words<br>**File Description**<br>• Provide the link for additional information<br>• Upload any additional information | **10** |

**TEXT**

IQAC has taken several initiatives on quality assurance strategies and processes. Here we focus on two interventions.

A. In its meeting on 21 August 2019 (Link to Minutes) a decision was taken to ensure Programme Specific Outcome and Course Outcome for all programmes and courses respectively. Homepage of all the 26 Programmes include PSOs now. The list is below.

| Program Name | Programme URL |
|---|---|
| M Sc (Environmental Science and Resource Management) | Link |
| M Sc (Climate Science & Policy) | Link |
| M Sc (Geoinformatics) | Link |
| M Sc (Economics) | Link |
| M Sc (Biotechnology) | Link |
| M Sc (Water Science & Governance) | Link |
| MBA (Infrastructure Management) | Link |
| MBA (Sustainability Management) | Link |
| MA (Public Policy & Sustainable Development) | Link |
| MA (Sustainable Development Practice) | Link |
| M.Tech (Renewable Energy Engineering & Management) | Link |
| M.Tech (Urban Development & Management) | Link |
| M.Tech (Water Resource Engineering & Management ) | Link |
| LLM | Link |
| Ph.D in Natural Resource Management | Link |
| Ph.D in Energy & Environment | Link |
| Ph.D in Business Sustainability | Link |
| Ph.D in Bioresources & Biotechnology | Link |
| Ph.D in Water Science & Governance | Link |
| Ph.D in Policy Studies | Link |
| Ph.D in Legal Studies | Link |
| PG diploma (Public Policy & Sustainable Development) | Link |
| PG Diploma (Water Science & Governance) | Link |
| PG diploma in Renewable Energy | Link |
| Advanced PG diploma in Renewable Energy | Link |
| Certificate (Water Science & Governance) | Link |

Similarly all course outlines include Course Outcome/Learning Outcome and connect them with different assessments. It has become mandatory to include these in every course presented before the AC or even the BoS. In short, it has become a part of academic culture at TERI SAS. Annexure 6.5.1.A includes a typical programme outline and set of courses with complete course outlines.

B. In its meeting on 18th February 2019 (Link to Minutes) two recommendations were made
(a) For cases of Review/Revision of Programmes a Report be made a part of Academic Council Agenda/ Minutes.
(b) Such reports may include feedback from a variety of stakeholders.
Subsequent programme revisions include such a Report. Annexure 6.5.1.B. includes one such Report connected with revision of MSc Economics programme. Typically BoS Minutes includes the stakeholder feedback on review of courses and ATR. One example is included in the Minutes of BoS of Department of Policy Studies held on 10 May 2019 (link to Minutes) concerned review of several courses in the M.Sc. Economics programme.

**10, INSTITUTIONAL AREA, VASANT KUNJ, NEW DELHI**

**SUB: 49th MEETING OF THE ACADEMIC COUNCIL**

**Enclosures**

Date : 17 July 2021
Venue : Online - Microsoft Team Platform
Time : 10.30 AM

| Item No. | Particulars |
|---|---|
| Enclosure 1 | List of experts for Selection Committee |
| Enclosure 2 | Anomaly in the course credits and teaching weeks |
| Enclosure 3(a) | Criteria for continuation of registration to subsequent semester |
| Enclosure 3(b) | Conversion of CGPA grades into percentage |
| Enclosure 4 | Copy of UGC notification for extension and the list of doctoral scholars |
| Enclosure 5 | New course outlines |
| Enclosure 6 | Guidelines and course outlines of project/thesis/internships |
| Enclosure 7 | Outlines of Ph.D programmes |
| Enclosure 8 | New programme structure of the M.Sc. (Biotechnology) Programme offered by Department of Biotechnology |
| Enclosure 9 | **C**hange in the structure of the M.Sc. (Economics) Programme offered by Department of Policy Studies |

**Enclosure 8**

**New programme structure of the M.Sc. (Biotechnology) Programme offered by Department of Biotechnology**

Department of Biotechnology
TERI School of Advanced Studies
New Delhi

# MASTER OF SCIENCE (M.Sc.) BIOTECHNOLOGY PROGRAMME

Available specialisations
Specialisation 1: Plant Biotechnology
Specialisation 2: Microbial Biotechnology

**Definitions**

‘Programme’ means an entire course of study designed to be taught and evaluated in a teaching Department/Centre or jointly under more than one such Department/ Centre

‘Course’ means a segment of a subject that is part of a Programme

‘Programme Structure’ means a list of courses (Core, Elective, Specialisation specific electives) that makes up a Programme, specifying the syllabus, credits, hours of teaching, evaluation and examination criteria, minimum number of credits required for successful completion of the programme etc., prepared in conformity to University Rules

‘Core Course’ means a course that a student admitted to a particular programme must successfully complete to receive the degree and which cannot be substituted by any other course

‘Elective Course’ means an optional course to be selected by a student out of such courses offered in the same or any other Department/Centre

‘Specialisation specific elective’ means a course to be selected by a student for as specialization

**About the Programme**

From July 2021, a Programme in M.Sc. in Biotechnology will be offered by the Department of Biotechnology, TERI SAS. The restructured programme, M.Sc. Biotechnology, aims to meet the growing requirement of qualified scholars supporting R&D in Research, Academia and Industries related to Biotechnology. The programme aims towards contributing to the objectives of several National Missions such as National Mission for Sustainable Agriculture, National Mission for Sustaining the Himalayan Ecosystem and National Water Mission and toward meeting the Sustainable Developmental Goals such as zero hunger, good health and well-being and quality education among several others. This programme, with a significantly broadened scope, compared to earlier M.Sc. Plant Biotechnology Programme will provide options to specialize either in Plant Biotechnology or Microbial Biotechnology. A multidisciplinary outlook will be inculcated in the students by encouraging students to take up courses from Social Sciences, Environment and Engineering streams of the University. Further, the restructured programme is futuristic in scope and in alignment with Choice Based Credit System (CBCS) mandated in UGC-NAAC guidelines and NEP 2020 framework.

**Programme Overview**

The M.Sc. Biotechnology Programme offers conceptual understanding by imparting cutting-edge disciplines of science along with an exposure to regulatory issues, IPRs and ethical concerns related to biotechnology. Emphasis is laid on training in applied mathematics, statistics, and computational skills in view of the projected demand for a trained cadre adept at approaching biological problems in truly interdisciplinary and integrative manner. Courses have been specifically structured to impart concepts pertaining to advanced areas of research in genomics and contemporary approaches employed by molecular biologists. Therefore, a graduate of this Programme can be expected to have both specialized knowledge and

practical experience required to address contemporary problems in both academic and industrial settings.

**Programme Objectives**

The objective of the programme is to highlight the role played by biotechnology in modern society and its relevance to sustainable development. The M.Sc. programme in Biotechnology seeks to provide education and training, empower students with technical skill-set, create capacities and build career opportunities in three key domains of biotechnology namely:

(i) Research and development in industry and academia
(ii) Science education
(iii) Policy, regulations and management

This is achieved through a combination of interdisciplinary curricula comprised of both theory as well as intensive laboratory work. Through its unique pedagogical methods, the academic programme allows transferability of acquired skills in domains unrelated to biotech sectors.

**Programme Outcomes (POs)**

| | |
|---|---|
| PO1 | A research-oriented learning that develops analytical and integrative problem-solving approaches. |
| PO2 | Specialized knowledge and practical training to address contemporary problems in academia and industry. |
| PO3 | Awareness of ethical issues and regulatory considerations while addressing societal needs for sustainability. |
| PO4 | To advance education and research in biotechnology and explore sustainable solutions for agriculture, environment and energy sectors. |
| PO5 | Promote an understanding of interdisciplinary approaches and technologies used in the analysis of complex biological information. |
| PO6 | Impart rigorous hands-on training in both laboratory-based methods and bio-informatics tools for biological research. |
| PO7 | Sensitize students about multifaceted regulatory issues and ethical concerns related to biotechnology. |

**Programme Specific Outcome (PSOs)**

| | |
|---|---|
| PSO1 | Molecular biology tools and experimental strategies, theoretical understanding of OMICS approaches. |
| PSO2 | DNA profiling and barcoding techniques, generation of transgenics, marker assisted breeding and selection, testing of hybrid purity. |
| PSO3 | Computational skills such as modelling, simulation analysis of data. |
| PSO4 | Structural and functional characterization of biological macromolecules. |
| PSO5 | IPRs, ethics and regulations in the field of biotechnology |
| PSO6 | Theoretical and applied knowledge and practical skills in Plant biotechnology for a better food, nutrition and environment for the mankind. |
| PSO7 | Microbial diversity, Molecular pathogenesis, host-microbe interactions, |

| | |
|---|---|
| | bioprocess engineering and environmental biotechnology. |

**Programme USPs**

- Research-led teaching
- Two full days of practical classes every week with hands-on-training
- Exposure to real-world problems during Major Project
- Options for specialization
- Additional focus on Intellectual Property Rights and Bioethics

**Eligibility Criteria**

A Bachelor's degree in Sciences/Engineering/Technology

**Selection Procedure**

Applications are invited from candidates through advertisements published on TERI SAS website (www.terisas.ac.in) and also in leading national newspapers and social media platforms. Admission to the M.Sc. Biotechnology Programme is made on the basis of a combined entrance examination followed by an interview conducted by a faculty panel from the Department of Biotechnology, TERI SAS.

