# DEPARTMENT OF MOLECULAR BIOLOGY AND GENETIC ENGINEERING (AUTONOMOUS)

## RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY

## NAGPUR

**M. Sc. Molecular Biology And Genetic Engineering Syllabus**

**Semester pattern with Choice Base Credits System**

**2023-24 and Onwards**

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Candidates opting for this course are advised to go through the direction relating to the course Vide G.R. No. NEP-2022/CR No. 09/VISHI-3/dated April 20, 2023, the directive , covering the credit distribution structure for the continuation of section 8 of this GR- ' Design of PG/ Master's Programmes' "STRUCTURE AND CREDIT DISTRIBUTION OF PG DEGREE PROGRAM" which is available on R. T. M. Nagpur University website. The direction will provide details on admission criteria, rules for ATKT, scheme of examination, coding pattern, pattern of question papers, practical, distribution of marks, research methodology, on job training, research projects (minor and major), internal assessment, calculation of SGPA and CGPA, etc.

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**POST GRADUATE TEACHING DEPARTMENT OF MOLECULAR BIOLOGY AND GENETIC ENGINEERING (AUTONOMOUS),**

**Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur**

M. Sc. Molecular Biology and Genetic Engineering (Autonomous) Syllabus

As per National Education Policy- 2020

Session 2023-24 and onwards

**Credit distribution structure for two/one year Post Graduate Degree Program**

| Year | Level & Code | Semester | Major Credits | | RM | OJT/ FP | Research Project (RP) | Total Credits | Degree |
|---|---|---|---|---|---|---|---|---|---|
| | | | Mandatory | Elective | | | | | |
| I | 6.0 | I | {Total= 14} (2 Theory + 2 Practical) | 4 | 4 | - | - | 22 | PG Diploma (after 3yr UG Degree) |
| | | II | {Total= 14} (2 Theory + 2 Practical) | 4 | - | 4 | - | 22 | |
| **Cum. Cr. For PG Diploma** | | | **28** | **8** | **4** | **4** | - | **44** | |
| **Exit option: PG Diploma 44 credits after three-year degree** | | | | | | | | | |
| II | 6.5 | III | {Total= 14} (3 Theory + 2 Practical) | 4 | - | - | 4 | 22 | PG Degree (after 3yr UG Degree) |
| | | IV | {Total= 12} (3 Theory) | 4 | - | - | 6 | 22 | |
| **Cum. Cr. For 1 yr PG Degree** | | | **26** | **8** | - | - | **10** | **44** | |
| **Cum. Cr. For 2 yr PG Degree** | | | **54** | **16** | **4** | **4** | **10** | **88** | |
| **PG Degree (88 credits) after 3 yr UG Degree or (44 credits) after 4 yr UG Degree** | | | | | | | | | |

## Appendix-I

## Scheme of Teaching under choice based credit system for M.Sc. Program in Molecular Biology and Genetic Engineering

## (Autonomous University Department)

| M. Sc. MBGE Semester I | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Code** | **Theory / Practical** | **Teaching scheme (Hours / Week)** | | | | **Credits** | **Examination Scheme** | | | | | |
| | | | | | | | **Duration in hrs.** | **Max. Marks** | | **Total Marks** | **Minimum Passing Marks** | |
| | | **Theory** | **Practical** | **Tutorial** | **Total** | | | **External Marks** | **Internal Ass** | | **Theory** | **Practical** |
| MMG1T01 | **Paper 1** CELL BIOLOGY (PROKARYOTES AND EUKARYOTES) | 4 | - | 2 | 6 | 4 | 3 | 60 | 40 | 100 | 50 | - |
| MMG1T02 | **Paper 2** MOLECULAR BIOLOGY I | 4 | - | 2 | 6 | 4 | 3 | 60 | 40 | 100 | 50 | - |
| MMG1T03 | **Paper 3**: **Electives^**<br>1. GENETICS- I<br>2. INDUSTRIAL AND ENVIRONMENTAL BIOTECHNOLOGY I<br>**OR** | 4 | - | 2 | 6 | 4 | 3 | 60 | 40 | 100 | 50 | - |
| | **Paper 3**: **Electives^**<br>EQUIVALENT ONLINE COURSE | Student will enroll for online course | | | | 4 | Student will appear for the examination conducted by the course coordinator and submit the passing certificate | | | | | |
| MMG1T04 | **Paper 4**: RESEARCH METHODOLOGY & BIOSTATISTICS | 4 | - | 2 | 6 | 4 | 3 | 60 | 40 | 100 | 50 | - |
| MMG1P01 | **Practical 1** | - | 6 | - | 6 | 3 | 8 | 50 | 50 | 100 | - | 50 |
| MMG1P02 | **Practical 2** | - | 6 | - | 6 | 3 | 8 | 50 | 50 | 100 | - | 50 |
| | **TOTAL** | **16** | **12** | **08** | **36** | **22** | -- | **340** | **260** | **600** | **200** | **100** |

| M. Sc. MBGE Semester II | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Code** | **Theory / Practical** | **Teaching scheme (Hours / Week)** | | | | **Credits** | **Examination Scheme** | | | | | |
| | | | | | | | **Duration in hrs.** | **Max. Marks** | | **Total Marks** | **Minimum Passing Marks** | |
| | | **Theory** | **Practical** | **Tutorial** | **Total** | | | **External Marks** | **Internal Ass** | | **Theory** | **Practical** |
| MMG2T01 | **Paper 5**<br>BIOCHEMISTRY | 4 | - | 2 | 6 | 4 | 3 | 60 | 40 | 100 | 50 | - |
| MMG2T02 | **Paper 6** MOLECULAR BIOLOGY- II | 4 | - | 2 | 6 | 4 | 3 | 60 | 40 | 100 | 50 | - |
| MMG2T03 | **Paper 7**:Electives<br>1. GENETICS- II<br>2. INDUSTRIAL AND ENVIRONMENTAL BIOTECHNOLOGY- II<br>**OR** | 4 | - | 2 | 6 | 4 | 3 | 60 | 40 | 100 | 50 | - |
| | **Paper 7**: **Electives^**<br>EQUIVALENT ONLINE COURSE | Student will enroll for online course | | | | 4 | Student will appear for the examination conducted by the course coordinator and submit the passing certificate | | | | | |
| MMG2P01 | On Job Training[#] | - | 6 | - | 6 | 4 | 8 | 100 | - | 100 | - | 50 |
| MMG2P02 | **Practical 3** | - | 6 | - | 6 | 3 | 8 | 50 | 50 | 100 | - | 50 |
| MMG2P03 | **Practical 4** | - | 6 | - | 6 | 3 | 8 | 50 | 50 | 100 | - | 50 |
| | **TOTAL** | **12** | **18** | **06** | **36** | **22** | - | **380** | **220** | **600** | **150** | **150** |

| **M. Sc. MBGE Semester III** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Code** | **Theory / Practical** | **Teaching scheme (Hours / Week)** | | | | **Credits** | **Examination Scheme** | | | | | |
| | | | | | | | **Duration in hrs.** | **Max. Marks** | | **Total Marks** | **Minimum Passing Marks** | |
| | | **Theory** | **Practical** | **Tutorial** | **Total** | | | **External Marks** | **Internal Ass** | | **Theory** | **Practical** |
| MMG3T01 | **Paper 8** GENETIC ENGINEERING AND NANOTECHNOLOGY | 4 | - | 2 | 6 | 4 | 3 | 60 | 40 | 100 | 50 | - |
| MMG3T02 | **Paper 9** BIOINFORMATICS AND BIOPHYSICAL TECHNIQUES | 4 | - | 2 | 6 | 4 | 3 | 60 | 40 | 100 | 50 | - |
| MMG3T03 | **Paper 10** PLANT AND ANIMAL TISSUE CULTURE | 4 | - | 2 | 6 | 4 | 3 | 60 | 40 | 100 | 50 | - |
| MMG3T04 | **Paper 11**: Electives<br>1. MOLECULAR DIAGNOSTICS- I<br>2. PLANT GENETIC ENGINEERING- I<br>3. BIOINFORMATICS - I | 4 | - | 2 | 6 | 4 | 3 | 60 | 40 | 100 | 50 | - |
| MMG3P01 | **Practical 5:** (Practical on electives of SEM III and IV) | - | 4 | - | 4 | 2 | 8 | 50 | 50 | 100 | - | 50 |
| MMG3P02 | **Practical 6:** Research Project (RP) Minor Work $ | - | 8 | - | 8 | 4 | 8 | 50 | 50 | 100 | - | 50 |
| | **TOTAL** | **16** | **12** | **08** | **36** | **22** | - | **340** | **260** | **600** | **200** | **100** |

| M. Sc. MBGE Semester IV | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Code | Theory / Practical | Teaching scheme (Hours / Week) | | | | Credits | Examination Scheme | | | | | |
| | | | | | | | Duration in hrs. | Max. Marks | | Total Marks | Minimum Passing Marks | |
| | | Theory | Practical | Tutorial | Total | | | External Marks | Internal Ass | | Theory | Practical |
| MMG4T01 | **Paper 12** RECOMBINANT DNA TECHNOLOGY | 4 | - | 2 | 6 | 4 | 3 | 60 | 40 | 100 | 50 | - |
| MMG4T02 | **Paper 13** IMMUNOLOGY | 4 | - | 2 | 6 | 4 | 3 | 60 | 40 | 100 | 50 | - |
| MMG4T03 | **Paper 14** IPR, ENTERPRENEURSHIP, BIOSAFETY, QA AND QC | 4 | - | 2 | 6 | 4 | 3 | 60 | 40 | 100 | 50 | - |
| MMG4T04 | **Paper 15 : Electives** 1. MOLECULAR DIAGNOSTICS- II 2. PLANT GENETIC ENGINEERING- II 3. BIOINFORMATICS - II | 4 | - | 2 | 6 | 4 | 3 | 60 | 40 | 100 | 50 | - |
| MMG4P01 | **Practical 7:** Research Project (RP) Major Work[$] | - | 12 | - | 12 | 6 | 8 | 100 | 100 | 200 | - | 100 |
| | **TOTAL** | **16** | **12** | **08** | **36** | **22** | - | **340** | **260** | **600** | **200** | **100** |

**Internal assessment can be done in all or any of the following ways such as attendance in theory and practical classes, participation in the departmental curricular, co - curricular and extra-curricular activities, participation in field tours, quiz during the class, class test, assignment, extension work, seminars and the general behavior in the department.**

1. The students will have to carry out the research based project work in lieu of practical in the third and fourth semester in the department or depending on the availability of placement; he/she will be attached to any of the national/regional/private research institute for the duration of fourth semester. The student will be randomly allotted the priority number for the selection of the supervisor in the third semester. The student

in consultation with supervisor will finalize the topic of the project work at the third semester.

2. The course can be taught by person having post graduate in relevant/ equivalent subjects. Preference shall be given to the candidate having NET/SET/GATE or having teaching/ research experience in that particular field.

**Pre-requisites to enroll for the course:**

The candidates who have passed the B.Sc. Examination in at least second division with any one or more subjects of life sciences or biological sciences, candidates who have passed B.Sc. Biotechnology in second division. Or The candidates who have passed the B.Pharm. Examination in at least second division. Or The candidates who have passed the graduation degree in agriculture or fisheries or veterinary sciences Examination in at least second division are eligible to enroll for M. Sc. (Molecular Biology and Genetic Engineering) course. However, the student who has completed four-year Bachelors course [B. Sc. (Honours) as per NEP- 2020] with Life Science (or allied subject) as the major subject with not less than 50% of aggregate marks (45% in case of student from reserved category) or equivalent CGPA from any of the recognized university is eligible to enroll directly in semester III of M. Sc. (Molecular Biology and Genetic Engineering) course.

**Teacher and research project supervisor**

In addition to the regular teachers appointed in the department, these courses can be taught by a person having a post-graduate degree in Life Science or any other relevant/equivalent subject or having research experience in that particular area. The regular full-time teacher of the department/contributory teacher approved by the university/scientist of government or private research laboratory appointed by university as a contributory teacher and having M. Phil. or Ph. D. degree in Life Science or any other relevant/equivalent subject can supervise the research project of the student.

**# On-Job training/Field project**

The objective of on-job training/field project is to allow the student to gain vocational training in academics/ research/industry based on plants and allied organisms. It is also aimed to encourage the student to take-up a life-time vocation based on the program he/she is pursuing. On-job training/field work will also allow the student to work in team and gain experience, which will be helpful in his/her future life.

The student can earn the credits for ‘On job training’ by working as an apprentice or an intern in an industrial or research organization of repute working in the area relevant to Molecular Biology and Genetic Engineering. Alternatively, the student can take-up a field project in any discipline allied to Molecular Biology and Genetic Engineering under the supervision of a recognized teacher of a university/college or a regular scientist in the national laboratory or a recognized private research laboratory. In any case, the student will complete the on-job training/field project during the vacation after the examination of semester II but before the commencement of semester III. If a student wishes to pursue on-

job training/field project during the session of semester II, he/she can do so. However, this should be not at the cost of the attendance in the regular classes and other departmental activities during the session.

In order to earn credits, the total duration of on-job training/field project will be 120 hours, which normally can be completed in twenty days by working for 6 hours per day. At the end of the on-job training/field project, the student will submit a report containing the details of the work carried out during the tenure. The report will be signed by the student, his/her immediate supervisor during the tenure and the Head of the institute/organisation. In addition, the report should contain a certificate (printed on the letter head of the institute/organisation) issued by the Head of the institute/organisation substantiating that the student has worked for 120 hours as an on-job trainee/undertook a field project. The format of the certificate should be as follows:

**Certificate**

This is to certify that Mr./Ms. _____ has worked as an on-job trainee/undertook a field project in this institute/organization under the supervision of Dr./Mr./Ms. _____ from _____ to _____. He/she has worked for not less than 120 hours during this tenure.

Signature

Head of the institute/organization

The student will be evaluated for the completion of on-job training/field work on the basis of report submitted by him/her and the power point presentation made by him/her in the presence of internal and external examiner during the examination.

**$Research project**

The objective of research project is to train the student in identifying the problem of research, develop the hypothesis, design the experiments/surveys to test the hypothesis, collect & analyze the data and draw conclusions from it. In addition, the aim is also to prepare the student to present the data in various forms such as project report, presentation in conferences & seminars and research paper. Research project is also aimed to prepare the student for doctoral research after the completion of the program.

The student will have to carry out a research-based project work in the third and fourth semester. The project work may be carried out in the parent department or any other institute. For this the student will be attached to any of the national/regional/private research

institute/organization for the duration of the third and fourth semester. If the student is working in the organization other than the parent department, then it will be the responsibility of the student to attend the classes and other departmental activities in order to be eligible to appear for the examination.

The student will be allotted the supervisor in the third semester; after which the student will finalize the topic of the project work in consultation with the supervisor. The research project of the student will be evaluated on the basis of the project report submitted by him/her and the power point presentation made by him/her in the presence of internal and external examiner during the examination.

**^Elective papers**

In addition to the mandatory papers, the student has to opt for elective papers in all the semesters. In semester I and II, the student has to opt either the elective paper taught in the department in offline mode (as indicated in table below) or any other equivalent online course of at least 4 credits offered by NPTEL or any other such platform. The equivalence of such courses will be decided by the departmental committee comprising of the faculty members of the department and chaired by the Head, Dept. of. Molecular Biology and Genetic Engineering. The student should get the equivalence letter of the course from this committee before enrolling for the course. The student should submit the passing certificate to the Head of the Department in order to include the marks in the marksheet.