**Pedagogical Tools**

The classroom/online lectures are complemented with extensive laboratory practical, case studies, classroom discussions, and guest lectures by experts. During the fourth semester, students are involved in full-time research for their major project.

**Programme Structure**

- The M.Sc. Biotechnology programme is a two-year programme divided into four semesters. A student is required to complete 75 credits for the completion of the programme and the award of degree.
- The M.Sc. Biotechnology programme provides options for specialization by completing a set of specialisation specific courses. Currently, two specialisations are being offered under the Programme: i) Plant Biotechnology and ii) Microbial Biotechnology.
- The entire M.Sc. Biotechnology Programme is comprised of core courses (51 credits), elective courses (audit only but equivalent to minimum 4 credits), Specialisation specific courses (8 credits) and a Major Project (16 credits). In addition, two courses, i) Technical Writing and Communication Skills and ii) Applied mathematics have been added as compulsory audit courses.
- The specialisation specific courses will be offered during second and third semesters. A student can opt for specialisation specific courses related to only one of the available specialisations.
- The elective courses are to be taken only as **audit course** only and the grades in those courses will not be considered while calculating the CGPA. A minimum 4 credits equivalent of elective courses need to be completed during the Programme. There is no upper limit for the number and credit equivalent for Elective courses. The Elective

courses may be taken in any semester when offered by the concerned Department and provided it doesn't conflict with any other course taken by the student.

- At the start of Semester 2, the students will be required to choose any one of the two specialisations. Maximum of 60% of the total number of students can be allotted a particular specialisation. Allotment of specialisation will be done based on a combination of merit (as per the Semester 1 grades) and preference.
- A strong component of Bioinformatics in the form of hands-on practical equivalent to 3 credits has been included in Semesters 2 and 3. This is in addition to the theoretical orientation on Bioinformatics of 2 credits that will be provided in Semester 1.

**Programme outline***

| Year | Courses | Credits | Duration |
|---|---|---|---|
| **First Year** | | | |
| 1st Semester | 7 core courses of 2-7 credits each, and 2 core audit courses | 21 | 15 weeks |
| 2nd Semester | 7 core courses of 2-7 credits and 1 course of 2 credits in the area of specialisation** | 22 | 15 weeks |
| | | | |
| **Second Year** | | | |
| 3rd Semester | 4 core courses of 2-7 credits and 1 course of 2 credits in the area of specialisation** | 16 | 15 weeks |
| 4th Semester | Major project | 16 | 15 weeks |

*In addition to above, a minimum 4 credits equivalent of elective courses (audit only) listed below need to be completed during the Programme which may be taken in any semester when offered by the concerned Department and provided it doesn't conflict with any other course taken by the student. There is no upper limit for the number and credit equivalent for Elective courses.

**Specialisation specific practical component equivalent to 2 credits will carried out under Biotechnology Laboratory- Part 2 (2nd Semester) and Biotechnology Laboratory- Part 3 (3rd Semester) each

| Semester 1 | | | | | | |
|---|---|---|---|---|---|---|
| **Course No.** | **Course title** | **Type** | **Number of Credits** | **No. of L-T-P** | **Course Coordinator** | **Course Offered** |
| BBP 101 | Biotechnology Laboratory - Part 1 | Core | 7 | 7-0-182 | Dr. Udit Soni | Yes |
| NRE 101 | Communication Skills and Technical Writing | Audit | 2* | 16-12-0 | Dr. Suneel Deambi | Yes |
| BBP 155 | Principles of Genetic Engineering and Recombinant DNA Technology | Core | 3 | 28-14-0 | Dr. Anandita Singh | Yes |
| NRE 113 | Applied Mathematics | Audit and bridge course | 0* | 31-11-0 | Dr. Akash Sondhi | Yes |
| BBP 158 | Conceptual Foundations of Molecular Biology | Core | 2 | 28-0-0 | Dr. Ramakrishnan Sitaraman | Yes |
| BBP 154 | Principles of Biochemistry and Biophysics | Core | 2 | 28-0-0 | Dr. Chaithanya Madhurantakam | Yes |
| BBP 111 | Bioanalytical Techniques | Core | 3 | 36-6-0 | Dr. Udit Soni | Yes |
| BBP 121 | Plant and Animal Biotechnology | Core | 2 | 28-0-0 | Dr. Shashi Bhushan Tripathi | Yes |
| BBP 174 | Bioinformatics and Computational Biology | Core | 2 | | | Yes |

| Semester 2 | | | | | | |
|---|---|---|---|---|---|---|
| **Course No.** | **Course title** | **Type** | **Number of Credits** | **No. of L-T-P** | **Course Coordinator** | **Course Offered** |
| TBA | Conservation Genetics and Genomics | Core | 2 | | Dr. Shashi Bhushan Tripathi | T |
| BBP 102 | Biotechnology Laboratory - Part 2 | Core* | 7 | | Dr. Anandita Singh | P |
| TBA | Introduction to Nanobiotechnology | Core | 2 | | Dr. Udit Soni | T |

| Semester 2 | | | | | | |
|---|---|---|---|---|---|---|
| **Course No.** | **Course title** | **Type** | **Number of Credits** | **No. of L-T-P** | **Course Coordinator** | **Course Offered** |
| BBP 130 | Molecular Microbiology and Immunology | Core | 2 | | Dr. Chaithanya Madhurantakam | T |
| BBP 112 | Statistics for The Life Sciences | Core | 3 | 28-14-0 | Dr. Prateek Sharma | T |
| BBP 114 | Molecular Cell Biology - From Genes to Communities | Core | 2 | | Dr. Ramakrishnan Sitaraman | T |
| TBA | Genome Organisation and Molecular Marker Techniques | Core | 2 | | Dr. Anandita Singh | T |
| BBP 156 | Molecular Plant Physiology and Metabolism | Specialisation (Plant Biotechnology) | 2 | | Dr. Shashi Bhushan Tripathi | |
| TBA | Microbial Pathogenesis | Specialisation (Microbial Biotechnology) | 2 | | Dr. Ramakrishnan Sitaraman | |

*Specialisation specific practical component equivalent to 2 credits will carried out under Biotechnology Laboratory- Part 2

| Semester 3 | | | | | | |
|---|---|---|---|---|---|---|
| **Course No.** | **Course title** | **Type** | **Number of Credits** | **No. of L-T-P** | **Course Coordinator** | **Course Offered** |
| BBP 103 | Biotechnology Laboratory - Part 3 | Core* | 7 | | | P |
| BBP 141 | Bioethics, IPR and Regulations in Biotechnology | Core | 3 | | | T |
| TBA | Gene Expression Analysis and | Core | 2 | | Dr. Ramakrishnan | T |

| Semester 3 | | | | | | |
|---|---|---|---|---|---|---|
| **Course No.** | **Course title** | **Type** | **Number of Credits** | **No. of L-T-P** | **Course Coordinator** | **Course Offered** |
| | Transcriptomics | | | | Sitaraman | |
| TBA | Proteomics and Protein Engineering | Core | 2 | | Dr. Chaithanya Madhurantakam | T |
| TBA | Functional Genomics in Plants | Specialisation (Plant Biotechnology) | 2 | | Dr. Anandita Singh | |
| TBA | Bioprocess Engineering and Environmental Biotechnology | Specialisation (Microbial Biotechnology) | 2 | | Dr. Chaithanya Madhurantakam | |

*Specialisation specific practical component equivalent to 2 credits will carried out under Biotechnology Laboratory- Part 3

| Elective courses (Audit only) | | | | | | |
|---|---|---|---|---|---|---|
| **Course No.** | **Course title** | **Type** | **Number of Credits** | **No. of L-T-P** | **Course Coordinator** | **Course Offered** |
| NRE 131 | Environmental Chemistry and Microbiology | Elective | 3 | 35-7-0 | Dr. Udit Soni | |
| NRE 165 | Introduction to Sustainable Development | Elective | 1 | 14-0-0 | D. Akash Sondhi | |
| TBA | Nanomaterials: Introduction and Applications | Elective | 2 | | Dr. Udit Soni | |
| NRE 123 | Biodiversity Assessment and Conservation | Elective | 3 | 17-15-20 | Dr. Sudipta Chatterjee | |
| NRE 168 | Food Security and Agriculture | Elective | 3 | 23-16-6 | Dr. Chubamenla Jamir | |
| NRE 112 | Multivariate Data Analysis | Elective | 3 | 28-14-0 | Dr. Neeti | |
| NRE 151 | Wildlife Conservation and | Elective | 3 | 35-7-0 | Dr. Sudipta | |

| Elective courses (Audit only) | | | | | | |
|---|---|---|---|---|---|---|
| **Course No.** | **Course title** | **Type** | **Number of Credits** | **No. of L-T-P** | **Course Coordinator** | **Course Offered** |
| | Management | | | | Chatterjee | |

| | | | |
|---|---|---|---|
| **Course title:** Biotechnology laboratory – Part 1 | | | |
| **Course code:** | **No. of credits:** 7 | **L-T-P:** (7-0-182) | **Learning hours:** 189 |
| **Pre-requisite course code and title (if any):** None | | | |
| **Department:** Department of Biotechnology | | | |
| **Course coordinator:** | **Course instructor:** | | |
| **Contact details:** | | | |
| **Course type: Core** | **Course offered in:** Semester1 | | |

**Course description:**

The objective of this laboratory course is to introduce students to experiments related to biotechnology. The course is designed to teach students the utility of set of experimental methods in biotechnology in a problem-oriented manner.

**Course objectives:**

1. To introduce the students to standard techniques of molecular biology and GLPs (good laboratory practices).
2. To impart intensive hands-on-training using molecular tools in a research project mode.
3. To train the students in designing experiments with appropriate controls.

**Course contents**

| Module | Topic | L | T | P |
|---|---|---|---|---|
| **Suggested practical** | | | | |
| **1** | Introduction to laboratory safety and safe practices in biotechnology laboratory. Introduction to Good Lab Practices (GLP) | 7 | 0 | 0 |
| **2** | **Analytical Techniques and Biochemistry-**<br>1. Preparing various stock solutions, working solutions, buffers solution.<br>2. To prepare an $CH_3COOH$-$CH_3COONa$ buffer system and validate the Henderson-Hasselbach equation.<br>3. Quantitative analysis by UV-Vis spectrophotometer- determination of unknown concentration of KMnO4 or BSA Solution.by plotting a standard graph and validating Beer- Lambert's Law.<br>4. Glucose assay by dinitro salicylic- determination of concentration of given unknown glucose solution by DNS/glucose assay by dinitro salicylic acid.<br>5. To determine concentration of unknown protein by Bradford protein assay method.<br>6. To determine concentration of unknown protein by Lowry method/Lowry assay method.<br>7. Enzyme kinetic analysis of catechol | 0 | 0 | 84 |

| | | | | |
|---|---|---|---|---|
| | oxidation by catechol oxidases from apple/potatoes/etc.<br>8. Effect of temperature and enzyme inhibitor on enzyme activity.<br>9. To perform catalase assay on given plant tissue<br>10. To Perform Lysozyme crystallization using vapor diffusion methods.<br>11. Overexpression of the target gene in a heterologous system<br>12. To purify a histidine tagged protein using Ni- NTA (Nitrilo -triacetic acid) affinity chromatography<br>13. To perform Ion exchange chromatography for purification of target protein<br>14. To perform gel exclusion chromatography for purification of target protein till homogeneity<br>15. To perform SDS- PAGE for the protein sample | | | |
| **3** | **Essential techniques in microbiology and molecular biology-**<br>1. Estimation of bacterial titre using colony counts from serial dilutions<br>2. Growth of bacterial culture and preparation of growth curve<br>3. Isolation of pure bacterial cultures from mixed cultures.<br>4. Qualitative and quantitative analysis of DNA.<br>5. Isolation and restriction enzyme analysis of DNA from soil samples.<br>6. Methylation analysis DNA using restriction enzymes.<br>7. Gel purification of DNA by silica binding.<br>8. Preparation of electrocompetent bacteria and estimating their transformation frequency. | 0 | 0 | 28 |
| **4** | **Isolation of nucleic acids and manipulation-**<br>1. PCR and optimization of factors affecting PCR<br>2. PCR based genotyping for confirmation of transgene insertion in plants<br>3. Isolation, qualitative and quantitative analysis of total cellular RNA from eukaryotic cell systems<br>4. 1st strand c-DNA synthesis and RT-PCRs<br>5. Restriction digestion of plant gDNA with rare and frequent cutters (restriction | 0 | 0 | 28 |

| | | | | |
|---|---|---|---|---|
| | enzymes)<br>6. Purification of plasmids from E. *coli* cells (Alkaline Lysis method and spin-column based methods)<br>7. Linearization of plasmid vectors<br>8. Screening of recombinant plasmid vectors by PCR based genotyping of inserts and restriction enzyme based release of inserts | | | |
| **5** | **Plant and Animal Biotechnology-**<br>1. Preparation of stock solutions for plant tissue culture media, vitamins and hormones<br>2. Sterilisation of explants and initiation of cultures for micropropagation<br>3. Initiation of various explants for direct and indirect organogenesis<br>4. Embryo culture<br>5. Control of phenolics under tissue culture conditions<br>6. In vitro and ex vitro hardening<br>7. Isolation of genomic DNA from plants<br>8. ISSR/RAPD for clonal uniformity testing<br>9. Cell viability assay<br>10. Sub-culturing and maintenance of cell lines<br>11. Genomic DNA isolation from blood/ cell cultures | 0 | 0 | 42 |
| **Evaluation criteria:**<br>1. Attendance: 5%<br>2. Preparation of lab record(s) throughout the semester :25%<br>3. End semester evaluation: 70% (Following components would be included)<br>a) Spotting – 15 %<br>b) Viva-voce– 15 %<br>c) Experiment(s) assigned on the day of the exam- 40% | | | | |
| **Learning outcomes:**<br>1. Ability to conduct experiments with adequate safety precautions.<br>2. Capacity to compare and evaluate various approaches in solving a given experimental problem.<br>3. Ability to design and interpret molecular biology experiments.<br>4. Proficiency in defining a research problem, drawing logical inferences from results and documenting outcomes in systematic manner. | | | | |
| **Pedagogical Approach:** Laboratory experiments, demonstration, writing and experiments result analysis. | | | | |
| **Skill Set:**<br>1. Able to work in biotechnology lab and perform experiments<br>**2.** Able to analyses experimental data and critical thinking. | | | | |
| **Employability:**<br>1. Academic and industrial research<br>2. Industries based on biotechnology, pharmacy, and agriculture. | | | | |
| **Materials-** | | | | |

1. Study material and laboratory protocol will be provided by course instructor.
2. "Biochemistry Laboratory: Modern Theory and Techniques" Rodney Boyer, second Edition, Pearson Education, 2012.
3. "Analytical Techniques in Biochemistry and Molecular Biology" Rajan Katoch, Springer, 2011.
4. "Molecular cloning: A laboratory manual" Sambrook, Joseph. & Russell, David W. & Cold Spring Harbor Laboratory, Cold Spring Harbor, N.Y : Cold Spring Harbor Laboratory, 2001.
5. "DNA and protein sequence analysis. A Practical approach" Bishop M.J., Rawlings C.J. (Eds.)1997.

Website

1. https://nptel.ac.in/

Journals

**1.** Peer reviewed relevant scientific journals.

**Advanced Reading Material**

Will be provided by instructor if require.

**Additional information (if any)**

List of experiments given in each module are representative, instructor may choose any of them for student's laboratory training as per requirements.

**Student responsibilities**

1. Class attendance.
2. Study of course materials as specified by the instructor.
3. Regular submission of given class assignments.

**Reviewers**

1. Dr. Manoj Shrivastava, Principal Scientist, Centre for Environment Science and Climate Resilient Agriculture (CESCRA), Nuclear Research Laboratory (NRL), Indian Agricultural Research Institute, New Delhi-110012
2. Dr. Rakesh Singh, M. Tech. (IIT, BHU) Ph.D. (NIPB, IARI) Principal Scientist (Plant Biotechnology) Division of Genomic Resources ICAR-NBPGR, New Delhi-110012

| | | | |
|---|---|---|---|
| **Course title:** Plant and Animal Biotechnology | | | |
| **Course code:** BBP 121 | **No. of credits: 2** | **L-T-P: 28**-0-0 | **Learning hours: 28** |
| **Pre-requisite course code and title (if any):** Science graduate | | | |
| **Department:** Department of Biotechnology | | | |
| **Course coordinator:** | | **Course instructor:** | |
| **Contact details:** | | | |
| **Course type:** Core | | **Course offered in:** Semester 1 | |

**Course description:**

The broad objective of the present core course is to provide an overview of plant and animal biotechnology. In this respect, students will be acquainted with principles and applications of different techniques of plant and animal cell/tissue culture and genetic transformation. In case of cell and tissue culture, the focus shall be on media composition and preparation, methods of *in vitro* regeneration, their applications and limitations. With respect to genetic transformation, the focus will be on detection and characterization of transformants. Further, the global status of GMOs, various case studies illustrating the application of biotechnology in developing crop varieties resistant to various biotic and abiotic stresses, enhancing nutritional quality and knock-out animal technology would be dealt in detail.