The semester III and IV will also have one optional paper each. These two papers will impart a deeper learning in any one of the disciplines of Molecular Biology and Genetic Engineering. The student will be allotted any one of the following papers based upon his/her merit and preference.

| Sr. No. | SEMESTER I | SEMESTER II | SEMESTER III | SEMESTER IV |
|---|---|---|---|---|
| 1. | Genetics I | Genetics II | Molecular Diagnostics I | Molecular Diagnostics II |
| 2. | Industrial and Environmental Biotechnology I | Industrial and Environmental Biotechnology I | Plant Genetic Engineering I | Plant Genetic Engineering II |
| 3. | Equivalent Online Course I | Equivalent Online Course II | Bioinformatics and Data Mining I | Bioinformatics and Data Mining II |

**Proforma question paper for the assessment of the student in the practical examinations at the end of each semester**

**SEMESTER I**

**M.Sc. EXAMINATION IN MOLECLAR BIOLOGY AND GENETIC ENGINEERING**

**PGMG1P1: PRACTICAL 1**

TIME: 08 HOURS FULL MARKS: 100

| | | |
|---|---|---|
| Q.1 | Major Practical from Part A | 12 |
| Q.2 | Minor Practical from Part A | 08 |
| Q.3 | Major Practical from Part B | 12 |
| Q.4 | Minor Practical from Part B | 08 |
| Q.5 | Comment on the spot | 10 |
| Q. 6 | Viva- Voce | 25 |
| Q. 7 | Practical records | 25 |

**SEMESTER I**

**M.Sc. EXAMINATION IN MOLECLAR BIOLOGY AND GENETIC ENGINEERING**

**PGMG1P2: PRACTICAL 2**

TIME: 08 HOURS FULL MARKS: 100

| | | |
|---|---|---|
| Q.1 | Major Practical from Part A | 12 |
| Q.2 | Minor Practical from Part A | 08 |
| Q.3 | Major Practical from Part B | 12 |
| Q.4 | Minor Practical from Part B | 08 |
| Q.5 | Comment on the spot | 10 |
| Q. 6 | Viva- Voce | 25 |
| Q. 7 | Practical records | 25 |

**SEMESTER II**

**M.Sc. EXAMINATION IN MOLECLAR BIOLOGY AND GENETIC ENGINEERING**

**PGMG2P1: ON JOB TRAINING**

TIME: 08 HOURS FULL MARKS : 100

| | | |
|---|---|---|
| Q.1 | Submission of report and certificate of tenure completion given by the institute/organization where the student has worked | 50 |
| Q.2 | Presentation on work done during OJT | 50 |

**SEMESTER II**

**M.Sc. EXAMINATION IN MOLECLAR BIOLOGY AND GENETIC ENGINEERING**

**PGMG2P2: PRACTICAL 3**

TIME: 08 HOURS FULL MARKS: 100

| | | |
|---|---|---|
| Q.1 | Major Practical from Part A | 12 |
| Q.2 | Minor Practical from Part A | 08 |
| Q.3 | Major Practical from Part B | 12 |
| Q.4 | Minor Practical from Part B | 08 |
| Q.5 | Comment on the spot | 10 |
| Q. 6 | Viva- Voce | 25 |
| Q. 7 | Practical records | 25 |

**SEMESTER II**

**M.Sc. EXAMINATION IN MOLECLAR BIOLOGY AND GENETIC ENGINEERING**

**PGMG2P3: PRACTICAL 4**

TIME: 08 HOURS FULL MARKS: 100

| | | |
|---|---|---|
| Q.1 | Major Practical from Part A | 12 |
| Q.2 | Minor Practical from Part A | 08 |
| Q.3 | Major Practical from Part B | 12 |
| Q.4 | Minor Practical from Part B | 08 |
| Q.5 | Comment on the spot | 10 |
| Q. 6 | Viva- Voce | 25 |
| Q. 7 | Practical records | 25 |

**SEMESTER III**

**M.Sc. EXAMINATION IN MOLECLAR BIOLOGY AND GENETIC ENGINEERING**

**PGMG3P1: PRACTICAL 5**

**(based on Elective Papers)**

TIME: 08 HOURS FULL MARKS: 100

| | | |
|---|---|---|
| Q.1 | Major Practical from Part A | 12 |
| Q.2 | Minor Practical from Part A | 08 |
| Q.3 | Major Practical from Part B | 12 |
| Q.4 | Minor Practical from Part B | 08 |
| Q.5 | Comment on the spot | 10 |
| Q. 6 | Viva- Voce | 25 |
| Q. 7 | Practical records | 25 |

**SEMESTER III**

**M.Sc. EXAMINATION IN MOLECLAR BIOLOGY AND GENETIC ENGINEERING**

**PGMG3P2: PRACTICAL 6 (MINOR PROJECT)**

TIME : 08 HOURS FULL MARKS :100

1. Project Report Evaluation by External Examiner 50M
2. Internal Evaluation 50M

**SEMESTER IV**

**M.Sc. EXAMINATION IN MOLECLAR BIOLOGY AND GENETIC ENGINEERING**

**PGMG4P1: PRACTICAL 7 (MAJOR PROJECT)**

TIME : 08 HOURS FULL MARKS :200

1. Project Report and presentation Evaluation by External Examiner 100M
2. Internal Evaluation (100M)
   a. Attendance 25M
   b. Laboratory Skills 25M
   c. Understanding of concept 25M
   d. Project Report Writing 25M

**Proforma question paper for the external assessment of the student in the mandatory and elective theory papers at the end of each semester**

Time: 3 hrs. Max. Marks: 60

Note: All questions are compulsory and carry equal marks. Draw labelled diagrams wherever necessary.

Q.1 A: Answer any of the Long Question from Module 1 from given choices 6M

Q.1 B: Answer the following Objective questions based on Module 1 (contains: fill in the blanks, MCQs, Match the pairs, Short answers, one word answers, true or false etc.) 6M

Q.2 A: Answer any of the Long Question from Module 2 from given choices 6M

Q.2 B: Answer the following Objective questions based on Module 2 (contains: fill in the blanks, MCQs, Match the pairs, Short answers, one word answers, true or false etc.) 6M

Q.3 A: Answer any of the Long Question from Module 3 from given choices 6M

Q.3 B: Answer the following Objective questions based on Module 3 (contains: fill in the blanks, MCQs, Match the pairs, Short answers, one word answers, true or false etc.) 6M

Q.4 A: Answer any of the Long Question from Module 4 from given choices 6M

Q.4 B: Answer the following Objective questions based on Module 4 (contains: fill in the blanks, MCQs, Match the pairs, Short answers, one word answers, true or false etc.) 6M

Q.5: Write short notes on: 12M

a. A very short answer question from Module 1.

b. A very short answer question from Module 2.

c. A very short answer question from Module 3.

d. A very short answer question from Module 4.

## SEMESTER I

**Course code/name:**

### PGMG1T1: CELL BIOLOGY (PROKARYOTES AND EUKARYOTES)

**Objectives:**

- To Understand the structure and function of the eukaryotic and prokaryotic cells.
- To Understand biological membranes, cytoskeletons and cell mobility.
- To Understand cell cycle and its regulation.
- To Understand the signal transduction.

**Outcomes:**

After successful completion of the course the students will be able to

- Elucidate the cellular organization of the eukaryotic and prokaryotic cells.
- Explain cell cycle and signal transduction pathways.

**Module I:** **15L**

Prokaryotic Cell and Eukaryotic cell:

Evolution of cell, diversification from ancestor, General structure and functions of prokaryotic and eukaryotic cell.

Bacteria: Microbial growth kinetics, Bacterial cell division- Z ring formation,

General characters of viruses:

Morphology and Components, Shapes and sizes, History of viruses, Classification of viruses, Structure, mode of transmission of TMV, adeno associated virus, T4, lambda and Corona virus, Virus and Environment interaction.

Virus like agents – Introduction to satellites, virions, Viroids and Prions

Overview of Viral Pandemic.

**Module II:** **15L**

Biological Membranes:

Plasma membrane – Lipid bilayer and its composition, transport Membrane proteins – association with Lipid bilayer, transmembrane proteins. Transport of ions and small molecules across membranes. In bacteria- permeation and bulk transport mechanisms

Cytoskeleton and cell motility:

Actin Filaments, Intermediate Filaments, Microfilaments, Cillia and Flagella, Myosins and Muscle movement, spindle apparatus, cytokinesis, cell migration- Lamellipodia, EMT (epithelial to mesynchymal transition)

Cell Adhesion and Cell Junctions:

Extracellular Matrix structure and Function – Collagen, Elastins, Adhesins, Fibronectin, Laminis, Integrins, Cell – Cell adhesion by transmembrane proteins, Tight Junctions and Gap Junctions, plasmodesmata

**Module III:** **15L**

Cell cycle regulation:

Cell division – overview of Mitosis and meiosis, Cell cycle – CDK activities, CDK-cyclin complexes, mitotic chromosome, condensation and segregation, Checkpoint controls, cell cycle deregulation leading to cancer.

Apoptosis:

Types of apoptotic pathways, Caspase, Inhibitors of apoptotic proteins, death receptor Signalling, Mitochondrial Pathway of apoptosis – Bcl-2 family proteins, Bax, BAD, and Bac cytochrome C, MOMP, Caspase independent death, its role in diseases.

Stem Cell:

Stem cell- evolution, Historical perspective, Types, source of isolation, Detection, Stem cell differentiation and role of Growth Factors with respect to autocrine and paracrine response, properties and characterization of embryonic stem cells, regulation of stemness.

**Module IV: 15L**

Signal Transductions – endocrine, exocrine and synaptic signal transduction,

Via Messengers and receptors – Chemical signals, G- Protein linked receptors, Enzyme linked receptors, Signalling in Plants.

Via Electrical signals – Morphology of Neurons understanding membrane potential, Nernst equation, effect of ions on membrane potential, Electrical excitability – ion channels and voltage gated ion channels, patch clamp technique. Generation of Action potential and propagation, role of Myelin Sheath, Synaptic transmission by Neurotransmitters- generation, transport and inactivation.

Intracellular Protein Transport:

Synthesis of secretory and membrane proteins, import to nucleus, mitochondria, chloroplast and peroxisomes, Receptor mediated endocytosis, Protein targeting and localization signals, role of Golgi.

**Books Recommended:**

1) Becker W. M., Kleinsmith L.J., Hardin J., The world of the cell, 6th edition, 2006, Pearson Publications.
   - Chapters : 4,7,8,12,13,14,15,16,17,19
2) Alberts B., Bray D., Lewis J., Raff M., Roberts K., Watson J., Molecular Biology of the Cell , 5th edition , 2008, Garland science publication.
   - Chapters : 10,11,15,
   - 16,17,18,19
3) Cassimeris L, Lingappa V. R., Plopper G., Lewin's Cells, 2007, Jones and Bartlett Publishers
   - Chapters : 1,2,3,7,8,9,10,11,12,14,15
4) Channarayappa, Cell Biology, 2010, Universities Press.
   - Chapters : 4,5,6,9,10,11,13,14,16
5) Willey J. M., Sherwood L., Woolverton C.J., Prescott's Microbiology, 8th edition, 2011, McGraw-Hill
   - Chapters : 1,3,4,7,25,36,37
6) Teri Shores, Understanding Viruses, 2009, Jones and Bartlett

- Chapters : 3,6,8,18,21

7) Black J. G., Microbiology: Principles and Explorations, 7th edition , 2008, John Wiley and Sons,
   - Chapters : 4,10,15
8) Robert Lanza , Handbook of Stem Cells, vol-1, 2004, Elsevier
   - Chapters: 1,2,3.
9) Nelson D., Lehninger A. M., Cox M., Lehninger Principles of Biochemistry, 5th edition, 2008, WH Freeman and Con.
   - Chapters: 11,12.
10) "Stem cell basics and application" Ed. By K. D. Deb and S. M. Totey, Tata McGraw Hill Pvt. Ltd, 2011. 2.
11) "Hand book of Stem Cells" Edited by RoberLanza, Elsevier, Academic Press, 2011. 3.
12) "Stem Cells Handbook", Edited by Stewart Sell, Human Press, 2010.
13) Pouryazdanpanah, Noushin et al. 2018. "Peripheral Blood-Derived Mesenchymal Stem Cells: Growth Factor-Free Isolation, Molecular Characterization and Differentiation." *Iranian Journal of Pathology* 13(4): 461–66.

## SEMESTER I

**Course code/name:**

### PGMG1T2: MOLECULAR BIOLOGY I

**Objectives:**

- Understanding the Concept of gene and genome organization.
- Understanding prokaryotic and eukaryotic replication, transcription and translation process.
- To Understand the Transcription and RNA splicing.
- To Understand the Translation and posttranslational modification.

**Outcomes:**

After successful completion of the course the students will be able to

- Know the gene function, genomic organization.
- Know the process of DNA replication, transcription and translation in detail.

**Module I:** **15L**

Genomes:

Prokaryotic – Types of genomes- Closed circular genome, Plasmid Genome , Archeal genome.

Eukaryotic – Chromosome structure, Nucleosome, nuclear genome genetic features – genome organization, genes and their function, Tandem repeats, Minisatellites, Interspersed repeats

Mitochondrial and Chloroplast Genome – Organization and Function.

Metagenome – A concept

Genes:

Types of genes: prokaryotes and eukaryotes, pseudogenes,

Concept of open reading frame

Classical concept of gene – Short history and Present Status – unit of transmission, recombination, mutation and Function. Genetic complementation and definition of gene, One gene one enzyme Hypothesis, DNA- material of basic inheritance.

Neoclassical Concept of gene – Unit of recombination, complementation, The cis-trans test, Cistron, Muton and recon, Unit of transcription, Relationship between Genes andA Chromosome structures, C- value paradox.

Modern concept of gene - Classification of genes.

**Module II:** **15L**

Nucleotides (DNA and RNA):

Ribose, deoxyribose, purines, pyrimidine, phosphodiester linkage, Double Helix, various conformations of DNA.

Introduction to DNA Replication:

Prokaryotic replication- Replicon, Bacterial circular genome, origin of replication, replication structures, Replication termination

Eukaryotic DNA replication:

Models for replication, DNA synthesis and protein machinery required, Eukaryotic chromosome having multiple origins, RNA synthesis during replication, The replication process- initiation, elongation and termination, Maintaining end of linear DNA, Regulation of Eukaryotic genome replication, Accessory proteins in DNA replication

**Module III:** **15L**

Transcription:

Organization of genes in prokaryotes and eukaryotes, role of Transcription factors, Transcription in prokaryotes and eukaryotes, mRNA biosynthesis- Mechanisms and regulation RNA polymerase,

Processing of primary transcript in eukaryotes: mRNA processing- 5' Cap formation, 3' end processing and polyadenylation.

RNA Splicing:

Spliceosome, Nucleotide Sequence signal, mechanism of splicing, Plasticity in RNA splicing, Exporting mature mRNA out of nucleus, non coding RNAs. – Group I, Group II, introns, cis-trans-splicing reaction.

**Module IV:** **15L**

Transfer RNA:

Cloverleaf structure, fidelity of proteins, genes for tRNA processing, synthesis of aminoacyl tRNA.

Ribosomes:

Types of ribosomes

Structures- hammer, head, hairpin, biogenesis at nucleolus

Protein Synthesis:

Initiation, elongation and termination- in prokaryotes and eukaryotes, regulation of translation, co and post translational modification, Wobble Hypothesis.