**Course objectives:**

1. To introduce the students to the principles and applications of plant tissue culture and animal cell culture
2. Development of plant transformation vectors specifically designed to facilitate transfer of improved/unique genetic traits to plants, and to provide knowledge on diverse genetic transformation technologies available for the production of transgenic plants in crop improvement programs.
3. Familiarization with knock-out and transgenic animals to model disease and study gene function.

**Course contents**

| Module | Topic | L | T | P |
|---|---|---|---|---|
| **1** | **Principles of Plant Tissue Culture** | **7** | 0 | 0 |
| | • History of plant tissue culture<br>• Set up of a plant tissue culture laboratory<br>• Media constituents and preparation<br>• Micropropagation and clonal fidelity testing<br>• Meristem culture for production of virus free plants<br>• Somatic Embryogenesis<br>• Organogenesis<br>• Micrografting<br>• Hardening and acclimatization | | | |
| **2** | **Applications of plant tissue culture** | 6 | 0 | 0 |
| | • Anther, pollen and ovary culture for production of doubled haploids<br>• Production of Triploids<br>• Embryo culture and embryo rescue<br>• Protoplast isolation, culture and fusion<br>• Cell culture and production of secondary metabolites<br>• Cryopreservation | | | |

| | | | | |
|---|---|---|---|---|
| | • Synthetic seed technology | | | |
| **3** | **Animal cell culture and biotechnology** | 8 | 0 | 0 |
| | • Brief history of animal cell culture; cell culture media and reagents (buffer and pH; blood buffering system)<br>• Basic techniques of mammalian cell culture<br>• Organotypic and histotypic cultures<br>• Primary culture, secondary culture, continuous cell lines (cancer cell line), suspension cultures<br>• Cell synchronization and transformation<br>• Clonal selection, cell fusion and monoclonal antibody production<br>• Application of animal cell culture for virus isolation and production of human and animal viral vaccines<br>• Application of animal cell culture for disease modelling and high throughput drug screening<br>• Application of animal cell culture for isolation of pharmaceutical proteins and recombinant anti-bodies<br>• Development of iPSC and human specific disease modelling<br>• Multiple Ovulation and Embryo Transfer Technology | | | |
| **4** | **Applications of transgenic technology** | 7 | 0 | 0 |
| | • Introduction to Agrobacterium tumefaciens and Ti Plasmids<br>• In-planta transformation methods<br>• Chloroplast Transformation<br>• Detection, characterization and expression of transformants (Genetic markers, reporter genes and transgene stability)<br>• Conferring resistance to biotic stresses (pests, viruses, fungi) and abiotic stresses (salt, drought, heat)<br>• Enhancing nutritional quality of crops<br>• Transgenics for male sterility<br>• Marker free transgenics<br>• Knock-out/in animal development using embryonic stem cells technology<br>• Transgenic animal development to model disease and study gene function. | | | |
| | **Total** | **28** | **0** | **0** |

**Evaluation criteria:**

1. Test 1- (Module 1) 30%
2. Test 2- (Module 2) 30%
3. Test 3- (Modules 3 and 4) 40%

**Learning outcomes:**

1. An understanding of principles of various plant and animal cell/tissue culture techniques (Test 1-3)
2. An understanding of commercial applications of various cell and tissue culture-based technologies in plants and animals (Test 1-2)
3. Ability to rationalize and develop strategies for incorporating novel traits in plants and animals through genetic engineering (Test 3)

**Pedagogical Approach:**

1. Online/classroom lectures and discussions

2. Case studies and examples from original research articles

**Skill Set:**

1. Formulation of media preparation for plant and animal cell cultures
2. Initiation and maintenance of plant and animal cell cultures
3. Genetic transformation of plants

**Employabilty:**

1. Academic organisations
2. Tissue culture facilities and horticulture companies
3. Agri-biotechnology and seed companies
4. Pharmaceutical and drug research companies
5. IPR consultancy firms

**Materials:**

**Suggested Readings**


1. George E. F., Hall A H, and De Klerk G J (2008) Plant propagation by tissue culture. Springer.
2. Bhojwani SS and Razdan M K (1996) Plant Tissue Culture : Theory and Practice. Elsevier.
3. Herman, Edwin B., (Ed.) (2009) Genetic modification of plants: methods and applications 2005-2009, USA: Agritech Consultants.
4. Herman, Edwin B., (Ed.) (2007) Microbial contaminants in plant tissue culture, Vol. III : 2003 – 2007. Agritech Consultants, Inc. Shrub Oak.
5. Neumann, K H, Kumar, A, Imani, J (2009) Plant Cell and Tissue Culture – A tool in biotechnology : Basics and applications.
6. Halford,Nigel G. (Ed.) (2006) Plant Biotechnology: Current and Future Applications of genetically modified crops. John Wiley and Sons Ltd.
7. Chrispeels MJ; Sadava DE (2003) Plant, Genes and Crop Biotechnology. Jones and Bartlett Publishers, Inc.
8. Pörtner, R. (2007) Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: Humana Press.
9. Freshney R.I. (2010) Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley, John & Sons, Inc; New Jersey


**Additional information (if any):**

**Student responsibilities:**

1. Class attendance.
2. Study of reading materials as specified by course instructor
3. Self-study

**Course reviewers:**

1. Prof. Ranjit Kumar Giri, National Brain Research Centre, Manesar, Haryana
2. Dr. Modhumita Ghosh, Scientist G, Institute of Forest Genetics and Tree Breeding, Coimbatore, Tamil Nadu

| | | | |
|---|---|---|---|
| **Course title:** Bioanalytical Techniques | | | |
| **Course code:** | **No. of credits:** 3 | **L-T-P:** 36-06-0 | **Learning hours:** 42 |
| **Pre-requisite course code and title (if any):** | | | |
| **Department:** Department of Biotechnology | | | |
| **Course coordinator:** | | **Course instructor** | |
| **Contact details:** | | | |
| **Course type:** core | **Course offered in:** Semester 1 | | |

**Course description:**

This course is introduced to bridge the gap between academics, research and industry. This course begins with a review of basic bio analytical technique and an introduction to general terminologies. This course contains bio analytical techniques along with their theory, working principal, common instrumentation and possible applications. This course will be equally beneficial to various scientific areas including, life science, chemical science, material science and environmental science.

**Course objectives:**

1. The primary objectives of this course are to develop the skills to understand the theory and practice of bio analytical techniques.
2. To provide scientific understanding of analytical techniques and detail interpretation of results.

**Course contents**

| S. No | Topic | L | T | P |
|---|---|---|---|---|
| 1. | **Spectroscopy study of chemical compounds and bio-molecules**<br>**Electromagnetic radiations and interactions with matters:** Electromagnetic spectrum. Quantization of energy, Electronic, vibrational and rotational spectroscopy. Franck–Condon principle, Jablonski diagram, radiative, nonradiative pathways, fluorescence and phosphorescence. Absorption of radiation, Beer-Lambert's law, deviation of Beer-Lambert's equation and its limitations.<br><br>**Principals, instrumentation, sampling and application of few spectroscopic techniques:** UV-Visible spectroscopy, Fluorescence spectroscopy, IR/Raman spectroscopy, NMR Spectroscopy and Mass spectroscopy. | 7 | 3 | 0 |
| 2. | **Microscopy:** Principals, instrumentation and applications of imaging techniques: Dark-field, Phase contrast, Fluorescence, Confocal microscopy, Atomic force microscopy, and Transmission and Scanning | 7 | 2 | 0 |

| | | | | |
|---|---|---|---|---|
| | electron microscopy. | | | |
| 3. | **Diffraction Technique:**<br>**Crystal geometry and structure**: Introduction to lattice and lattice systems, Bragg's plane, miller indices<br>**Principle of diffraction and X-ray diffraction:** X-rays production, X- ray spectra, Bragg's law and intensity of X- rays, Mosley's law, powdered XRD, percentage crystallinity, single crystal XRD, macromolecular XRD (protein crystallization, data collection and structure solution). | 7 | 0 | 0 |
| 4. | **Chromatography:** Classification of chromatographic techniques and their principles, Theory of chromatography, band broadening, rate and plate theory factors responsible for separation. Column chromatography, TLC, Paper chromatography.<br>**Liquid Chromatography and HPLC**: Instrumentation, pumps, solvent delivery system, isocratic and gradient programming modes, sample introduction system, columns, detectors, reversed phase and normal phase chromatography.<br>**Gas Chromatography**: Instrumentation, carrier gas supply, injectors, columns, packed and capillary columns, column oven and temperature programming, different detectors.<br>Introduction to hyphenated techniques in chromatography, GC-MS and LC-MS. | 6 | 1 | 0 |
| 5. | **Electrophoretic Techniques:** Principle, equipment and process, Agarose gel electrophoresis, horizontal and vertical gel electrophoresis, electrophoresis techniques, Isoelectric focusing, capillary electrophoresis and application of electrophoresis in analyzing macromolecules. | 6 | 0 | 0 |
| 6. | **Automation**: Interdisciplinary association, Automation in analysis, sample collection, sample process, High Throughput Process, High throughput screening | 3 | 0 | 0 |
| | **Total** | **36** | **6** | **0** |
| **Evaluation criteria:**<br>1. Test 1: 30%<br>2. Test 2: 30%<br>3. Test 3: 30%<br>4. Assignment/Presentation: 10% | | | | |
| **Learning outcomes:** | | | | |

1. Students will be able to use selected analytical techniques. (Test 1-3)
2. Students become familiar with working principals, tools and techniques of analytical techniques. (Test 1-3)
3. Students will understand the strengths, limitations and creative use of techniques for problem-solving. (Test 1-3 and Assignment/Presentation)

**Pedagogical Approach:**
Classroom/online lectures, tutorials, and demonstration of analytical techniques. Case studies based on peer reviewed research articles.

**Skill Set:**
1. Able to select analytical technique for case study.
2. Able to design experiments and understand the instrumentation.

**Employability:**
1. Academic and industrial research organization.
2. Industries based on biotechnology, pharmacy, agriculture, and chemical.

**Materials:**

**Suggested readings:**


1. I. D. Campbell, *Biological spectroscopy* (Benjamin/Cummings Pub. Co, Menlo Park, Calif, 1984), *Biophysical techniques series*.
2. K. Wilson, J. M. Walker, Eds., *Principles and techniques of biochemistry and molecular biology* (Cambridge University Press, Cambridge, UK : New York, 7th ed., 2009).
3. R. F. Boyer, *Biochemistry laboratory: modern theory and techniques* (Prentice Hall, Boston, 2nd ed., 2012).
4. R. Katoch, *Analytical techniques in biochemistry and molecular biology* (Springer, New York, 2011).
5. D. L. Spector, R. D. Goldman, Eds., *Basic methods in microscopy: protocols and concepts from cells: a laboratory manual* (Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y, 2006).
6. R. L. Switzer, *Experimental biochemistry* (W. H. Freeman and Co, New York, 3rd ed., 1999).
7. R. F. Boyer, *Modern experimental biochemistry* (Benjamin Cummings, San Francisco, 3rd ed., 2000).
8. J. R. Lakowicz, *Principles of fluorescence spectroscopy* (Springer, New York, 2006; http://site.ebrary.com/id/10229235).
9. B. Fultz, *Transmission electron microscopy and diffractometry of materials* (Springer, Berlin ; New York, 2nd ed., 2002).
10. D. B. Williams, C. B. Carter, *Transmission electron microscopy a textbook for materials science* (Springer, New York, 2009; http://dx.doi.org/10.1007/978-0-387-76501-3).
11. R. M. Silverstein, *Spectrometric identification of organic compounds* (John Wiley & Sons, Hoboken, NJ, 7th ed., 2005).
12. D. Harvey, *Modern analytical chemistry* (McGraw-Hill, Boston, 2000).


**Additional information (if any):**
Please keep in mind that this course, require hands on experience to strengthen the concepts; however, this course provides supplemental material in order to

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|---|
| communicate this information. |
| **Student responsibilities:**<br>1. Class attendance.<br>2. Study of course materials as specified by the instructor.<br>3. Regular submission of given class assignments**.** |

**Reviewers-**

1. Dr Narendra Tuteja, Visiting Scientist and Former Group Leader/Senior Scientist, PMB Group, International Centre for Genetic Engineering & Biotechnology, Aruna Asaf Ali Marg, New Delhi.
2. Dr. Anil K. Malik, Professor, Department of Physics, Ch. Charan Singh University, Meerut, India, Teachers' Fellow UGC, Govt. of India.

| | | | |
|---|---|---|---|
| **Course title:** Principles of genetic engineering and recombinant DNA technology | | | |
| **Course code:** BBP 155 | **No. of credits:** 3 | **L-T-P:** 28-14-0 | **Learning hours:** 42 |
| **Pre-requisite course code and title (if any):** | | | |
| **Faculty:** Anandita Singh | | **Department:** Department of Biotechnology | |
| **Course coordinator(s):** | | **Course instructor(s):** | |
| **Contact details:** | | | |
| **Course type:** Core | | **Course offered in:** Semester 1 | |

**Course description:**

The ability to genetically manipulate and engineer genomic sequences by precise recombination of genetic elements across organismal boundaries lies at the core of biotechnology. This foundation level core course is designed for students interested in developing a conceptual framework and technical know-how on genetic engineering methodologies. Upon successful completion of the course, students will gain an in-depth knowledge in principles of genetic manipulation and will develop an appreciation on centrality of genetic engineering in driving R&D across multiple branches of biotechnology. Students will gain proficiency in creative deployment of techniques for isolation, manipulation, novel design of genomic sequences. An introduction to properties of general DNA modifying enzymes will be given along with their applications. For example, the conceptualization, innovation, evolution and application aspects of PCR will be discussed in context to thermo-stable polymerases. An introduction to versatile and atypical modifying enzymes including non-specific endonucleases implied in new-age mutation technologies and genome engineering research will be provided. Cloning strategies with be contextualized to vector categories and applications such as plant transformation, protein expression, genomic and cDNA library construction to name a few. Host specificities and design of selection and screening strategies will be illustrated. Approaches for site-directed mutagenesis of cloned genomic fragments will be taught. Basic and advanced analytical techniques of molecular biology will not be covered in this course. To ensure coverage and sufficient depth on contemporary tools, outmoded methods no longer used has been intentionally avoided. However, students will be oriented to historical information for illustrating evolution of procedures used in contemporary biological research. Finally, an exposure will be provided to software used for *in-silico* annotation and manipulation of DNA sequences for efficient design, tracking, and management of cloning experiments in the laboratory.

**Course objectives:**

1. To develop an appreciation for importance of fundamental knowledge in discovery and innovation of modern day tools and techniques of genetic engineering
2. To provide a theoretical and practical framework underlying recombinant DNA technology
3. To train and provide technical skills to students for devising broad research methodologies by creative deployment of genetic engineering techniques

**Course contents**

| | | L | T | P |
|---|---|---|---|---|
| **1** | **Properties and applications of DNA Modifying Enzymes:** Host controlled restriction modification system (Type I-IV restriction endonucleases, Isoschizomers and Neoschizomers, Homing Endonucleases); DNA Methyltransferases; Methylation Dependent Restriction Endonucleases; Exonucleases and non-specific endonucleases (Cas9 endonuclease, Structure and mis-match specific endonucleases: Fok I, FEN, Endo, Cel I and other site directed nucleases); Genome Editing with Engineered Nucleases (GEEN), Ligases; site-specific Recombinases used in cloning technologies; DNA polymerases: Special case of thermo-stable DNA polymerases in context to PCR (History, concept, invention, enzymology, applications); Reverse transcriptases and expression analysis (semi-quantitative and quantitative RT-PCRs); Phosphatases and Kinases | 7 | 7 | |
| **2** | **Generalised cloning strategies**<br>Host genotype specificities; classical and contemporary strategies for selection and screening; Marker and reporter genes; positive and negative selection; insertional inactivation; α-complementation; TA-cloning vectors; TOPO-TA and GATEWAY cloning vectors | 3 | 1 | |
| **3** | **Vector categories and selection schemes**<br>History and evolution of plasmid and Lambda phase based vectors and their derivatives (Insertional vectors, replacement vectors, cosmids, phasmids, phagemids, *in-vitro* packaging); High-cloning capacity vectors (Virus based single stranded DNA vectors: M13, fd, f1; YACs, BACs, PACs, BIBACs); Plant transformation vectors (Binary and Conjugate), Components of Gene expression Cassettes; Protein Expression Vectors (expression systems for high level protein expression in *E. coli* and yeast, transcriptional control, inducible promoters, translational efficiency, translational initiation, elongation, codon usage), protein extraction and purification (protein purification tags, Histidine and GST tags, IMAC) | 8 | 2 | |
| **4** | **DNA modifying enzymes and labelling of nucleic acid sequences**<br>End-Labelling (3'- and 5'-), Random priming and Nick translation using radioactive non-radioactive labelling techniques. | 2 | | |
| **5** | **Construction of genomic DNA libraries** Procedures for partial, representative, enriched, large-insert DNA libraries in context to medium and high-capacity cloning vectors; cDNA libraries (Self-priming methods, replacement synthesis, Okayama and Berg strategy, use of Adapters/Linkers and methylation for directional cloning) | 2 | | |
| **6** | **Site Directed Mutagenesis**<br>PCR based methods for site-directed mutagenesis (Single primer methods viz. Mis-incorporation of mismatched oligos, Over-lap extension), whole plasmid single round PCR), mis-repair of mutant | 2 | | |