**Recommended books:**

1. Portin, Petter. (1993). The Concept of the Gene: Short History and Present Status. The Quarterly review of biology. 68. 173-223. 10.1086/418039.
2. James Watson, Molecular Biology of the gene, 2004, Pearson Publication.

   14) Chapters – 7,9,10,11,21.
3. Krebs J.E., Goldstein E.S., Kilpatrick S.T., Lewin's Genes X, 2011, Jones and Bartlett pub.

   15) Chapters – 1,5,6,7,9,11,13,14,15,16.
4. Lodish, H.F., Lodish, B., Berk, A., Darnell, J.E., Zipursky, S.L., Baltimore, D., Matsudaira, P., Molecular Cell biology, 6th edn, 2007, WH Freeman

   16) Chapters – 6, 25.
5. Tamarin R.H., Principles of Genetics, 7th edn, 2002,McGraw Hill.

   17) Chapters – 9,12,15,16,17.
6. Brown T.A., Genomes 3, 2007, Garland science.

18) Chapters – 3,4,7,8,9,15,16,17.

7. Griffiths A.J.F., Wessler S.R., Carrol S.B., Deobley J, Introduction to genetic analysis; 10th edn, 2010, WH Freeman.

   19) Chapters – 2.6,5,8,17.

8. Molecular Biology of the Gene - J. D. Watson, N. H. Hopkins, J. W, Robertis , A. Steitz and A.M. Weiner, Benjamin cummings Publ. California – 1988
9. Genes VII. - Benjamin Lewin, Oxford Univ. Press, Oxford (2000)
10. Molecular Biology – Freifelder, D, Narosa Publishing house New York, Delhi, 1987.
11. Advance Molecular Biology Twyman, R.M., Bios Scientific publishers Oxford 1998.
12. Essentials of Molecular Biology. D. Freifelder, Panima publishing corporation

## SEMESTER I

**Course code/name: ELECTIVE 1**

## PGMG1T3: GENETICS - I

**Objectives:**

- To understand the structure and molecular organization of chromosomes and variations in chromosomes.
- Understanding Mendelian genetics and gene interaction.
- To understand the non -Mendelian, Polygenic inheritance and Sex determination.
- Understanding the chemical nature of the gene and epigenetics.

**Outcomes:**

After successful completion of the course the students will be able to

- Elucidate the genetic basis of inheritance and gene interaction.
- Explain the chemical nature of the gene and importance of epigenetics.

**Module I:** **15L**

Chromosome:

Structure and Molecular organization of chromosomes- Molecular organization of centromere and telomere; rRNA genes; Euchromatin and heterochromatin; Special chromosomes (lampbrush chromosomes, polytene chromosomes, B-chromosomes); Karyotype and its evolution, Molecular basis of chromosome pairing

Variations in chromosome:

Numerical variations (heteroploidy), aneuploids and euploids- their occurrence, inheritance, subtypes and significance; structural variations- their occurrence, inheritance, subtypes and significance

**Module II:** **15L**

Mendelian Genetics:

Mendel's work on pea, laws of inheritance; deviations from Mendel's findings: incomplete dominance, co-dominance, multiple alleles, iso-alleles, modifier genes, suppressor genes, pleiotropic genes

Gene interaction:

Non-epistatic and epistatic (9:7, 9:3:4, 13:3, 12:3:1, 15:1)

Lethal genes: Penetrance and expressivity, Dominant and recessive lethal, balanced lethal system

**Module III:** **15L**

Non-Mendelian inheritance:

Maternal effect; Cytoplasmic inheritance Linkage and crossing over; genetic and cytological mapping; tetrad analysis

Polygenic inheritance:

Multiple gene hypothesis; examples- skin color in humans and flower length of tobacco, Pure lines of Johannsen and multiple factor hypothesis; simple and complex quantitative traits

Sex determination:

Sex-linked, sex-influenced and sex-limited characters; mechanism of sex determination- Chromosomal, genic and environmental

**Module IV:** **15L**

Chemical nature of gene:

Nucleic acid as genetic material; structure of nucleic acids

Fine structure of gene; position effect; pseudoalleles, Overlapping genes; pseudogenes; Retrogenes; cryptic genes

Epigenetics:

Introduction: Definition, histone code, base modification, effect on RNA molecules; Effect of epigenetic processes: MEDEA of Arabidopsis, Paramutations in maize, changes induced by maternal behavior in mice, effects of early stress and effects in cognition; Callipyge sheep; Epigenetics and Lamarckism; Epigenome and epigenomics

**Recommended reading**

1. Gupta P K 2007 Genetics: Classical to Modern. Rastogi Publications, Meerut.
2. Hexter W and Yost Jr. H T 1977 The Science of Genetics. Prentice Hall of India Pvt. Ltd., New Delhi.
3. Hartl D L and Jones E W 1998 Genetics: Principles and Analysis (4thed.). Jones and Barflett Publishers, USA.
4. Khush G S 1973 Cytogentics of Aneuploids.Academic press, New York.
5. Pierce B A 2012 Genetics- A conceptual approach. WH Freeman and Company, New York
6. Snustad D P and Simmons M J 2000 Principles of Genetics (2 ed.) John Wiley and Son Inc., USA.
7. Griffiths A.J.F., Wessler S.R., Carrol S.B., Deobley J, Introduction to genetic analysis; 10th edn, 2010, WH Freeman.

## SEMESTER I:

**Course code/name: ELECTIVE 2**

### PGMG1T3: INDUSTRIAL AND ENVIRONMENTAL BIOTECHNOLOGY- I

**Objectives:**

- To understand the concepts of bioprocess engineering and use of recombinant microorganisms for industrial processes.
- To understand the industrial applications of genetically engineered entities.
- To understand the basics of environment, its pollution and important factors of GHG emissions.
- To understand the Environmental biotechnology and solid waste management.

**Outcomes:**

After successful completion of the course the students will be able to

- Explain the steps involved in complete Bioprocess engineering.
- Explain how to manufacture the different cell lines and their use in biopharmaceuticals.
- Interpret the effect of environmental pollution on climate change and biological system.
- Elucidate about the environment and its beneficiation using genetically engineered organisms.

**Module I** **15L**

Bioprocess Engineering: Steps involved in the development of a complete bioprocess for commercial

manufacture of a new recombinant- DNA derived product. Fermentation processes.

Microbial growth kinetics Batch culture, Continuous culture, Fed batch culture . Heat and mass transfer in bioreactors.

**Module II** **15L**

Upstream processing- Preservation and improvement of Industrially important micro-organisms. Inoculum development, medium preparation, Types of growth media- synthetic and crude medium, animal cell culture media. Sterilization.

**Module III** **15L**

Environmental Pollution: Types,Ozone depletion, UV-B, green -house effect and acid rain measurement and control measures.

CO2 emissions: Carbon footprint, water footprint, carbon capture and storage- definition and

new techniques. CO2 fertilization and agriculture

**Module IV** **15L**

Waste Management: Physical, chemical, biological and advance treatment processes of waste water from MSME, large scale industries and small scale industries.

Solid waste management: Landfills, biotechnologies for plastic & e-waste management.

Biopesticides and Integrated pest Management

**Recommended Books:**

1. P. T. Kalaichelvan and I. Arul Pandi 2007 Bioprocess Technology, MJP Pub. , Chennai.
2. Alexander, M. 1994 Biodegradation and Bioremediation, Acad. Press, San Diego, CA
3. Bailey, J. E. and Ollis, D. F. 1987 Biochemical Engineering Fundamentals 2nd Edn. Mc Graw Hill, New Delhi.
4. Malik, V. S. and Sridhar, P. 1992 Industrial Biotechnoogy, Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi.
5. Yoshida, T. and Tanner, R. D. 1993 Bioproducts and Bioprocess Vol. 2 Springer-Verlag, Berlin
6. Casida, L. E. 1994 Industrial Microbiology, Wiley Eastern Ltd., New Delhi
7. Gadd, G. M. 2001 Fungi in Bioremediation, Cambridge Univ. Press, U.K.
8. Demain, A.L. and Davies, J.E. (1999). Manual of Industrial Microbiology and Biotechnology. ASM Press.
9. Environmental Biotechnology, M.H. Fulekar, Science publishers, 2010
10. Tortora, G. J., Fernke, B. R. and Case, C. L. (2001) Microbiology – An Introduction, Benjamin Cummings.
11. Standbary P. F. A. Whitaker and Hall. 1995, Principles of Fermentation Technology. Pergaman. McNeul and Harvey. 1990.
12. Michael Shiler and Kargi, Bioprocess Engineering.
13. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.
14. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.
15. Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley and Sons.
16. Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.
17. Mukhopadhaya S.N. ( 2001 ) Process Biotechnology Fundamentals. Viva Books Pvt. Ltd. New Delhi.
18. E.M.T. EL` Mansi and C.F.A. Bryce Fermentation Technology and Biotechnolgy

## SEMESTER I

**Course code/name:**

### PGMG1T4: RESEARCH METHODOLOGY AND BIOSTATISTICS

### (Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

**Objectives:**

- To know the aspects fundamental to research and to understand the methods of research.
- To know the nuances of technical writing of scientific documents like thesis and journal articles.
- To understand the statistical tools, concepts of hypothesis testing and its importance in biological research.

**Outcomes:**

After successful completion of the course the students will be able to

- Prepare the objectives and types of research. Apply inclusion, exclusion criteria and blinded trials with respect to clinical trial.
- Prepare the components of thesis writing. Distinguish between thesis components and journal components.
- Apply the methods of sampling, diagrammatic and graphical representation of data for analyzing the data.
- Use the measure of central tendency, deviation, correlation and regression for analysing and to inferring data. Illustrate on probability and theoretical distribution of data and also outline the hypothesis testing.

**Module I:** **15L**

Research methodology:

Meaning of research, objectives of research, types of research, research methodology and research designs, single blind and double blind trials; Inclusion and exclusion criteria: Importance of inclusion and exclusion criteria in animal and human research with special reference to clinical research (elementary concepts only), examples and case studies

Review of Literature:

The scientific literature – primary, secondary, and tertiary literature; Database searches – tools and strategies; Reading and evaluating the scientific literature - Academic writing – plagiarism and referencing, Format and Style; Writing a literature review.

**Module II:** **15L**

Writing a thesis: Layout of the thesis, preparing the components of the thesis: hypothesis, abstract, introduction, review of literature, methodology, results, discussion, summary and conclusion, references;

Writing a journal article: format of an article; Journal requirements; Differences between the thesis components and article components; Abstract preparation; Concise presentation; Outline of work presented; Keywords: List of important technical terms;

Main article: introduction, materials and methods, results, discussion, presentation of tables, figures and graphs, conclusion, acknowledgement, references, conflicts of interest;

Avoiding plagiarism:–definition of plagiarism, ethical issues, copyright issues

**Module III: 15L**

Statistical survey: Organization of a statistical survey, methods of data collection, data representation, diagrammatical and graphical representation of data Sampling fundamentals: Need for sampling, properties of an ideal sample, sampling procedures

Properties of the data:

Organization of data, Central tendency, dispersion, linear regression and correlation-test of significance, skewness and kurtosis and their various measures, percentiles Simple linear correlation and regression analysis. Analysis of variance.

Population and sample:

Random sample, use of table of random numbers, parameter and statistics, sampling distribution of sample means, Standard error; confidence intervals.

**Module IV: 15L**

Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems.

Probability distributions: Binomial, Poisson and Normal distributions and a few simple problems.

Statistical Inference: Estimation, standard error, confidence interval for means and proportion.

Testing of hypothesis: basic concepts and definitions, types of errors.

Hypothesis testing: Formulation of null and alternate hypotheses, testing the Tests based on Normal, student's t, chi-square and F distributions, interpretation of "p" value.

**Recommended Books:**

1. Gupta, S.P. (2010) Statistical methods, Sultan Chand and Sons, New Delhi.
2. Day, R.A. (2006) How to write and publish a scientific paper, Cambridge University Press, UK.
3. Banerjee, P.K. (2008) Introduction to Biostatistics, S. Chand and Co., New Delhi.
4. Rastogi V B, Biostatistics, 3rd edition, MEDTECH 2019.
5. Kothari, C.R. (2004) Research Methodology, Methods and Techniques, II Edition, New Age International Publishers, New Delhi.
6. Alred, G.J., Bursaw, C.T. and Oliu, W.E. (2003) The Handbook of Technical Writing, McGraw Hill Publishers, NewJersey.
7. Arumugam N. (2016), Research Methodology for life sciences, Saras Publications, India.

## SEMESTER I

**Course code/name:**

### PGMG1P1: PRACTICAL 1

**Objectives:**

- Understanding and performing various microbiological techniques.
- Understanding and performing techniques related to cell biology.
- Understanding and performing techniques related to immunology.
- Understanding and performing techniques related to molecular biology.

**Outcomes:**

After successful completion of the course the students will be able to

- Sterilize microbial growth media, culture the bacteria and measure their growth, stain them and identify them microscopically.
- Perform various immunotechniques use for research and pathology.
- Isolate DNA, RNA and check their purity.

**PART A (Cell Biology and Immunology)**

1. Microscopic observation, Staining and identification of bacteria, algae and fungi
2. Sterilization techniques, Culturing and preservation of microorganisms: Tube culture (slant/broth), plate culture, flask culture and preservation.
3. Measurement of microbial growth (Viable count and turbidometry) and Study for bacterial growth curve (Aerobic/anaerobic).
4. Isolation of bacteria from various sources - Its colony, morphological, Gram and biochemical (IMViC) characterization
5. Isolation of fungus from various sources and its characterization.
6. Cell fractionation by centrifugation
7. Isolation of bacteriophage on bacterial lawn culture.
8. Introduction to stem cell isolation using FACS and umbilical cord blood (demo).
9. Observation of extracellular matrix by fluorescent microscopy (demo)
10. Biochemical analysis of quorum sensing molecule (AHL) from gram negative bacteria.
11. Formation of biofilm using common laboratory bacteria.
12. Metabolic pathway search by using KEGG Pathway database
13. Sandwitch Enzyme-Linked Immuno-sorbent Assay (ELISA) to test antigen concentration
14. Radial immunodiffusion Assay for finding the concentration of Antigen
15. Immunoelectrophoresis to test serum.
16. Ouchterlony Double Diffusion assay to compare the two antigens against an antibody.
17. Latex agglutination test for detection of antigen and antibody

18. Blood Grouping test
19. Widal slide test for typhoid detection
20. Immunoprecipitation
21. Collection of human blood, separation of mononuclear cells and counting of cells

**PART B (Molecular Biology)**

1. Morphological study of mitotic and meiotic chromosomes
2. Study of structural chromosomal rearrangements
3. Isolation of DNA from suitable organisms
4. Extraction of total RNA from suitable organisms
5. RNA Estimation
6. Molecular weight calculation of the protein from given RNA sequence
7. Molecular docking experiment for analyzing interaction of DNA with proteins using Autodock or SwissDock platforms
8. Molecular docking experiment for analyzing interaction of RNA with proteins using Autodock or SwissDock platforms

## SEMESTER I

**Course code/name:**

## PGMG1P2: PRACTICAL 2

**Objectives:**

- Understanding and perform various techniques involved in Genetics.
- Perform various techniques used in Horizontal gene transfer.
- Perform techniques of Industrial biotechnology.
- Perform techniques of environmental biotechnology.

**Outcomes:**

After successful completion of the course the students will be able to

- Solve the problems related to basic Mendelian genetics, Non Mendelian genetics and population genetics.
- Analyze the gene expression using assays and transformations in plants and bacteria respectively.
- Isolate industrially important microbes, develop bioreactors and isolate the related material.
- Develop biofertilizers, biopesticides and perform environmental monitoring for biological and physical factors.