| | | | | |
|---|---|---|---|---|
| | oligonucleotides, selection of mutant (dut/ung E. coli strains for SDM through uracil replacement), Ligase chain reaction | | | |
| **7** | **Sequence verification**: Reading electropherograms, *in-silico* analysis, plasmid mapping software for cloning designs; annotation of DNA sequence features | | 4 | |
| **8** | **Genetic manipulation to Genome Modification and Engineering:** Impact of Genetic engineering on Transgenic Technology, Genome Editing: Case Studies from Biomedical research and crop biotechnology in Research and Development | 4 | | |
| | **Total** | **28** | **14** | |
| | | | | |

**Evaluation criteria:**

1. Test 1: 30%
2. Test 2: 30%
3. Test 3: 30%
4. Assignments/Presentations: 10%

**Learning outcomes:**

1. Technical know-how on versatile techniques in recombinant DNA technology **(Test 1-3, Assignments)**
2. Understanding in application of genetic engineering techniques in basic and applied biological research **(Test 1-3, Assignments)**
3. Proficiency in designing and conducting experiments involving genetic manipulation **(Test 1-3, Assignments)**

**Pedagogical Approach:**

Lectures and tutorials in online or offline mode with a major emphasis on the detailed discussion of original research articles

**Skill Set:**

1. Isolation, manipulating, design and analysis of DNA sequences using DNA modifying enzymes
2. Designing cloning experiments using routine and specialized vectors for such applications as plant transformation, protein expression and genomic DNA library construction
3. Editing genomic sequences using site-directed mutagenesis

**Employability:**

1. Science Education, Research and Development, Management and Bio-services
2. Bio-pharma and Agri-biotechnology companies
3. Law firms and knowledge processing organizations (IP management consultancy)
4. Regulatory bodies and funding agencies

**Materials:**

**Books**

1. M. R. Green, J. Sambrook. Molecular Cloning: A Laboratory Manual (Cold Spring Harbor, ed. 4, 2012).
2. M. Wink. An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology (Wiley, ed. 2, 2011).
3. K. Wilson, J. Walker. Principles and Techniques of Biochemistry and Molecular Biology (Cambridge University Press, ed. 7, 2010).
4. B. R. Glick, J.J. Pasternak and C.L .Pattern. Molecular Biotechnology: Principles and Applications of Recombinant DNA (ASM Press, ed. 4, 2010).

5. S. B. Primrose, R. Twyman. Principles of Gene Manipulation and Genomics (Wiley-Blackwell, ed. 7, 2006)
6. M. M. Burell. Enzymes of Molecular Biology (Humana Press, 1993)
7. H. M. Eun. Enzymology Primer for Recombinant DNA Technology (Academic Press, 2008)

**Additional information (if any):** The list of books suggested in the readings will only provide basic knowledge on the concepts. The actual readings will involve comprehension of prescribed Journal articles and Reviews across topics.

**Representative Software (Source):**

1. Gene Construction Kit® **(GCK)** (http://www.textco.com/gene-construction-kit.php): DNA manipulation and analysis tool, useful in plasmid mapping and restriction based cloning operations.
2. Gene Inspector® **(GI)** (http://www.textco.com/gene-construction-kit.php): DNA and protein sequence analysis package.
3. Vector NTI® Software (http://www.lifetechnologies.com/in/en/home/life-science/cloning/vector-nti-software.html): Integrated suite for sequence analysis

**Student responsibilities:**
1. Class attendance
2. Study of course materials as specified by the instructor
3. Self-study

**Course reviewers:**
The course was previously reviewed and commented on by the following experts:

1. Prof. Anil Grover
Head, Department of Plant Molecular Biology
University of Delhi, South Campus, New Delhi- 110021, India

2. Dr. Neeti Sanan Mishra
Group Leader: Plant RNAi,
International Centre for Genetic Engineering and Biotechnology
Aruna Asaf Ali Marg
New Delhi-110 067, India

| | | | |
|---|---|---|---|
| **Course title:** Conceptual Foundations of Molecular Biology | | | |
| **Course code:** | **No. of credits:** 2 | **L-T-P:** 28-0-0 | **Learning hours:** 28 |
| **Pre-requisite course code and title (if any):** None | | | |
| **Department:** Department of Biotechnology | | | |
| **Course coordinator(s):** | | **Course instructor(s):** | |
| **Contact details:** | | | |
| **Course type:** Core | | **Course offered in:** Semester 1 | |

**Course description:** The objective of this foundational course is to familiarize students of varied academic backgrounds (including non-biology degree holders) with the interdisciplinary knowledge that underlies molecular biology. The approach will not only ensure the transmission of this knowledge, but also emphasize the scientific method, creative thought processes, fortuitous discoveries and elegant experimental approaches that led to classic insights and discoveries in this field. The course will be taught with a special focus on the overarching framework of evolutionary theory that underlies all of biology. Original research articles, book excerpts and reviews highlighting seminal insights in the field will be discussed in detail. Finally, the value of this information will be underscored by a detailed description of instances of gene regulation.

**Course objectives:**

1. To provide students of varied backgrounds the history of ideas in, and the theoretical bases of molecular biology.
2. To highlight the interdisciplinary nature of major advances in molecular biology.
3. To present an overview of gene regulation.
4. To emphasize the importance of evolutionary theory in the understanding of biological phenomena.

**Course contents**

| S.No | Topic | L | T | P |
|---|---|---|---|---|
| **Module 1** | **The Importance of Evolutionary Theory to all Biology** | | | |
| | Early evolutionary ideas; Darwin, Mendel and the modern synthesis; symbiosis and evolution; natural selection across scales – from molecules to complex systems | 3 | | |
| | Beyond dichotomies – evolution and molecular phylogeny, formulation of the three-domain system of classification by Woese and Fox, gene transfer and role of viruses in evolution. | 3 | | |
| **Module 2** | **The Development of Molecular Biology** | | | |
| 1 | Historical background<br>The scientific method, vital force theory, classic experiments related to vital force theory and spontaneous generation | 3 | | |
| 2 | Physico-chemical approach to biology<br>The influence of *What is life* by Schrodinger on molecular biology | 3 | | |
| 3 | The nature and mutability of the genetic material<br>The chromosomal location of genes, DNA as the genetic material, DNA structure, semi-conservative replication of DNA, the Luria-Delbruck fluctuation test. | 4 | | |
| 4 | The flow of genetic information<br>The central dogma and its continuing relevance, sequence hypothesis, adaptor hypothesis, messenger RNA | 4 | | |

| | | | | |
|---|---|---|---|---|
| 5 | The physical nature and universality of Mendel's 'genes' Benzer's experiments on phage T4, the existence and nature of the triplet code | 4 | | |
| 6 | Gene expression and control<br>Positive and negative control of gene expression, considerations in the global regulation of gene expression | 4 | | |
| | **Total** | **28** | **0** | **0** |

**Evaluation criteria:**
Test 1 – 30% weightage
Test 2 – 30% weightage
Test 3 – 40% weightage

**Learning outcomes:**
1. Understanding of essential evolutionary concepts and their application to molecular biology (Tests 1-3).
2. Recognition of crucial advances in molecular biology based on model systems. (Tests 2-3).
3. Knowledge of different modes and levels of the regulation of gene regulation (Test 3).
4. Critical analysis of primary scientific literature (Tests 1-3).
5. Problem-solving skills (Tests 1-3).

**Pedagogical Approach:**
Online/offline lectures emphasizing the detailed discussion of research/review articles from scientific journals in class.

**Skill Set:**
1. Design of molecular biology/genetic engineering experiments.
2. Critical analysis of molecular biology/genetic engineering experimental results.
3. Formulation of experimental strategies for molecular genetic studies of simple model organisms.

**Employability:**
1. Academic and industrial research involving molecular biology approaches.
2. Intellectual property firms.
3. Life science teaching at school and undergraduate levels.

**Materials:**
**Required texts**
1. E. Schrödinger. What Is Life? : The Physical Aspect of the Living Cell with Mind and Matter and
Autobiographical Sketches (Cambridge University Press, Canto series, Cambridge, 11th reprint, 2004).
2. J.C. Herron, S. Freeman. Evolutionary Analysis. Pearson Education, India. ed. 5, 2013.
3. J. D. Watson, F. H. C. Crick. *Nature*, 3, 737-738 (1953).
4. M. Messelson, F. W. Stahl. *Proc. Natl. Acad. Sci. USA*, 44, 671-682 (1958).
5. F. H. C. Crick. *Nature*, 227,561-563 (1970).
6. F. H. C. Crick *et al. Nature*, 192, 1227-1232 (1961).
7. S. Benzer. *Proc. Natl. Acad. Sci. USA*, 45, 1607-1620 (1959).
8. S. Benzer. *Proc. Natl. Acad. Sci. USA*, 47, 403-415 (1961).
9. S. Brenner. *Proc. Natl. Acad. Sci. USA*, 43, 687-693 (1957).
10. S. Brenner *et al. Nature*, 190, 576-581 (1961).
11. G. W. Beadle, E. L. Tatum. *Proc. Natl. Acad. Sci. USA*, 27, 499-506 (1941).

12.O. T. Avery *et al. J. Exp. Biol.*, 79, 137-158 (1944).
13.S. E. Luria, M. Delbrück. *Genetics*, 28, 491-511 (1943).
14.B. Magasanik. *Proc. Natl. Acad. Sci. USA*, 97, 14044-14045 (2000).
15.C. R. Woese, G. E. Fox. *Proc. Natl. Acad. Sci. USA*, 74, 5088-5090 (1977).
16. T.H. Morgan. Sex-limited inheritance in Drosophila, *Science*, 32, 120-122 (1910).

**Suggested readings**

1. J. D. Watson., *et al.* Molecular Biology of the Gene. Pearson, Cold Spring Harbor, ed. 7, 2014.
2. B. Alberts, *et al.* Molecular Biology of the Cell. Garland Science, New York, ed. 5, 2008.
3. J. E. Krebs *et al.* Lewin's GENES XII. Jones and Bartlett Publishers, Inc., Burlington, ed. 12, 2017
4. T. H. Morgan *et al.* The Mechanism of Mendelian Heredity. Henry Holt and Company, New York, 1915.

**Case studies**

**Websites**

**Journals**

**Other readings**

**Additional information (if any):**

**Student responsibilities:**

1. Class attendance (online/offline).
2. Study/self-study of course materials as specified by the instructor.
3. Ensuring functionality of essential IT hardware & software at their preferred location(s).

**Course reviewers:**

1. Dr. Neel Sarovar Bhavesh, Group leader (equivalent to Professor), International Centre for Genetic Engineering and Biotechnology, Aruna Asaf Ali Marg, New Delhi – 110067, India.

2. Prof. Vijaya Satchidanandam, Department of Microbiology and Cell Biology, Indian Institute of Science, Bengaluru (superannuated) and Adjunct Professor, St. John's Medical College, Sarjapur Road, Bengaluru – 560034

| | | | |
|---|---|---|---|
| **Course title:** Principles of Biochemistry and Biophysics | | | |
| **Course code:** BBP ___ | **No. of credits: 2** | **L-T-P:** 28-0-0 | **Learning hours:** 28 |
| **Pre-requisite course code and title (if any):** Science graduate | | | |
| **Department:** Department of Biotechnology | | | |
| **Course coordinator:** | **Course instructor** | | |
| **Contact details:** | | | |
| **Course type:** Core | **Course offered in:** Semester 1 | | |

**Course description:**

The course is designed to provide students with basic concepts, principles and applications of biochemistry and biophysics. This is aimed at providing information on molecular logic of life, supramolecular chemistry, structure and function of macromolecules, molecular circuits/ information processing cellular networks, cell mechanics and dynamics, molecular bioenergetics, and applications. The course will provide inputs on how emerging biochemical and biophysical techniques greatly enhanced our understanding of biological systems and functioning. Furthermore, the course is focused on recent developments and evolving scenarios in biochemistry and biophysics and will be a good platform for students to further pursue their careers in sciences.

**Course objectives:**

1. Introduction to the molecular components of a cell, complex chemistry, and their interactions with the environment.
2. Familiarization of students with the macromolecular structural organization and relation to the functional significance of such a conformation through enzyme kinetics.
3. Acquainting the students with concepts of cell mechanics and applications, cellular dynamics and techniques employed.
4. Familiarization with biomolecular interplay involved in signal transduction and ubiquitination, apoptosis, transport mechanisms and metabolic pathways.
5. Providing students with fundamentals of laws of thermodynamics, Non equilibrium thermodynamics and cellular bioenergetics.

**Course contents**

| Module | Topic | L | T | P |
|---|---|---|---|---|
| **Module 1: Biomolecules and supramolecular chemistry** | | | | |
| 1.1 | Biomolecules, Bioactive compounds and Molecular Environment, Supra-molecular Chemistry of Biomolecules (Specific and Non-specific Molecular, Interactions, Short range Repulsions, Electrostatic Interactions, Dipolar, Interactions, Fluctuating Dipoles, Hydrogen Bonding, Cation-π Interactions, Hydrophobic Effect, Counter-ion Release) | 4 | 0 | 0 |
| **Module 2: Structure and function of macromolecules** | | | | |
| 2.1 | Levels of Structural Organization & Conformation, DNA structure, Protein structure, DSSP Classification, Ramachandran's Plot, Protein Folding & Misfolding, Structural Proteins & Regulatory Proteins, Enzyme catalysis and kinetics | 4 | 0 | 0 |
| **Module 3: Cell mechanics and dynamics** | | | | |
| 3.1 | **Fundamentals in cell mechanics** Bio-membranes (Structure, Activity, Fluidity, Permeability and | 4 | 0 | 0 |

| | | | | |
|---|---|---|---|---|
| | Dynamics), Membrane Channels, Ion pumps & Transporters, Membrane Potential, Diffusion coefficient, association and Brownian motion in biological systems | | | |
| 3.2 | **Cytoskeleton dynamics, models, and techniques** Force generation by cellular polymers, Power stroke and Brownian ratchet models of molecular motors, Helix-Coil transition model (DNA and Protein), Reynolds Number, Fluorescence Correlation Spectroscopy, Patch Clamps (electrophysiology), Cytological Optical Tweezers | 6 | 0 | 0 |
| **Module 4: Molecular circuits and signalling** | | | | |
| 4.1 | Signal Transduction Cascades, Primary and Secondary Messengers, EGF Signalling and Receptor Tyrosine Kinases the Ras-MAPK pathway, Wnt Signalling, Apoptosis, Ubiquitin System, Metabolic Pathways of Macromolecules and Cellular Respiration | 4 | 0 | 0 |
| **Module 5: Thermodynamics in biosystems** | | | | |
| 5.1 | The Laws of Thermodynamics, Gibbs free energy and Free energy changes, Redox Potentials and energy currency, The Three Levels of Bioenergetics in Eukaryotes/ Energy Transfer within Biosphere, Non-Equilibrium Thermodynamics (NET) | 3 | 0 | 0 |
| 5.2 | Thermogenesis, Uncoupling Protein Thermogenin and Mitochondrial Thermogenesis, Chloroplast Bioenergetics | 3 | 0 | 0 |
| | **Total** | **28** | **0** | **0** |

**Evaluation criteria:**

4. Test 1 30%
5. Test 2 30%
6. Test 3 (end semester) 40%

**Learning outcomes:**

1. An understanding of the basic components and chemistry involved in cell survival (Tests 1, 2 & 3)
2. An insight into macromolecular organization and its structural as well as functional importance (Test 1 & 2).
3. The ability to apprehend the concepts of cell dynamics and techniques employed to study cell mechanics (Test 2).
4. A detailed analysis of various signalling mechanisms vital for living systems. Grasp of molecular networks and their interplay (Test 3).
5. The ability to understand molecular bioenergetics and apply the energy transformation mechanisms and laws governing the transformations (Test 3).

**Pedagogical Approach:**

1. Online/Offline teaching.
2. Providing case studies to support the concepts.
3. Peer-reviewed research articles to discuss various modules in the course.

**Skill Set:**

4. Analytical skills based on case studies provided.
5. Knowledge of macromolecular applications in various sectors.
6. Knowledge of techniques employed to understand cellular systems.