### PART A (Genetics and Molecular Biology)

1. Experiment of monohybrid, dihybrid, trihybrid, test cross and back cross
2. To study the karyotype of the given organism.
3. To study the chiasma frequency in the given material.
4. To solve the given problems on interaction of genes (at least five).
5. To solve the given problem on population genetics (at least three).
6. To study the linkage and crossover analysis ( two and three point cross over)
7. Study of expression of inducible genes: PAL Assay
8. Regulation of bacterial gene expression
9. Effect of chemical mutagen on physiology and genetic material of suitable organism
10. Effect of physical mutagen on physiology and genetic material of suitable organism
11. Commet assay for measuring DNA damage
12. Bacterial conjugation
13. Bacterial transduction
14. Plasmid curing for removal of resistant genes of bacteria.

### PART B (Industrial and environmental Biotechnology)

1. Effect of growth parameters on microbial growth curve.
2. Isolation of Industrially important microorganisms from microbial processes
3. Isolation of rhizobium and azotobacter from plant and soil on selective media
4. Preparation of antimicrobial compound from plant extract and its evaluation by membrane filtration technique
5. Development of laboratory scale bioreactors: (for waste water treatment)

6. Recovery of product from fermentation broth by ammonium sulphate precipitation
7. Comparative studies of ethanol production using different substrates
8. Production of microbial biofertilizers and biopesticides
9. Microbial degradation of organic matter
10. Testing for microbial biodegradation of pesticides
11. Determination of dissolved oxygen level (DO) in sewage sample
12. Determination of Biology Oxygen demand (BOD) of sewage sample
13. Determination of Chemical Oxygen demand (COD) of sewage sample
14. Testing for microbiological quality of potable water (Coli form test):
    a. Determination of dissolved oxygen level (DO)
    b. Determination of Biology Oxygen demand (BOD)
    c. Determination of Chemical Oxygen demand (COD)
    d. Determination of TDS
    e. Determination of TSS
15. Visit to biopharmaceutical industry.

## SEMESTER II

**Course code/name:**

## PGMG2T1: BIOCHEMISTRY

**Objectives:**

- To understand the Carbohydrate and its metabolism.
- To understand the Protein and nucleic acid metabolism.
- To understand the Lipid metabolism and Importance of Vitamins.
- To understand the Enzymes, types, principle of action and its regulation.

**Outcomes:**

After successful completion of the course the students will be able to

- Explain the structure and function of biomolecules like carbohydrates, lipids, proteins.
- Elucidate the metabolism of carbohydrate, lipids and amino acids and vitamins.
- Interpret the importance of enzymes and its regulation.

**Module I:** 15**L**

Carbohydrates:

Monosaccharides – Cyclic sugars. Aldoses, Ketoses, Glycocidic bonds, role as reducing agents

Complex Carbohydrates(Structure and Function) – Sucrose, lactose, maltose, starch

Glycogen, Cellulose

Glycoconjugates – Proteoglycans, Glycoproteins, Glycoproteins and Lectins (glycolysis)

Carbohydrate Metabolism:

Carbon fixation by photoautotrophs

Pathways and their regulation: Gluconeogenesis, Energy conversion, Glycolysis and its control in prokaryotes and eukaryotes.

Glycogenesis and Glycogenolysis – Pathway and regulation,

Krebs cycle, Krebs karnberg cycle – reaction regulation

**Module II**: 15**L**

Amino Acids and proteins:

Amino acids Classification and rare amino acids. Peptide bond, introduction to protein structure ($1^o$, $2^o$ ,$3^o$ and $4^o$ structures), Ramachandran Plot, Protein denaturation and folding.

Amino acid metabolism:

Biosynthesis of amino acids: from alpha-ketoglutarate (Arginine), from 3 phospoglycerate (Cysteine).

Amino acid oxidation and the production of urea, urea cycle

Nucleotide Metabolism:

Biosynthesis of purine nucleotides, Pyrimidine nucleotides, salvage of purines andpyrimidine.

**Module III:** **15L**

Lipids:

Structure and Function of – storage lipids, membrane lipids- phospholipids and Glycolipids.

Fatty acid Catabolism:

Digestion, mobilization and transport of fats, Oxidation of Fatty acids- pathway and regulation, Ketone bodies

Biosynthesis of:

Fatty acids and Eicosanoids, triacylglycerols, phospholipids, cholesterol.

Vitamins:

General characteristics, structure and properties of vitamins.

**Module IV**: **15L**

Introduction to Enzymes:

Classification and nomenclature, prosthetic groups, cofactors, Mechanism of enzyme action and properties of enzymes as catalysts. Enzyme kinetics (equilibrium and steady state theory, rate equation and determination of Km and Vmax.), specific activity, turn over number and catalytic center activity, Enzyme inhibition.

Enzyme regulation:

Principles of catalysis, mechanism of enzyme catalysis, Factors affecting rate of enzyme catalyzed reactions: pH, temperature, etc. Enzyme inhibition: reversible and irreversible inhibition, Allosteric enzymes: Model of allostery (ATCase), types and kinetics; Isoenzymes and isozymes. Multienzyme complex and its role in metabolic regulation (Fatty acid synthase complex and Pyruvate dehydrogenase complex). Mechanism of catalysis by Lysozyme, Ribonuclease and Carboxypeptidase

**Books Recommended:**

1. Nelson D., Lehninger A. M., Cox M., Lehninger Principles of Biochemistry, 5th edition, 2008, WH Freeman and Con.
   20) Chapters – 3,4,7,10,14,15,16,17,18,21,23.
2. Devlin T.M., Textbook of Biochemistry with clinical correlations, 6th edn, 2006, Wiley-Less
   21) Chapters – 3,14,15,16,17,18,19,21,23.
3. Berg J.M., Tymoczko J.L., Stryer L., Biochemistry, 7th edn, 2011, Macmillan Higher Education.
   22) Chapters – 2,7,11,12,16,17,20,21,22,26.
4. Jain J.L., Fundamentals of Biochemistry, 6th edn, 2005, S. Chand ;
   23) Chapters – 31,32,33,34.

5. Horton H.R., Moran L.A., Ochs R.S., Rawn D., Scrimgeour K.G., Principles of Biochemistry, 4th edn, 2006, Prentice Hall.

   24) Chapters – 3,4,8,9,11,12,13,16,17.

6. Voet, D.; Voet, J., Biochemistry –3rd Edn., 2004. John Wiley and sons Inc.
7. Harper's Principles of Biochemistry-Murray, Gardener, Mayes, Rodwell, 27th Edn.
8. Textbook of biochemistry-West, Todd, Mason, VanBrergen, 4th edn. Oxford and IBH, 1966.
9. Biochemistry- Champe, P., 3rd Edn., Lippincott Willams and Wilkins, 2005.
10. Biochemistry-Zubay, G., 3rd Edn., Pearson Education P.Ltd, 2003
11. Enzymes- Palmer, T. , Affiliated East West Press Pvt. Ltd., 2004
12. Cell and Molecular biology, Gerald Karp, John Wiley and sons Inc.
13. Introductory Practical Biochemistry by Sawhney and Randhir Singh., Narora Pub. House.
14. Biochemical method. 2nd Edition, Sadasivam *et al*. New Age International.
15. Practical Biochemistry 3rd Edition, David Plummer. Tata McGraw Hill.
16. Short Protocals in cell Biology. Borifacino ehale, Jon Wiley Plublishing House.
17. Das, H. K. Text book of Biotechnology, wiley dream tech India pvt ltd. 2005.

## SEMESTER II

**Course code/name:**

## PGMG2T2: MOLECULAR BIOLOGY II

**Objectives:**

- Understanding recombination and genetics of bacteria and viruses.
- Understanding DNA damage and repair mechanisms.
- Understanding the regulation of gene expression.
- To Understand developmental genetics and genetic switches.

**Outcomes:**

After successful completion of the course the students will be able to

- Explain the different Recombination and horizontal gene transfer methods.
- Know the DNA damage repair mechanisms.
- Explain the gene expression regulation mechanism.
- Explain Molecular genetics in Humans.

**Module I:** **15L**

Recombination:

Homologous recombination protein machines, Homologous recombination in eukaryotes, Site specific recombination, Non homologous end joining, transposition. Genetic consequences of recombination – gene conversion.

Genetics in bacteria and Viruses:

Transformation – Nature of transformation, Chromosomal mapping wing transformation,

Conjugation – Structure of F plasmid, Mechanisms of transfer of F plasmid HFR, integration of F Plasmid to chromosome, mapping bacterial chromosome, R plasmids, Plasmid curing

Bacteriophage Genetics – Infecting bacteria by phage, mapping phage chromosome using phage cross.

Transduction – Generalized, Specialized, mechanism of specialized transduction.

**Module II:** **15L**

DNA Mutation, repair:

-Mutation:- Genetic fine structure, Colinearity, Spontaneous vs induced mutations.

Mutation rates, Point mutations, Mutagenesis - Chemical, physical, molecular mechanisms

-DNA damage and repair :- Replication errors escape proofreading, Mismatch repair for removing errors, Damage reversal, Excision repair, Double strand break repair, Post replicative Repair, SOS repair,

-DNA rearrangements:- Complete and Segmental genome duplication, insertion deletion, Translocation

**Module III:** **15L**

The Operon:

Induction and repression, Lac Operon, Trp operon, Ara operon, attenuation, positive and negative control.

Eukaryotic transcription regulation:

Activators and repressor binding , DNA binding domains, Histone acetylation, GAL genes- model for activation and repression, and chromatin modification, Transcription Factors, Promotor efficiency,

RNA interference:

RNAi pathways – siRNA, micro RNA, Functions of RNAi - (Protection against viral infections, securing genome stability, repression of protein synthesis and regulation, chromatin condensation and transcriptional suppression, RNAi as an experimental tool for suppressing gene expression, potential therapeutic use of RNAi, Molecular mechanism of antisense molecules)

**Module IV:** **15L**

Developmental Genetics of Drosophila, P- element biology

Genetic Switches: Complex switches regulation during drosophila development, circadian clocks based on feedback loop.

Molecular Genetics of Human:

X-linked and Y-linked disorders, Oncogenes and tumor suppressor genes, mechanism of action of RB1 and p53

**Recommended books:**

1. Alberts B., Bray D., Lewis J., Raff M., Roberts K., Watson J., Molecular Biology of the Cell , 5th edition , 2008, Garland science publication.
   Chapters :- 5,6,7,12,13.
2. Robertis and Robertis, Cell and Molecular Biology, 8th edn, , 2001, Wotters Klwer
   Chapters :- 8,9,19,21,22
3. Horton H.R., Moran L.A., Ochs R.S., Rawn D., Scrimgeour K.G., Principles of Biochemistry, 4th edn, 2006, Prentice Hall.
   Chapters :- 18,19,20,21,22.
4. Krebs J.E., Goldstein E.S., Kilpatrick S.T., Lewin's Genes X, 2011, Jones and Bartlett pub.
   Chapters :- 14,19,20,21,22.
5. Brown T.A., Genomes 3, 2007, Garland science.
   Chapters :- 11,12,13,15,
6. Tamarin R.H., Principles of Genetics, 7th edn, 2002,McGraw Hill.
   Chapters :- 9,10,11,16.
7. Lodish, H.F., Lodish, B., Berk, A., Darnell, J.E., Zipursky, S.L., Baltimore, D., Matsudaira, P., Molecular Cell biology, 6th edn, 2007, WH Freeman
   Chapters :- 4,7,8,13,14.

8. J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick , Molecular Biology of the Gene, 5th edn. (2004), Pearson Education Inc.
9. Buchanan, B. B., Gruissem, W. and Jones, R. L. 2000 Biochemistry and Molecular Biology of Plants. American Soc. Of Plant Physiologists, Maryland, USA
10. Karp, G. 1999 Cells and Molecular Biology; Concepts and Experiments. John Wiley and Sons, Inc., USA.
11. Kleinsmith, L. J. and Kish, V. M. 1995 Principles of Cell and Molecular Biology (2nd Edn.) Harper Collins Coll. Publisher, New York, USA.
12. Malacinski, G. M. and Freifelder, D. 1998 Essentials of Molecular Biology (3rd Edi.) Jones and Bartiet Pub. Inc., London
13. Wolf, S. L. 1993. Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA

## SEMESTER II

**Course code/name: ELECTIVE 1**

## PGMG2T3: GENETICS II

**Objectives:**

- To Understand the Population and behavioral genetics.
- To Understand the Evolutionary and Developmental genetics.
- To learn the different Plant breeding techniques.
- To Understand the concept of Eugenetics and chromosome mapping in humans.

**Outcomes:**

After successful completion of the course the students will be able to

- Elucidate the Importance of Population, Evolutionary, Developmental and behavioral genetics.
- Learn the concept of Plant breeding, Eugenetics and chromosome mapping in humans.

**Module I:** **15L**

Population genetics:

Gene pool and gene frequencies; Hardy-Weinberg's law; factors affecting Hardy-Weinberg's equilibrium- mutation, migration, genetic drift and selection; Random drift and Wright-Fisher model; molecular population genetics- AMOVA; genetic distance; genetic relatedness and identity; detection of selection events; coalescent theory

Behavioral genetics:

History; evidences for genetic basis of behavior; methods for genetic analysis of behavior; Examples- Courtship in *Drosophila*, temperament in mammals, emotional stability and schizophrenia; effect of environment on behavior; ethical and social issues

**Module II:** **15L**

Evolutionary genetics:

Theories of organic evolution; mutation theory; original synthetic theory; evolution at molecular level; processes of creating variation; genotype and phenotype spaces; genetics of speciation- species and races, concept of species; isolating mechanisms; adaptive landscapes and speciation; models of speciation; molecular genetics of speciation; speciation revolution

Developmental genetics:

Introduction; Pattern formation in *Drosophila*- development, egg-polarity genes, segmentation genes, homeotic genes, epigenetic changes; flower anatomy and genetic control of flower development

**Module III:** **15L**

Plant breeding:

Genetic basis of plant breeding; Methods of breeding sexually (self- and cross-pollinated) and vegetatively propagated crops; Genetic basis of inbreeding depression and heterosis; Self-incompatibility; male sterility- types and its use in plant breeding;

Molecular plant breeding;

Crop genetic resources; seed production and certification

**Module IV:** **15L**

Eugenetics:

Human karyotype- Chromosome number and morphology, banding, FISH, McFISH; Genetic disorders- Turner's syndrome, Klinefelter's syndrome, Down's syndrome, Patau syndrome, superfemale; Dizygotic and monozygotic twins;

Chromosome mapping in humans:

linkage maps, molecular maps, transcript map; Use of human genetics in medical science- Chromosome or DNA tests

**Recommended Books:**

Chopra V L 2000 Plant breeding theory and practice 2e. Oxford and IBH, New Delhi.

Gupta P K 2007 Genetics: Classical to Modern. Rastogi Publications, Meerut.

Hexter W and Yost Jr. H T 1977 The Science of Genetics. Prentice Hall of India Pvt. Ltd., New Delhi.

Hartl D L and Jones E W 1998 Genetics: Principles and Analysis (4thed.). Jones and Barflett Publishers, USA.

Pierce B A 2012 Genetics- A conceptual approach. WH Freeman and Company, New York

Snustad D P and Simmons M J 2000 Principles of Genetics (2 ed.) John Wiley and Son Inc., USA.

## SEMESTER II

**Course code/name: ELECTIVE 2**

### PGMG2T3: INDUSTRIAL & ENVIRONMENTAL BIOTECHNOLOGY II

**Objectives**

- To learn about different types of Bioreactors.
- To learn about the Bioprocess Engineering.
- To learn about different Downstream processing steps.
- To learn about the Industrial production of chemicals and industrial applications of Microbes.

**Outcomes**

After successful completion of the course the students will be able to

- Explain about different types of Bioreactors and their control of bioprocess parameters.
- Explain about the different steps involved in development of Bioprocess.
- Explain about different Downstream processing steps required for final protein product formation.
- Explain about the Industrial scale production of different type of chemicals and their modifications.

**Module I:** **15L**

Design of Fermenter, Bioreactors and bioreactions - requirements for Bioprocessing- raw material, biocatalyst, water, supply of nutrients, and other micronutrient supply, Bioreactor design, Scale and Instrumentation of Bioreactors and fermenters and Bioprocess control.

Types of bioreactors- Micro and minibioreactors, miniplant, Membrane bioreactor.

**Module II:** **15L**

Downstream processing- recovery; concentration, cell lysis, refolding proteins from inclusion bodies, purification; chromatographic techniques, industrial scale protein purification.

Synthesis of commercial products by recombinant microorganisms: L Ascorbic acid, antibiotics, biopolymers.

**Module III:** **15L**

Bioremediation-microbial, phycoremediation, mycoremediation, phytoremediation- its mechanism, techniques and applications for reclamation of contaminated soils, Waste land, water bodies and industrial effluents, advantages, disadvantages of

Bioremediation technology. Nano remediation -Nanotechnology DNAPL remediation, Nanofilteration techniques, Protein based nanoparticle remediation. Nanofertilizers.

**Module IV:** **15L**

Climate Change and its effect on biological systems:

Global warming and climate change; impact of climate change on atmosphere, weather

Patterns, sea level rise, agricultural productivity and biological responses - range shift of Species; impact on economy and spread of human diseases, Renewable Energy. Biomass Energy, Biogas technology, Biodiesel, Biohydrogen production.

**Recommended books:**


1. Factors affecting ethanol production. P. T. Kalaichelvan and I. Arul Pandi 2007 Bioprocess Technology, MJP Pub. , Chennai.
2. Bailey, J. E. and Ollis, D. F. 1987 Biochemical Engineering Fundamentals 2nd Edn. Mc Graw Hill, New Delhi.
3. Malik, V. S. and Sridhar, P. 1992 Industrial Biotechnoogy, Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi.
4. Yoshida, T. and Tanner, R. D. 1993 Bioproducts and Bioprocess Vol. 2 Springer-Verlag, Berlin
5. Casida, L. E. 1994 Industrial Microbiology, Wiley Eastern Ltd., New Delhi
6. Demain, A.L. and Davies, J.E. (1999). Manual of Industrial Microbiology and Biotechnology. ASM Press.
7. Tortora, G. J., Fernke, B. R. and Case, C. L. (2001) Microbiology – An Introduction, Benjamin Cummings.
8. Standbary P. F. A. Whitaker and Hall. 1995, Principles of Fermentation Technology. Pergaman. McNeul and Harvey. 1990.
9. Michael Shiler and Kargi, Bioprocess Engineering.
10. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.
11. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.
12. Mukhopadhaya S.N. ( 2001 ) Process Biotechnology Fundamentals. Viva Books Pvt. Ltd. New Delhi.
13. E.M.T. EL` Mansi and C.F.A. Bryce Fermentation Technology and Biotechnolgy

## SEMESTER II

**Course code/name:**

## PGMG2P2: PRACTICAL 3

**Objectives:**

- Understanding and perform various biochemical assays and enzyme kinetics.
- Understand the process of patent filing, entrepreneurship and startup development and biosafety assessments in India.
- Understand and use various tools of bioinformatics.
- Understand and perform various biophysical analytical techniques.

**Outcomes:**

After successful completion of the course the students will be able to

- Estimate protein, carbohydrate, lipid content in the sample using biochemical methods and perform experimentations related to enzymology.
- Learn to file patent, develop entrepreneurship or startup idea, and understand the process of biosafety assessment of GMOs in India.
- Search various databases related to Nucleic acid and protein according to the need of analysis, Analyze sequences, align sequences and generate phylogenic tree.
- Perform spectrometric, chromatographic and microscopic techniques.

**PART A (Biochemistry and IPR)**

1. Preparation of various Buffers and to check its pH, preparation of solution of given Morality, Normality and its Standardization by titration methods.
2. Qualitative estimation of Carbohydrates by benedict's reagent, Barfoed's reagent, iodine reagent
3. Quantitative estimation of Carbohydrates by DNSA reagent.
4. Qualitative determination of proteins by Biuret's method.
5. Quantitative estimation of proteins by Lowry's method.
6. Quantitative estimation of amino acid by Ninhydrin Method.
7. Qualitative detection of oil bodies in oil seeds by Sudan III staining.
8. Determination of acid number, iodine value in fats.
9. Study of activity of decarboxylase enzyme
10. Study of enzymatic hydrolysis of starch.
11. Determination of sugars by anthrone method
12. Calculation of Km, Vmax, Kcat of alpha amylase using Lineweaver Burk Plot
13. Study of Isocitrate dehydrogenase in yeast- An allosteric enzyme
14. Electrophoresis of serum proteins by SDS-PAGE
15. Method for immobilization of enzymes by alginate method
16. Preparation of patent application
17. Searching patent documents on Indian patent search engine
18. Report submission on Biotechnological Startup idea.

19. Report submission on Biosafety assessments: on transgenic crop,
20. Seeking permission to work on GM crops: Indian and international committees,
21. BSL I and II (case studies),
22. Designing of different biosafety level laboratory.
23. Report on Industrial, BSLs and IPR institute visit.

**PART B (Bioinformatics and biophysical Techniques)**

1. Study of Laboratory Instruments:

   Electrophoresis unit, Autoclave, Water bath, Hot air oven, Laminar air flow, Light microscope, Haemocytometer and cell number determination, pH meter, Centrifuge, Spectrophotometer, HPCL / GC , balance, Micropipettes
2. Separation and Identification of Biomolecules by TLC/ gel filtration/ ion exchange/affinity chromatography
3. Study of cell morphology by Phase contrast microscope
4. Using ImageJ software to analyze the electrophoresis results.
5. Analysis of confocal images using Fiji software
6. Training on usage of various bioinformatics tools (online), software packages, web portals
7. Online searching of various databases (nucleic acids, proteins, organisms) using diff. Bioinformatics tools (FASTA, BLAST)
8. To find the sequences of a given protein in SWISS-Prot, Uni-Prot
9. To work out the sequence from given autoradiogram and to identify it from Gene Bank by BLAST method.
10. To generate Pair-wise and multiple sequence alignment of a given organisms
11. To generate phylogenetic tree using given sequences.
12. To predict a protein from given sequence by using online tools from NCBI.
13. To design PCR primers for isolation of given gene and to clone it in the given vector.
14. To generate the map of given plasmid and find the Reporter gene.
15. To find out ORF in the given gene sequence.
16. To find out the promoter in the given sequence.

## SEMESTER II

**Course code/name:**

## PGMG2P3: PRACTICAL 4

**Objectives:**

- Understand and perform plant tissue culture
- Understand and perform animal tissue culture
- Understand and perform the *in vitro* recombination using bacterial DNA.

**Outcomes:**

After successful completion of the course the students will be able to

- Perform Micropropagation, haploid production and various plant tissue culture methods
- Prepare media for animal cell culture, culturing cells and checking viability
- Performing *in vitro* recombination using bacterial DNA.

### PART A (Plant and Animal Tissue Culture)

**Plant tissue culture based practical**

1. Preparation of plant tissue culture media using growth hormones.
2. Sterilization of seeds and inoculation in tissue culture media
3. Meristem and axillary bud culture on suitable tissue culture medium.
4. Callus induction and callus culture.
5. *In vitro* induction of somatic embryogenesis and preparation of artificial seeds.
6. Embryo culture and Embryo Rescue Technique
7. Anther /Pollen culture technique
8. Protoplast Isolation and fusion

**Animal tissue culture based practical**

1. Preparation of Tissue culture medium, membrane filtration and role of serum in cell culture.
2. Initiation of cell culture and maintenance of established cell line in laboratory
3. Cell counting and cell viability.
4. Isolation of DNA from cell culture.
5. Cryopreservation and thawing.
6. Demonstration of Hybridoma technology.

**PART B (Recombinant DNA Technology)**

1. Isolation of DNA from suitable microorganism/ higher organism
2. Isolation of Plasmid DNA from suitable microorganism
3. Restriction digestion of genomic or lambda DNA and size determination of the fragments
4. Determination of insert size by R.E analysis
5. Ligation of vector and DNA of interest, and checking of LM
6. DNA amplification by PCR
7. Gel extraction for the PCR Product.
8. Preparation of competent cells, transformation of *E.coli* and screening of transformants (Blue / white screening)
9. Analysis of recombinant clone
10. Western Blotting
11. RAPD Analysis
12. RT-PCR

## SEMESTER III

**Course code/name:**

### PGMG3T1: GENETIC ENGINEERING AND NANOTECHNOLOGY

**Objectives:**

- To learn the scope and molecular tools used in recombinant DNA technology.
- To learn the different nucleic acid hybridization and sequencing methods.
- To learn the scope and applications of Nanotechnology.
- To understand the importance of bioethics.

**Outcomes:**

- After successful completion of the course the students will be able to
- Explain the importance of different Molecular tools used in Genetic Engineering.
- Explain the importance of DNA, RNA and protein synthesis along with the hybridization and sequencing methods.
- Explain the characterization of nanomaterials and applications of Nanotechnology.
- Explain the Bioethics relevant to Indian context.

**Module I:** **15L**

Scope of Recombinant DNA Technology:

Milestones in Genetic Engineering- historical overview,

Preparatory methods for RDT:

isolation, purification, and quantification of DNA and RNA, Preparation of total cellular DNA from animal & plant,

Cutting, joining and modifying DNA:

Restriction endonucleases, Ligases, Alkaline phosphatase, polymerases, DNA primers, Linkers, adaptors and their chemical synthesis, Double digest modification of restriction fragment ends. Other ways of joining DNA.

Amplification of DNA:

PCR : Basic features, optimization of PCR parameters, types of PCR and

applications,

**Module II:** **15L**

*In vitro* DNA synthesis: chemical synthesis of oligonucleotides; *In vitro* transcription, *in vitro* translation

DNA, and RNA markers, Restriction mapping of DNA Fragments and map construction. Formation of Point mutations and molecular mechanism

Nucleic acid hybridization:

Principles and applications, preparation of probes, assays and micro-assays.

Nucleic Acid sequencing methods: sanger, Maxam Gillbert, Pyrosequencing and next generation sequencing.

**Module III:** **15L**

Nanotechnology

Characteristics of Nanomaterials: shapes and sizes of nanomaterials, determination of nanostructures by SEM, TEM, XRD, EDAX, Zeta potential- Principles and concepts.

Stability of nanoparticles and capping agents,

Nanobiomaterials And Biocompatibility: synthetic and natural nanobiomaterials

Surface and Bulk Properties of Bio materials, Nanobiomaterials, NanoCeramics, Nanopolymers, Nano Silica, Hydroxy apatite, Carbon Based nanomaterials, NanoBots-concept note

Role of nanoparticles in drug delivery

Applications of nanobiotechnology in medicine, agriculture and food

**Module IV:** **15L**

Ethics: Introduction and Guidelines

Introduction to bioethics, ethical issues in preclinical (animal) studies and clinical studies- Ethical principles, Institutional Review Board, Special issues in research. Ethical Guidelines-ICMR, Institutional Ethics Committees,

Animal ethics:

Basic philosophies of animal ethics: (3 'R's), Animal Ethics Committee, executive, meetings, confidentiality and indemnity, period of approval, joint animal ethics committee, process to establish an AEC, guidelines for ethical conduct in the care and use of animals. Social responsibility for clinical researcher

Bioethics and Society (Indian context):

Ethical issues on New Genetics – Human Genome Project, Gene therapy, Genetic screening and Experimentation with human subjects

**Recommended Books:**

1. Vedpal, S. Malik, Padma Sridhar, Sharma, M. C. and Polasa, H. (1992) Industrial Biotechnology, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
2. Nanobiotechnology: Concepts, Applications and Perspectives by Niemeyer C. M., Wiley – VCH, 2006.
3. Bionanotechnology by David S Goodsell, John Wiley and Sons, 2004.
4. Bio-Nanotechnology: A Revolution in Food, Biomedical and Health Sciences by Debasis Bagchi, Manashi Bagchi, Hiroyoshi Moriyama, Fereidoon Shahidi, Wiley-Blackwell, 2013
5. Physiological basis of Medicine (Best and Taylor)
6. Teitz text book of clinical biochemistry 3rd edition – Burtiset al., William Heinmann medical books, Ltd.

7. Clinical biochemistry – Metabolic and clinical aspects, Pearson Professional Ltd
8. Lippincott's illustrated reviews: Pharmacology byRichard a Harvey, Pamela C ChampeRichardFinkel, Luigi X Cubeddu ,michelle a clarke, 4th edition, 2008 12. Pharmacognosy by G.E. Trease, W.C. Evans, ELBS, 2002

## SEMESTER III

**Course code/name:**

### PGMG3T2: BIOINFORMATICS AND BIOPHYSICAL TECHNIQUES

**Objectives:**

- To learn different bioinformatics databases, tools and resources.
- To learn about different sequence analysis methods in bioinformatics.
- Understanding the instrumentation of the techniques used in the life science laboratory.
- Understanding the principles of biophysical techniques

**Outcomes:**

After successful completion of the course the students will be able to

- Explain the importance of bioinformatics databases, tools and resources.
- Explain the use of Bioinformatics to analyses the biological data.
- Explain the use and applications of Microscopy and spectrometry techniques.
- Explain the applications of Biophysical techniques in industries and research laboratories

**Module I**: **15L**

Introduction to Bioinformatics:

Importance of the subject in handling biological data

Bioinformatics data – nucleic acid sequence, protein sequence, protein structure, genomic, proteomic and metabolomic information

Bioinformatics databases:

types (Nucleic acid sequence databases: GenBank, EMBL, DDBJ; Protein databases: UniProt, SWISS-PROT, TrEMBL, PIR_PSD ; Genome Databases (NCBI, EBI, TIGR, SANGER ), file formats (genbank, fasta, gcg, msf, nbrfpir etc. ), access tools with examples

Bioinformatics tools and Resources:

free online tools, downloadable free tools, software packages, internet, Bioinformatics books and Journals, Bioinformatics web- portals

**Module II:** **15L**

Basic concepts of sequence:

Similarity, identity and homology, definitions of homologues, orthologues, paralogues,

Sequence analysis methods in bioinformatics:

Dot-matrix comparison (Pairwise alignment algorithms – Needleman and Wunch algorithm, Smith Watermann algorithm , Scoring matrices: basic concept of a scoring matrix,

Matrices for nucleic acid and proteins sequences (PAM and BLOSUM series) Sequence alignment:

match, mismatch, gaps, scoring alignments, gap penalty, protein vs DNA alignment

Multiple sequence alignment algorithms – progressive alignment algorithms, heuristic algorithms - Blast algorithm, FASTA algorithm.

Molecular Phylogenetics

Multiple sequence alignment( MSA) based databases searching:

Consensus sequence, patterns, profiles.