**Employability:**
The course will provide skillsets and knowledge that may play key role to get employed in Universities, R & D industry, Medical centres/Colleges, Research Institutes and Diagnostic centres apart from specialized units like pharma, breweries, dairy and agri sectors.

**Materials:**
**Suggested Readings**


1. Delbianco M, Bharate P, Varela-Aramburu S, Seeberger PH. Carbohydrates in Supramolecular Chemistry. Chem Rev. 2016 Feb 24;116(4):1693-752. doi: 10.1021/acs.chemrev.5b00516. Epub 2015 Dec 24. PMID: 26702928.
2. RAMACHANDRAN GN, RAMAKRISHNAN C, SASISEKHARAN V. Stereochemistry of polypeptide chain configurations. J Mol Biol. 1963 Jul;7:95-9. doi: 10.1016/s0022-2836(63)80023-6. PMID: 13990617.
3. Dobson CM. Protein folding and misfolding. Nature. 2003 Dec 18;426(6968):884-90. doi: 10.1038/nature02261. PMID: 14685248.
4. Chiti F, Dobson CM. Protein Misfolding, Amyloid Formation, and Human Disease: A Summary of Progress Over the Last Decade. Annu Rev Biochem. 2017 Jun 20;86:27-68. doi: 10.1146/annurev-biochem-061516-045115. Epub 2017 May 12. PMID: 28498720.
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| **Additional information (if any): Not Applicable** |
| --- |
| **Student responsibilities:**<br>Study of course material as specified by the instructor. |

**Course reviewers:**

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**10, INSTITUTIONAL AREA, VASANT KUNJ, NEW DELHI**

**SUB: 49th MEETING OF THE ACADEMIC COUNCIL**

**Enclosures**

Date : 17 July 2021
Venue : Online - Microsoft Team Platform
Time : 10.30 AM

| Item No. | Particulars |
|---|---|
| Enclosure 1 | List of experts for Selection Committee |
| Enclosure 2 | Anomaly in the course credits and teaching weeks |
| Enclosure 3(a) | Criteria for continuation of registration to subsequent semester |
| Enclosure 3(b) | Conversion of CGPA grades into percentage |
| Enclosure 4 | Copy of UGC notification for extension and the list of doctoral scholars |
| Enclosure 5 | New course outlines |
| Enclosure 6 | Guidelines and course outlines of project/thesis/internships |
| Enclosure 7 | Outlines of Ph.D programmes |
| Enclosure 8 | New programme structure of the M.Sc. (Biotechnology) Programme offered by Department of Biotechnology |
| Enclosure 9 | **C**hange in the structure of the M.Sc. (Economics) Programme offered by Department of Policy Studies |

**Enclosure 9**

**Change in the structure of the M.Sc. (Economics) Programme offered by Department of Policy Studies**

<table>
<tr><td>Semester</td><td>Current Structure</td><td colspan="2">Proposed Structure</td></tr>
<tr><td>Semester 1</td><td>4 Core Courses (Total 16 credits):<br>Probability and Statistics (4 credits)<br>Mathematical Methods for Economics (4 credits)<br>Macroeconomics (4 credits)<br>Microeconomics (4 credits)</td><td colspan="2">4 Core Courses (Total 16 credits):<br>Probability and Statistics (4 credits)<br>Mathematical Methods for Economics (4 credits)<br>Macroeconomics (4 credits)<br>Microeconomics (4 credits</td></tr>
<tr><td>Semester 2</td><td>4 Core Courses (Total 16 credits):<br>Econometrics (4 credits)<br>Environment and Economic Development (4 credits)<br>Growth Economics (4 credits)<br>Development Economics (4 credits)</td><td colspan="2">4 Core Courses (Total 16 credits):<br>Econometrics (4 credits)<br>Environment and Economic Development (4 credits)<br>Growth Economics (4 credits)<br>Development Economics (4 credits)</td></tr>
<tr><td>Semester 3</td><td>3 Core Courses + Elective Courses worth 8 credits (Total 20 credits):<br>Methods of Research in Economics (Core; 4 credits)<br>Environmental Economics (Core; 4 credits)<br>Natural Resource Economics (Core; 4 credits)<br>Elective Courses worth 8 credits (see list below)</td><td colspan="2">3 Core Courses + Elective Course worth 4 credits (Total 16 credits):<br>Methods of Research in Economics (Core; 4 credits)<br>Environmental Economics (Core; 4 credits)<br>Natural Resource Economics (Core; 4 credits)<br>Elective Course (see list below)</td></tr>
<tr><td rowspan="2">Semester 4</td><td rowspan="2">Master’s Thesis (20 credits)</td><td colspan="2">Option between Thesis Track and Coursework Track (16 credits)</td></tr>
<tr><td>Master’s Thesis (16 credits)</td><td>Elective Courses worth 16 credits (see list below)</td></tr>
<tr><td>Total</td><td>72 credits</td><td colspan="2">64 credits</td></tr>
</table>

The list of courses approved for offering as elective in the MSc Economics programme is given below:

Indian agricultural development: Contemporary
Issues Economics of health and environment
Trade, Development and
Environment Time series and
regression analysis Advanced
Econometrics Microeconomics-II

Labour Economics
Ecological Economics
Energy Economics
Advanced
Macroeconomics
Industrial Organisation
Theory of Contracts
Law and Economics
Theory of Finance
Public Economics
Collective action and environmental management

It is proposed that if this structure is approved, the assessment criteria of electives offered by the programme in its fourth semester will place higher weightage on term papers/literature survey, presentations etc. This will enable the students to apply their learning to problems of current interest and in turn, improve their job market prospects.

The students of the programme can also fulfil their elective credit requirements from courses offered in other programmes in the institute, subject to approval from the Programme Coordinator.

**Background for the proposed change:**

A similar programme structure, conceived by the MPEC of MSc Economics programme on the basis of student feedback, was placed and approved at the Board of Studies meeting on 25th April 2018. This structure was shared with stakeholders including recruiters, academicians, current and past students to obtain their feedback. The Academic Council suggested further changes that led to the current programme structure as approved in its 43rd meeting dated 12th June 2018. The Academic Council further recommended that "the structured feedback from various stakeholders be obtained in order to take inputs on the programme structure and analysis of the same be presented in the next Academic Council".

The current programme structure was implemented from the July-December semester of 2018. Since students are the most important constituent of stakeholders, the MPEC Economics collected structured feedback from two batches of students, viz., the 2018-20 batch and the 2019-21 batch. The salient features of the feedback (Annexure D) are presented in the Table below.

| **Salient Features of Student Feedback on Programme Structure (Total 51 respondents from two batches)** | |
|---|---|
| Major Shortcomings of current structure (60% respondents listed at least one) | (a) Less number of subjects/electives on offer<br>(b) Too much focus on research<br>(c) Busy schedule of assessments<br>(d) The courses are less practical in nature |

| | |
|---|---|
| Comparison to previous structure | About 60% respondents preferred the current structure over the previous one |
| Distribution of credits | About 60% respondents felt that the current distribution is appropriate |
| Electives in third semester | About 80% respondents felt that there should be more electives to choose from in third semester |
| Electives in fourth semester | About 55% respondents did not feel need of electives in fourth semester, while rest felt the need of electives in the fourth semester, but either as an option to be exercised, or to make up for lost credits |
| Electives in the second semester | Almost 80% respondents wanted electives to be introduced in the second semester Itself |
| Master's Thesis be made non-compulsory | About 40% respondents wanted master's thesis to be made non-compulsory, while about 60% wanted master's thesis to remain Compulsory |

It follows from the student feedback that while a section of the students value the research orientation of the programme, another section wanted to exercise freedom in terms of choosing more electives. This necessitated that the course structure approved by the Board of Studies in its April 2018 meeting be revisited.

Feedback was collected from academicians, employers and alumni (Annexure A-C) seeking their opinion on a programme revision in the lines of the course structure approved by the Board of Studies in its April 2018 meeting. The salient features of this feedback, which reaffirm the justification of the proposed change in programme structure, are presented below.

| **Salient Features of Stakeholder Feedback on Programme Structure** | |
|---|---|
| **Stakeholder type** | **Feedback** |
| Academicians (16 respondents) | Most respondents felt that<br>(a) the proposed changes in the programme structure satisfy the objectives better than the old one.<br>(b) exercising the course track option may affect the future career prospects of the students positively.<br>(c) the programme with proposed changes will continue to imbibe research aptitude among the students, as it will allow the interested students to commit to producing quality dissertations. |

| | |
|---|---|
| Recruiters (5 respondents) | Recruiters mostly agreed that proposed changes can help in imbibing most of the qualities that they would like a future employee to possess. |
| Alumni (4 respondents) | Alumni members found that less number of electives offered is a shortcoming of the current structure. The responses were equally divided on offering master's thesis as an optional track. |