**Module III:** **15L**

Fundamentals of radiation of light:

properties of light, Absorption and Emission spectrum, jablonski diagram, energy states, atomic rotations and vibrations,

Theory, instrumentation and application of spectrometry:

visible, UV, IR, , NMR, ESR, fluorescence, Raman and Mass spectrometric techniques, data representation and analysis.

Microscopy:

Optical and electron microscopy basics and principles, numerical aperture, resolution limit, magnification. Optical microscopes- theory, instruments, applications and limits- bright field, phase contrast, fluorescence, confocal, scanning tunneling and polarization microscopy; Electron microscopes- theory instrument, applications and limits- SEM, TEM

**Module IV:** **15L**

Basic concept and theory of Chromatographic Techniques:

Types of interactions, concept of partition, partition coefficient, chromatography performance parameters, $R_f$ values etc.

Types of Chromatography techniques:

principles, instrumentation and applications of Techniques in chromatography- a) Plain- paper, TLC, HPTLC and b) Column chromatography

Electrophoresis:

Electrophoretic mobility, Principles and basics, Techniques in electrophoresis- Principles, instrumentation of a) Gel electrophoresis- Gel electrophoresis and components- Agarose, starch, polyacrylamide b) Native-PAGE, c) SDS-PAGE, d) Pulse field gel electrophoresis.

Other techniques:

a) Isoelectric focusing c) 2D gel electrophoresis

Cell sorter and its applications:

flow cytometry, FACS

**Recommended Books:**

1) A textbook of biophysics, R. N. Roy, New Central Publication, 1st edition.

2) Elementary biophysics. P. K. Srivastava Narosa Publication, 1st edition.

3) Biophysical Chemistry. Upadhyay and Nath, Himalaya publications 3rd edition.

4) Biological thermodynamics. Donald T. Haynie, Cambridge University Press, 1st edition.

5) Principles of Physical Biochemistry. Kensl E.van Holde, W. Curtis Johnson, P. Shing Ho, Pearson Prentice Hall, 2nd edition.

6) Biophysical chemistry Part I: The conformation of biological macromolecules. Cantor and Schimmel, W. H. Freeman and Company, 10th edition

7) Biophysical chemistry Part III: The behavior of biological macromolecules. Cantor and Schimmel, W. H. Freeman and Company, 10th edition

8) Biochemistry of nucleic acids. 1992. Adams *et. al*. Chapman and Hall.

9) Crystallography made crystal clear. 1993. G. Rhodes. Academic Press.

10) Principles of physical biochemistry. 1998. Van Holde et. Al. Prentice Hall.

11) Principles and Techniques of Biochemistry and Molecular Biology, 6th Ed. Wilson Keith and Walker John (2005) Cambridge University Press, NewYork.

## SEMESTER III

**Course code/name:**

### PGMG3T3: PLANT AND ANIMAL TISSUE CULTURE

**Objectives:**

- To understand the different techniques of plant tissue culture.
- To understand about different plant transformation techniques for transgenic plant production and its application.
- To understand the concept of animal tissue culture and its applications.
- To understand the Conventional methods of animal improvement and its applications.

**Outcomes:**

After successful completion of the course the students will be able to

- Learn the basic plant tissue culture techniques from different sources.
- Learn the concept of Transgenic plants production.
- Explain the Animal tissue culture, its advanced culture techniques and applications.
- Explain the applications of Animal Biotechnology.

**Module I:** **15L**

Callus culture: Initiation and maintenance of callus,

Suspension culture: Initiation, maintenance and growth curve.

Micropropagation: methods and stages of micropropagation, Organogenesis, Shoot tip culture, Rapid clonal propagation and Production of virus free plant.

Embryo culture and embryo rescue technique.

Somatic embryogenesis and artificial seeds, Anther and ovary culture.

Conservation techniques: Germplasm conservation, Cryopreservation, slow growth.

Protoplast isolation and culture technique: Protoplast fusion and somatic cell hybridization. Practical applications of protoplast technology.

Production of natural products by plant cell, tissue and organ culture.

**Module II:** **15L**

Plant Transformation technology for Transgenic production: Basis of tumor formation, hairy root features of TI and RI plasmids, mechanisms of DNA transfer, Role of virulence genes, use of TI and RI as vectors, binary vectors,

Application of Plant Transformation for productivity and performance:

Herbicide Resistance: Phosphoinothricin, Glyphosate, Sufonyl urea, atrazine;

Insect resistance: Bt genes, Non-Bt like Protease Inhibitors, alpha amylase inhibitor; Virus resistance: Coat protein mediated, nucleocapsid gene;

Disease resistance: Chitinase, 1-3 beta Glucanase, Ribosome Inactivating Proteins (RIP), antifungal proteins, Thionins, Plant Receptor (PR) proteins; Nematode resistance; Abiotic stress

**Module III**: **15L**

Media for Mammalian cultured cells and tissues: natural and defined media, Preparation of various tissue culture media, sterilization and sterility testing.

Cell cultures: Setting up of primary cell cultures, establishment and Maintenance of continuous cell lines in the laboratory, Hayflick limit, Cell synchronization, Embryonic Stem cells – isolation, culture and preservation.

Advance culture techniques: Three dimensional culture, Histotypic culture, organ culture

Applications using animal cell culture: use of hybridoma cell lines for the production of monoclonal antibodies, MTT Assay, Immunohistochemistry.

**Module IV:** **15L**

Conventional methods of animal Improvement – Selective Breeding and Cross breeding. Embryo Biotechniques for augmentation of replication efficiency and faster multiplication: of superior germplasm, Super ovulation, Oestrus synchronizaion, embryo collection and transfer, embryo culture and preservation.

*In vitro* culture: of oocytes, *in vitro* fertilization,

Micromanipulation and cloning: Somatic cell cloning, Embryo sexing.

Identification and isolation of genes of economic importance.

Applications of animal biotechnology: Production of animals as bioreactors for proteins of pharmaceutical value, Gene mapping in farm animals: Livestock breed and their productivity, artificial insemination methods and hazards, Marker assisted selection and genetic improvement of live stocks.

**Books Recommended:**

1. Plant Tissue Culture and its Biotechnological Applications - W. Barz, E. Reinhard, M.H. Zenk

2. Plant Tissue Culture - Akio Fujiwara

3. Frontiers of Plant Tissue Culture - Trevor A. Thorpe

4. In Vitro Haploid Production of Higher Plants - S. Mohan Jain, S.K. Sopory, R.E. Veilleux

5. Plant Tissue Culture : Theory and Practice - S.S. Bhojwani and A. Razdan

6. Plant Cell, Tissue and Organ Culture - Applied AND Fundamental Aspects - Y.P.S. Bajaj and A. Reinhard

7. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999. Molecular Biology of Cell, Garland Publishing, Inc., New York

8. Buchanan, B. B., Gruissem, W. and Jones, R. L. 2000 Biochemistry and Molecular Biology of Plants. American Soc. Of Plant Physiologists, Maryland, USA

**Recommended Books:**

1. C. Helgasson; Basic cell culture protocols, 3rd edition, Human press

2. E. D. Rang, H.P. Dale, M.M. Ritter; Pharmacology, 5th edition

3. J. Mather and d. Barnes; Animal cell culture methods, Elsevier, vol 57

4. J. R. W. Masters; Animal Cell Culture-A practical approach, Oxford university press

5. J. Paul Basic Protocols in cell and tissue culture

6. M. Butler; Animal cell technology-Principles and products, Open University press

7. M. Butler and M. Dawson, Cell culture lab. fax, Bios scientific Pvt. Ltd.

8. M. Cylnes; Animal cell culture techniques, Springer Verlag

9. M. M. Young; Animal Biotechnology, Pergamon press, Oxford

10. N. Jenkins; Animal cell biotechnology-Methods and protocols, Human Press

11. R. I. Freshney; Culture of animal cells:A manual of basic techniques, John Wiley and sons, $4^{th}$ edn.

12. H. K. Das, Text book of Biotechnology, Wiley dream tech India pvt.ltd.,2005

13.S. Sasidhara animal Biotechnology, MJP Pub. Chennai

14. S.S. Tomar Text book of Animal breeding Kalyani Pub. Kolkata

## SEMESTER III

**Course code/name: ELECTIVE 1**

### PGMG3T4: MOLECULAR DIAGNOSTICS - I

**Objectives:**

- To learn the different gene amplification techniques.
- Understanding different techniques of molecular diagnostics- DNA amplification based, sequencing techniques.
- Understanding the different molecular diagnostics methods and its applications.
- Understanding the model organisms and various molecular systems based on those models.

**Outcomes:**

After successful completion of the course the students will be able to

- Explain about different gene and signal amplification techniques.
- Explain the basic and advanced nucleic acid sequencing methods.
- Explain about the molecular diagnostics methods and their use in different disease conditions.
- Explain about the different models used in molecular diagnosis.

**Module I**: **15L**

Gene amplification techniques:

Polymerase Chain Reaction: Basic features, optimization of PCR parameters, variations in PCR and applications.

Hyphenated PCR- PCR-ELISA, RAPD

Isothermal Amplification: TMA, NASBA, LAMP, Ligation assay

Signal Amplification techniques:

Branched DNA Amplification, Hybrid Capture Assay, Invader technology, probe amplification techniques

**Module II**: **15L**

Nucleic acid hybridization: Preparation of probes, principles and applications of nucleic acid hybridization, nucleic acid *in situ* hybridization assays - Southern, Northern and Western methods, Dot and Slot methods,

DNA sequencing methods**:**

Principles and various DNA sequencing methods Sanger sequencing, Maxam Gilbert sequencing;

Next –generation sequencing:

Massively parallel sequencing platforms, Titanium, Illumina Genome analyzer II SOLiD 3 system, Nanopore technology, paired End sequencing; Pyrosequencing-microarrays; DNA bar coding data analysis and storage.

**Module III**: **15L**

Molecular Diagnostics:

Introduction to Molecular diagnostics and its significance in post genomic era in health care industry;

Molecular diagnosis methods:

Identifying Disease genes and genetic susceptibility to complex diseases (immune disorders and cancer); genetic linkage analysis/ GWAS, role of molecular methods in cancer management

Molecular tools in genetic counseling:

pre-symptomatic, prenatal tests and new born screening; Concerns in Molecular diagnostics and genetic testing: regulatory and ethical issues.

Applications in Health care and forensics:

History of forensic genetics, sample collection, forensic for human identification, biomarkers in forensics, personalized genomics in disease diagnosis

**Module IV**: **15L**

Models for molecular diagnosis
yeast: Haploid and diploid cells Genome of yeast- Cell type determination, Cell cycle regulation, GAL System
*C. elegans*: Rapid life cycle, gene silencing pathway, cell death pathway,
*Drosophila*: Developmental genetics, Genetic mosaics and use of GAL system from yeast, transgenic fruit flies and genetic screens P- clement biology.

*Arabidopsis thaliana*: model for developmental genetics, ABC model for Flower development

**Recommended Books:**

1. Molecular Biology of the Gene, 5th edn. (2004) J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick, Pearson Education Inc.
2. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999. Molecular Biology of Cell, Garland Publishing, Inc., New York
3. Buchanan, B. B., Gruissem, W. and Jones, R. L. 2000 Biochemistry and Molecular Biology of Plants. American Soc. Of Plant Physiologists, Maryland, USA
4. Karp, G. 1999 Cells and Molecular Biology; Concepts and Experiments. John Wiley and Sons, Inc., USA.
5. John R. ten Bosch, Wayne W. Grody,Chapter 6 - Next-Generation Sequencing in Molecular Diagnostics,Molecular Diagnostics,Academic Press,2010

## SEMESTER III

**Course code/name: ELECTIVE 2**

## PGMG3T4: PLANT GENETIC ENGINEERING I

**Objectives:**

- To Understand the different techniques of plant breeding and tissue culture.
- To Understand the Suspension culture, Haploid plant production and Protoplast culture.
- To Understand the different Plant transformation technology and its applications.
- To Understand the Molecular marker aided breeding, metabolic engineering and industrial production.

**Outcomes:**

After successful completion of the course the students will be able to

- Elucidate techniques of plant breeding, Suspension culture, Haploid plant production, Protoplast culture and other plant tissue culture techniques.
- Explain the different Plant transformation technology and its applications.
- Interpret the Molecular marker aided breeding, metabolic engineering and industrial production.

**Module I:** **15L**

Plant breeding technique and domestication of plant

Historical account of plant tissue culture

Technique of plant tissue culture: Shoot tip and meristem cell culture-isolation and culture of plant stem cell for clonal propagation and disease free plant propagules multiple shoot induction.

Somatic Embryogenesis- direct and indirect .role of growth regulators ,explants types, genotype and cultural condition and somaclonal variation.

**Module II:** **15L**

Suspension culture and production of plant secondary metabolites

Production of haploid plants and homozygous lines and its signification in crop improvement

Protoplast isolation ,culture and fusion technique – selection and regeneration of hybrid plants, symmetric and asymmetric hybrids cybrids.embryo rescue technique. Synthetic seed technology.

**Module III :** **15L**

Plant transformation technology-

Basis of tumour formation ,mechanism of DNA transfer . Feature of Ti and Ri plasmid and their uses as vector, role of virulence gene , binary vectors markers. Use of reporter of gene 35 S and other promoter . Methods of nuclear transformation -direct and indirect.

Application of plant transformation for productivity and performance. Development of transgenic plant for herbicide,insect resistance and disease resistance

Male sterility-Bar and Barnes system.

**Modules IV:** **15L**

Metabolic engineering and industrial production : plant secondary metabolites, control mechanism and manipulation of phenoilpropanoid pathway, shikimate pathway, alkaloids, industrial enzyme, biodegradable plastics,polyhydroxybutyrate, therapeutic protein, lysosomal enzymes, antibodies ,edible vaccines ,purification strategies oleosin partitioning technology.

Molecular marker aided breeding: RFLP maps, linkage analysis , RAPD markers STS microsatellite ,SCAR (sequence characterized amplified region), SSCP(single stranded conformational polymorphism)AFLP, QTL, map based cloning, molecular marker assisted selection.

**Book Recommendations:**

1. Plant Tissue Culture and its Biotechnological Applications - W. Barz, E. Reinhard, M.H. Zenk
2. Plant Tissue Culture - Akio Fujiwara
3. Frontiers of Plant Tissue Culture - Trevor A. Thorpe
4. In Vitro Haploid Production of Higher Plants - S. Mohan Jain, S.K. Sopory, R.E. Veilleux
5. Plant Tissue Culture : Theory and Practice - S.S. Bhojwani and A. Razdan
6. Plant Cell, Tissue and Organ Culture - Applied AND Fundamental Aspects - Y.P.S. Bajaj and A. Reinhard

## SEMESTER III

**Course code/name: ELECTIVE 3**

## PGMG3T4: BIOINFORMATICS - I

**Objectives:**

- To build a strong background and potential in bioinformatics and to give a detailed knowledge about biological databases and make the students familiar with various bioinformatics tools.
- To understand in detail about various molecular sequence alignment tools
- To learn the Molecular phylogeny.
- To master the computational techniques used in biological nucleotide sequence and structure analysis.

**Outcomes:**

Students will be able to

- Explain types of data available from the most common sequence and structure databases.
- Explain the theories underlying sequence searches and alignment;
- Demonstrate the different approaches of creating phylogenetic trees and evaluating them.
- Analyze the nucleotide sequence and structure with various bioinformatics tools;

**Module I:** **15L**

Introduction to Bioinformatics and Databases

Bioinformatics: definition, aim, scope/research areas, branches and applications; Introduction to Biological databases: importance and functioning; types of biological databases: nucleic acid databases, protein sequence and structure databases, specialized databases, genome databases, mapping databases, carbohydrate databases, model organism databases, literature databases; Sequence and molecular file formats, information retrieval systems - Entrez and SRS.

.

**Module II:** **15L**

Sequence Alignment

Molecular sequence alignment: Importance, homology, identity, similarity; Scoring matrices: PAM and BLOSUM; Pairwise alignment algorithm: global (Needleman and Wunsch) and local alignment (Smith and Waterman), statistical analysis of pairwise alignment; BLAST: introduction, types and steps, FASTA search algorithm and types; Multiple sequence alignment: Progressive alignment methods, Iterative method (MultiAlin), Genetic algorithm, Profilescan, PROBE, Clustal.

.

**Module III:** **15L**

Molecular Phylogeny and Evolution

Molecular Phylogeny: Goals, historical background, molecular clock hypothesis; properties and types of phylogenetic trees; Stages of phylogenetic tree construction and methods: distance-based (UPGMA, NJ), phylogenetic inference (Maximum parsimony), model-based

phylogenetic inference (Maximum Likelihood), Tree inference (Bayesian method), tree evaluation (Bootstrapping).

**Module IV:** **15L**

Analysis of Nucleotide Sequence

Gene prediction and regulation of prokaryotes and eukaryotes: ORFs, promotor and regulatory region; gene finding methods: Neural Network, problems in gene finding, constructing restriction maps; RNA: Types, level of organization and prediction of secondary structure of RNA; Searching RNA specific genes and importance.

**Recommended Books:**

1. Jonathan Pevsner (2019), Bioinformatics and Functional Genomics, 3rd Ed. Wiley Blackwell.

2. JinXiong, (2006), Essential Bioinformatics, Cambridge University Press.

3. Lesk, M.A. (2014), Introduction to Bioinformatics, 4th Ed. Oxford University Press, New York.

4. Andres D Baxevanis.(2009), Bioinformatics- A practical guide to the analysis of Genes and proteins, 3rd Ed.. Willey.

5. Campbell, A.M. and Heyer, L.J. (2013), Discovering Genomics, Proteomics and Bioinformatics, 2nd Ed. pearson Education INC, India.

6. Mount. (2005) Bioinformatics - Sequence and Genome analysis. Cold Spring Harbor Laboratory Press.

## SEMESTER III

**Course code/name:**

### PGMG 3P1: PRACTICAL 5

### (Based On Elective I: Molecular Diagnostics I and II)

**Objectives:**

- Understanding and performing various molecular methods used for identification of diseases.
- Understanding and undertaking bioethics survey and its analysis.
- Understanding and performing molecular techniques based on DNA amplification and sequencing.
- To learn the analysis of immunohistographs and cancer databases having molecular marker information.

**Outcomes:**

After successful completion of the course the students will be able to

- Amplify, isolate and identify specific gene and proteins related to specific disease.
- Perform bioethical survey and analyze the data for output.
- Analyzing immunohistographs using software and analysis done using cancer database for prognosis and survival.

**PART A**

1. Real time PCR
2. PCR-ELISA
3. RFLP and PCR-RFLP
4. RAPD
5. Analysis of DNA sequencing data obtained from sanger sequencing.
6. Analysis of DNA sequencing data obtained from Pyrosequencing.
7. Isolation of Polytene chromosome from chironomus insect larvae
8. Genetic screen scheme development for identifying tumor suppressor genes using Drosophila (demo)
9. Western blotting
10. Southern blotting

**PART B**

1. PCR for 16S RNA from bacteria
2. PCR mediated site directed mutagenesis
3. Single nucleotide polymorphism testing
4. GMO Detection by PCR
5. Malaria detection using nested PCR
6. Bioethics and Society survey and data analysis using biostatistics

7. Immunohistochemistry (demo)
8. Image analysis using Fiji Software of confocal images for neoplasticity
9. Clinical diagnosis of cancers using cBioPortal and KM Plotter.

**SEMESTER III**

**Course code/name:**

## PGMG3P1: PRACTICAL 5

### (Based On Elective II: Plant Genetic Engineering I and II)

**Objectives:**

- Understand and perform methods of plant tissue culture
- Understand and perform the Molecular methods involved in culturing
- Understand and perform Plant genetic engineering processes.

**Outcomes:**

After successful completion of the course the students will be able to

- Perform Micropropagation, haploid production of Plants
- Isolate, quantitatively and qualitatively analyze plant DNA
- Perform various plant tissue culture methods and their callus induction
- Transgene formation using genetic engineering

**PART A**

1. Media Preparation
2. Meristem and axillary bud culture
3. Organogenesis and Somatic Embryogenesis
4. Embryo Rescue Technique
5. Anther /Pollen culture technique
6. Morphology and cytology of callus
7. Isolation of DNA
8. Estimation of plant DNA by agarose gel electrophoresis.
9. Spectrophotometric estimation of DNA.
10. Cell suspension culture technique.

**PART B**

1. Induction of shoots from shoot tip in MS medium containing growth regulators
2. Induction of callus and somatic embryogenesis in monocot plants
3. Anther culture and production of haploid callus
4. Induction of callus and isolation of salt tolerant cell line
5. Induction of hairy roots and production of secondary metabolites
6. Transformation of gus gene in plants through Agro-bacterium
7. Amplification of transgene from plant by PCR
8. Endosperm culture

## SEMESTER III

**Course code/name:**

### PGMG3P1: PRACTICAL 5

### (Based On Elective II: Bioinformatics I and II)

**Objectives:**

- Understanding and perform different Nucleic acid and protein databases and its related tools
- Understanding and perform Genomics and proteomics tools
- Understanding and perform the analysis of microarray and phylogenic tree

**Outcomes:**

After successful completion of the course the students will be able to

- Use various tools related to Genomics and proteomics
- Search various databases related to Nucleic acid and protein according to the need of analysis
- Analyze sequences, align sequences and generate phylogenic tree

**PART A**

1. Nucleic acid sequence databases, Protein sequence databases, Database search engines, Database Similarity Searches, Multiple sequence alignment, Genome databases, Structural databases, Derived databases
2. Information retrieval using Entrez, SRS
3. Nucleotide BLAST, Protein blast, PSI-BLAST, DELTA-BLAST, PHI-BLAST, MegaBLAST, HMMER, BLAT
4. FASTA search
5. Near and Far relative sequence identification using BLAST
6. PHYLIP – construction of rooted and unrooted phylogenetic trees

**PART B**

1. Sequence analysis using UCSC Genome Browser, Ensembl browser, Galaxy
2. Gene finding programs (GeneMark, GenScan)
3. Protein sequence analysis : ExPASy Proteomic tools
4. Molecular visualization: downloading atom coordinates from PDB: using the coordinate files to view the molecules using molecular visualization tools
5. Structural data, databases and structure analysis, Molecular visualization tools, Structure prediction tools and homology modeling, Molecular dynamics simulation and docking
6. Multiple alignment and database search using motif models, ClustalW, Pattern recognition,
7. Expression profiling by microarray/gene chip,
8. Modeling and prediction of structure of proteins

## SEMESTER IV

**Course code/name:**

### PGMG4T1: RECOMBINANT DNA TECHNOLOGY

**Objectives:**

- Understanding the tools for manipulating DNA e.g. enzymes, vectors, cloning systems etc.
- Understanding different tools used for RDT in plants, animals and microbes
- Understanding the applications of RDT on plants, animals and microbes

**Outcomes:**

After successful completion of the course the students will be able to

- Learn about the recombinant DNA technology and its use in DNA modification and gene cloning
- Learn different techniques used for RDT
- Perform *in vitro* recombination using bacterial DNA.

**Module I:** **15L**

Gene Cloning Vectors:

Plasmids, bacteriophages, phagemids, cosmids, Artificial chromosomes.

Gene cloning:

PCR and non PCR based, mRNA enrichment, reverse transcription, cDNA Synthesis and Cloning, Library construction and screening of genomic libraries.

Directed mutagenesis: oligonucleotide directed mutagenesis with M13 DNA, with plasmid DNA, PCR amplified oligonucleotide directed mutagenesis,

Random mutagenesis: with degenerate Primer, with nucleotide analog,

**Module II:** **15L**

Tools for analyzing gene expression:

Reporter genes, Analysis of gene regulation, purification and detection tags

Detection of recombinant clone:

by colony hybridization, identification by Two-and three hybrid Systems, Fluorescently labelled genes, Plaque lift procedure, immunological screening of λgt II or λZAP recombinant plaque

Gene expression from strong and regulatable promoter: regulatable promoter, increasing protein production, large scale system,

Fusion proteins: Cleavage of fusion proteins, uses of fusion proteins

Translation expression vector

DNA integration to host chromosome

**Module III:** **15L**

Transgenic and gene knockout technologies:

methods for producing knockout mice- pronuclear microinjection, recombinant retrovirus, Chimeric embryo by transfection of ES cells, YAC, mitochondrial transgenesis, integration mechanisms of targeting vectors, introduction of mutations using vectors, Application of GM mice, Nuclear transfer techniques for animal Cloning

Methods of gene transfer techniques in plants and animals:

*Agrobacterium* mediated, electroporation and particle gun, liposome, PEG, nanoassemblies. Gene transfer techniques for: Xenopus, Fish, Fruit flies,

**Module IV:** **15L**

Chromosome engineering Introduction; Cre/loxP mechanism: Technique, example of engineering the baker's yeast; CRISPR/Cas mechanism: Limitations of Cre/loxP mechanism, advantage of CRISPR/Cas mechanism, the technique and CRISPR/Cas components; Targeted chromosome arrangement in plants; Applications of chromosome engineering.

Protein Engineering: Adding disulfide bond, Changing Asparagine to other amino acids, Reducing the Number of Free Sulfhydryl Residues, Increasing Enzymatic Activity, Modifying Metal Cofactor Requirements, Modifying Enzyme Specificity, Increasing Enzyme Stability and Specificity.

**Recommended Books:**

1) RNA methodologies-A laboratory guide for isolation and characterization, 3rd Edn., Farell, R. Elsevier 2005

2) Molecular Cell Biology-Lodish , Berk, 5th Edn. Freeman 2003

3) Molecular Biology of the Cell, 5th edn, Alberts 2008, Grandland science

4) Cells-Levin, 1st Ed. Jones and Bartlett Publisher 2006

5) The cell – A molecular Approach 4th Edu. Geoffrey M. Cooper, Rober E. Hausman

6) Genes IX - Lewin B. 2004, Prentice Hall

7) Biochemistry – Voet D. Voet J. G. 3rd Edn., Johnwiley and Sons inc. 2004

8) Cell and Molecular and William and Wilkins 2006

9) DNA repair mutagenesis: Friedberg E. C. ASM press 1995.

10) Enzymology primer for Recombinant DNA technology Eun HM, Elservier, 1996.

11) Glick, B.R. and Pasternak, J.J. (1994) Molecular Biotechnology, ASM Press.

12) John G. Webster. (2004) Bioinstrumentation. Univ. of Wisconsin, John Wiley and Sons, Inc.

13) Sambrrok, J. and Ruseell, D.W. (2001) Molecular Cloning – A Laboratory Manual (3rd edn.,

Vol. 1,2,3) Cold Spring Laboratory Press, New York.

14) Savile Pradbury (1991) Basic measurement techniques for light microscopy, Oxford Univ.

Press, Royal Microscopical Society.

15) Surzeki, S. (2000). Basic Techniques in Molecular Biology, Springer.

16) Westermeier, R (1993) Electroporesis in practice – VCH – Federal Republic of Germany.

17) Willett, J.E. (1991) Gas Chromatography, John Wiley and Sons.

18) Wilson, K. and Walker (1995) Practical Biochemistry Principles and Techniques, Cambridge

Univ. Press

## SEMESTER IV

**Course code/name:**

## PGMG4T2: IMMUNOLOGY

**Objectives:**

- Understanding the basics of Immunology
- Understanding the process of immune system activation and memory formation, autoimmunity.
- To learn the classification of Immunoglobulins and antigen-antibody interaction.
- To learn various immunological diseases and immunotechniques.

**Outcomes:**

After successful completion of the course the students will be able to

- Learn to differentiate between innate and adaptive immune system
- Understand the immunological response.
- Learn about the immune system, antigen representation and immune cell activation
- Explain various immunological techniques

**Module I:** **15L**

Introduction to immune system:

History, Immunity, immune response, Antigens, factors affecting antigenicity,

Types of immunity:

Innate and adaptive Immunity, Cells and molecules of immune system (Phagocytic cells, B and T lymphocytes, NK cells, Cytokines, etc). Primary and secondary organs of immune system. Humoral and cell mediated immune response. Primary and secondary immune modulation.

**Module II:** **15L**

Complement System, Major Histocompatibility Complexes (MHC-I and MHC-II). Antigen processing and presentation, Activation and differentiation of B and T cells, B and T cell receptors, Toll-like receptors. Memory cell formation

Autoimmunity

Hypersensitivity (Hypersensitivity reactions (Gell and Coombs classification, IgE mediated [Type-I], Antibody-mediated cytotoxic [Type-II], Immune complex mediated [Type III], Delayed type hypersensitivity [DTH] i.e. Type-IV), RAST testing, Autoimmunity and its proposed induction mechanism(Organ specific autoimmune diseases, Systemic autoimmune diseases), autoantibodies in health and disease, Immuno-supression; General and specific immunosuppressant therapy; Immunological tolerance,

**Module III:** **15L**

Classification of immunoglobulin (IgM, IgD, IgG, IgE, IgA), isotypes, allotypes and idiotypes. Organization of antibody genes, Gene rearrangement, Expression of light and

heavy chain immunoglobulin, Class switching, clonal deletion, Allelic exclusion. Generation of antibody diversity, Somatic hypermutation, Gene conversion. Antigen-antibody interactions, Kinetics of antigen-antibody binding, affinity, avidity, high and low affinity antibodies.

**Module IV:** **15L**

Immunology for diseases:

Host pathogen interaction, subversion of host immune response by intracellular parasites (Immune response during bacterial (TB), Parasitic (malaria), and viral (HIV) infections, Congenital and acquired immune deficiencies), Immunological basis and clinical manifestations of graft rejection, immune tolerance to allografts, Clinical transplantation

Vaccinology (Traditional, Recombinant Protein and DNA vaccines), super antigens, antibody therapies

Immunotechniques:

Principles, instrumentation and applications of RIA, Immunodiffusion, Immunoprecipitation, ELISA, agglutination, Immunofluorescence. Antibody engineering, Development of monoclonal antibodies (Hybridoma technique) and their use in diagnostics and therapeutics.

**Recommended Books:**

1. Immunology – R. A. Goldsby, T. J. Kindt, B. A. Osborne, Janis Kuby; W.H. Freeman andCompany, 5th edn. (2003)
2. Essential Immunology - Ivan M. Roitt, Peter J. Delves Blackwell Science Ltd., 10th Edn. (2001)
3. An Introduction to Immunology - C.V. Rao; Narosa Publishing House,1st Edi.(2004)
4. Instant Notes in Immunology - P.M. Lydyard, A. Whelan, M.W. Fanger BIOS Scientific Publ. Ltd, 1st Edn. (2003)
5. Immunology: Introductory textbook; Nandini Shetty, New Age International pvt. Ltd. 1st Edn. (2003).
6. A Handbook of Practical and clinical Immunology - Short protocols in Immunology Vol 1. Talwar and S. K. Gupte, 2nd Edn. (2003) , Coliganetal John Wiley.
7. Immunology II Edn., Kuby, J. W. H., Freeman and Company, New York.
8. Immunology - Klaus D. Elgert , Wiley-Liss. NY.
9. Text Book on Principles of Bacteriology, Virology and Immunology, IX Edn. (5 volumes)
10. Topley and Wilson's, Edward Arnold, London. The Experimental Foundations of Modern Immunology - Clark, V.R., John Willey and Sons, Incl.
11. Fundamental Immunology – W. E. Paul, Raven Press, New York.
12. Fundamentals of Immunology - R. M. Coleman, M. F. Lombord and R. E. Sicard 2nd edn. C. Brown publishers.
13. Immunology - D. M. Weir and J. Steward 7th Edn.

## SEMESTER IV

**Course code/name:**

### PGMG4T3: IPR, ENTERPRENEURSHIP, BIOSAFETY, QA AND QC

**Objectives:**

- Learn about the various Intellectual Property Rights (IPR)
- Understand the basics of entrepreneurship
- Learn about biosafety assessment and regulations
- Learn the process of Quality assurance and control.

**Outcomes:**

After successful completion of the course the students will be able to

- Understand the basics of patent application filing and the applications of IPR in India and abroad and learn to file the patent application.
- Understand the issues and concerns related to biotechnological inventions for filing patents
- Get motivated for entrepreneurship development.
- Understand the procedure for biosafety and QA QC rules

**Module I:** **15L**

Intellectual property rights (IPR): Coyrights, trademark, Geographical Indicators, Industrial Design,Conventional Biological Diversity (CBD), patenting

General agreement on trade and tariffs:

Protection of Plant Variety and Farmers Rights Act (PPVFR), World Trade Organisation (WTO) with reference to biotechnological affairs, Trade related Aspects of IPR (TRIPs)

Basic Requirements of Patentability:

Patentable subject matter, novelty in the public domain, non-obviousness.

Special issues in Biotechnology Patents:

Disclosure requirements, Collaborative research, Competitive research.

Plant biotechnology Indian patents and foreign patents,

Recent Developments in Patent System and Patentability of biotechnological inventions:

Salient features of Indian Patent Act 1970, IPR issues in Indian Context Role of patent in pharmaceutical industry, Case studies Rice, Turmeric, Margo, etc. and challenges ahead.

**Module II:** **15L**

Entrepreneurship:

Concept, definition, structure and theories of entrepreneurship, Types of entrepreneurship, environment, process of entrepreneurial development, Entrepreneurial culture, entrepreneurial leadership,

Product planning and development:

Project management, Search for business idea- how entrepreneurship differ than business, Generating a startup- types, requirements and funding scenarios in India,

Concept of projects:

Project identification, formulation, Design and network analysis Project report and project appraisal

Market analysis and commercialization of product

**Module III:** **15L**

Biosafety in the laboratory institution:

Laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety, prudent biosafety practices in the laboratory/ institution

Biosafety regulations in the handling of recombinant DNA processes and products in institutions and industries, biosafety assessment procedures in India and abroad

Biotechnology and food safety:

The GM-food debate and biosafety assessment, procedures for biotech foods and related products, including transgenic food crops, case studies of relevance, Ecological safety assessment of recombinant organisms and transgenic crops, case studies of relevance (Eg. Bt cotton), Biosafety assessment of biotech pharmaceutical products such as drugs/vaccines etc.

International dimensions in biosafety:

Cartagena protocol on biosafety, bioterrorism and convention on biological weapons

**Module IV:** **15L**

Laboratory Management:

Administration of Laboratories, Laboratory design, Safety measures, Laboratory Information management system (LIMS)

Good laboratory practices, good manufacturing practices, laboratory acModuleation- NABL Guidelines for AcModulation in India

Standards for analysis:

Basic standards, Need of standards in analytical sciences, Analytical standards- Reference materials/controls (positive and negative), High purity substances, certified reference material, Biological standards: Biochemical standards, Microbial cell lines and standards

Quality control:

Concept and evolution and scopes of Quality Control and Quality Assurance, Good Laboratory Practice, GMP, Overview of ICH Guidelines – QSEM, with special emphasis on Qseries guidelines. Good Laboratory Practices: Scope of GLP, Definitions, Quality assurance unit, protocol for conduct of non clinical testing, control on animal house, report preparation and documentation. CPCSEA guidelines.

Quality Management:

Quality Assurance and Management: Fundamentals of total quality management, elements of quality assurance program. External quality assessment Identifying the source of analytical errors. Quality system, Inspection and testing, Handling, Storage, Packaging, Preservation of the material, Internal quality audits, Quality assurance.

**Recommended Books :**

1. Environmental Biotechnology, M.H. Fulekar, Science publishers, 2010
2. Intellectual Property Rights - Brigitte Anderson, Edward Elgar Publishing
3. Intellectual Property Rights and the Life Sciences Industries - Graham Dutfield, Ashgate Pub.
4. WIPO Intellectual Property Handbook
5. Intellectual Property Rights - William Rodelph Cornish, David Clewelyn
6. Entrepreneurship: New Venture Creation - David H. Holt
7. Biotechnology-The science and the business Mosses V, CapeRE,2nd edn., CRC press 2000.
8. Patterns of Entrepreneurship - Jack M. Kaplan
9. Entrepreneurship and Small Business Management: C. B. Gupta, S. S. Khanka, Sultan Chand
10. Indian Patents Law, Mittal, D.P. (1999) Taxmann, Allied Services (p) Ltd.
11. Handbook of Indian Patent Law and Practice - Subbaram , N. R. , S. Viswanathan (Printers
12. and Publishers) Pvt. Ltd., 1998.
13. Biotechnology, Biosafety, and Biodiversity: Scientific and Ethical Issues for Sustainable Development by Sivramiah Shantharam, Jane F. Montgomery and Satellite Symposium on Biotechnology and Biodiversity
14. Quality Assurance Guide by organization of Pharmaceutical Procedures of India, 3rd revised edition, Volume I and II, Mumbai, 1996.
15. Good Laboratory Practice Regulations, 2nd Edition, Sandy Weinberg Vol. 69, Marcel Dekker Series, 1995.
16. Quality Assurance of Pharmaceuticals- A compedium of Guide lines and Related materials Vol I and II, 2nd edition, WHO Publications, 1999.
17. How to Practice GMP's – P P Sharma, Vandana Publications, Agra, 1991.
18. **Websites:**1)Intellectual Property Today : Volume 8, No. 5, May 2001, www.iptoday.com

## SEMESTER IV:

**Course code/name: ELECTIVE 1**

## PGMG4T4: MOLECULAR DIAGNOSTICS - II

**Objectives:**

- To learn the different molecular techniques used for the diagnosis of disease caused by bacteria, fungi, protozoa and Helminthes.
- To learn the different genetic disorders along with neonatal and prenatal diagnosis.
- To learn the different metabolic genetic disorders and neurogenetic disorder.
- To learn about different plant diseases and its control.

**Outcomes:**

After successful completion of the course the students will be able to

- Understand the biology of the diseases- infection caused by bacteria, virus, fungi, protozoa etc.
- Understand different genetic disorders and its diagnosis.
- Understand different metabolic disorders and its diagnosis.
- Understand different Plant diseases, its diagnosis and methods to control the diseases caused by different pathogens.

**Module I:** **15L**

Types of infectious diseases: mode of transmission of diseases caused by fungi, protozoa's, helminthes;

Diagnosis of infections caused by fungi such as Dermetophytoses, Candidiosis and Aspergillosis;

caused by protozoa's such as *Amoebiosis, Malaria, Trypnosomiosis, Leishmaniasis;*

caused by helminthes such as *Fasciola hepatica, Ascaris lumbricoides, Filariasis* and *Schistosomiasis.*

Infections caused by bacteria such as *Streptococcus, Coliforms, Salmonella, Shigella, Vibrio* and *Mycobacterium;*

bacterial food poisoning, cholera, *E.coli* diarrhea.

**Module II:** **15L**

Genetic disorders:

Sickle cell anaemia, Thalassemias, Hemophilias

Duchenne muscular dystrophy and Becker Muscular dystrophy, Cystic Fibrosis, spinomuscular atrophy, neurofibromatosis I

Colourblindness, Retinitis pigmentosae, Glaucoma and Cataracts

oncogenes andtumour suppressor genes, Mechanism of action of pRB and p53. Retinoblastoma, Colorectal cancer, Breast cancer, Factor V Leiden mutation.

Neonatal and Prenatal disease diagnostics, X- Linked and Y- linked disorders, Male infertility based on Y genes, Mitochondrial DNA for maternal inherited diseases.

**Module III:** **15L**

Metabolic genetic disorders (mono- and polygenic): Phenylketonuria, Galactosemia, Mucopolysaccharidosis, diabetes mellitus, Tay Sach's Syndrome and Marfan Syndrome. Neurogenetic disorders: Alzheimer disease and syndromes due to triplet nucleotide expansion like Huntington disease, spinocerebellar ataxia.

**Module IV:** **15L**

Plant disease diagnosis:

Bacterial diseases of plants: Bacterial blight of rice; Tundu disease of wheat; Angular leaf spot of cotton; Stalk rot of maize; Fire blight of apple; Bacterial soft rot of fruits and vegetables.

Viral Diseases of Plant: Bunchy top of banana; Leaf curl of papaya; Yellow vein mosaic of bhindi. Mosaic of cucurbits; Viral diseases of tobacco, potato and tomato.

Mycoplasma/Phytoplama (PPLO) Diseases of Plants: Citrus greening, Rice yellow dwarf; Little leaf of brinjal, Sandal spike

Principles and methods of plant disease control- cultural methods, chemical methods, biological control, transgenic approach for plant disease control, integrated pest management (IPM), biopesticides.

**Recommended Books:**

1. Wayne, W., Grody, Robert M. Nakamura, Charles M. Strom and Frederick L. Kiechle Molecular Diagnostics: Techniques and application for the clinical laboratory.
2. William B. Coleman and Gregory J. Tsongalis Molecular Diagnostics: For the clinical laboratories.
3. Editors: Tang, Yi-Wei, Stratton, Charles W. (Eds.) Advanced Techniques in Diagnostic Microbiology ISBN 978-1-4614-3970-7

4.Molecular diagnostics : fundamentals, methods, and clinical applications /Lela Buckingham, Maribeth Flaws.

5. Aneja, K.R. (1993) Experimental in Microbiology, Plant Pathology & Tissue Culture, Wiswa Prakashan, New Delhi.

6. Bilgrami, K.S. and H.C.Dube (1985) A text Book of Modern Plant Pathology, Vikas Publication House, New Delhi.

## SEMESTER IV

**Course code/name: ELECTIVE 2**

## PGMG4T4: PLANT GENETIC ENGINEERING II

**Objectives:**

- To Understand the Cloning, Somatic Embryogenesis and *in vitro* Pollination and fertilization.
- To Understand the Genetic resources, germplasm conservation and production of secondary metabolites cell culture technique.
- To Understand the genetic engineering for crop improvement.
- To Understand the Molecular characterization of transgenic for gene integration.

**Outcomes:**

After successful completion of the course the students will be able to

- Elucidate gene Cloning, Somatic Embryogenesis and *in vitro* Pollination and fertilization.
- Interpret the Genetic resources, germplasm conservation and production of secondary metabolites through cell culture technique and the genetic engineering for crop improvement.

**Module I:** **15L**

Cloning: Isolation of single cells, culturing of single cell - Different methods, viability test of cultured cells, role of hormones in morphogenesis.

Somatic embryogenesis: Physical and chemical factors responsible for induction of somatic embryos, molecular basis of somatic embryogenesis, genotype specificity of somatic embryogenesis.

In-vitro pollination and fertilization, overcoming barriers to wide hybridization, production of dihaploids and their application in genetics and plant breeding, polyploids through endosperm culture and their application in plant breeding.

**Module II:** **15L**

Genetic resources, germplasm conservation, gene bank – some case studies on success stories on commercial application of plant tissue culture, abiotic stress resistant: isolation and culture of salt tolerant cell lines.

Production of secondary metabolites through cell culture technique in some important medicinal plants, factors affecting production, biotransformation, elicitors induced production, hairy root culture and production of secondary metabolites.

**Module III:** **15L**

Genetic engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation, nutrient uptake efficiency.

Genetic engineering for abiotic stress like drought, flooding, salt and temperature.

Genetic engineering for quality improvement of protein, lipids, carbohydrates, vitamins and mineral nutrients. RNAi approach

Chloroplast transformation – advantages, vectors and success.

**Module IV:** **15L**

Molecular characterization of transgenic for gene integration – PCR, Southern blot, gene expression, Western blot, ELISA, marker free methodologies, gene stability, gene silencing, gene staking,

Contained green house trial , field trial of transgenic plants, selection of promising events, point of integration, RCGM, GEAC.

**Books Recommended:**

1.Plant Tissue Culture and its Biotechnological Applications - W. Barz, E. Reinhard, M.H. Zenk

2. Plant Tissue Culture - Akio Fujiwara

3. Frontiers of Plant Tissue Culture - Trevor A. Thorpe

4. In Vitro Haploid Production of Higher Plants - S. Mohan Jain, S.K. Sopory, R.E. Veilleux

5. Plant Tissue Culture : Theory and Practice - S.S. Bhojwani and A. Razdan

6. Plant Cell, Tissue and Organ Culture - Applied AND Fundamental Aspects - Y.P.S. Bajaj and A. Reinhard

## SEMESTER IV

**Course code/name: ELECTIVE 3**

## PGMG4T4: BIOINFORMATICS - II

**Objectives:**

- To understand about molecular interaction and structure prediction
- To understand the basis of drug action.
- To learn the different drug designing approaches.
- To learn the system biology and different databases and software's which are for its analysis.

**Outcomes:**

After successful completion of the course the students will be able to

- Explain basic principle of experimental methods for determination of macromolecule structure and use of different type of protein prediction tools.
- Explain how drug works
- Understand the different drug designing approaches.
- Explain Biological networks and software's for their analysis.

**Module I:** **15L**

Protein Structure Predictions

Experimental methods of structure determination: Fundamentals of X-ray diffraction, NMR spectroscopy and Cryo- electron microscopy.

Computational methods of protein tertiary structure prediction methods: Homology Modeling, Fold Recognition, Ab-intio method.

Motif and Domain: Motif databases and analysis tools; Domain databases and analysis tools; HMM (Hidden Markov Model): Introduction to HMM, its application in Sequence alignment and HMM based Softwares; Role of neural network in structure prediction.

**Module II:** **15L**

Drug Designing

Basis of drug action: How drugs work - Pharmacokinetics (ADME) and pharmacodynamics basis of drug action. New drug discovery process - Target identification and validation, lead identification and optimization. Pre-clinical and clinical testing of new drugs

**Module III:** **15L**

Drug Design approaches:- Structure based drug design: Prediction and validation of 3D structure of proteins using homology modeling for docking. Basis of Docking (pose prediction and scoring algorithms) and its application in lead identification and optimization, De Novo Drug Design (Fragment Placements, Connection Methods, Sequential Grow), Virtual screening strategies for lead identification. Ligand based drug design - Pharmacophore generation (3D database searching, conformation searches, deriving and using 3D Pharmacophore, constrained systematic search, Genetic Algorithm, clique detection techniques, maximum likelihood method) and application for virtual screening. Introduction to QSAR, descriptors used in QSAR study, model building (regression Analysis, Partial

Least Squares (PLS), Principle Components Analysis (PCA)), model validation methods and applications of QSAR.

**Module IV:** **15L**

System Biology

Introduction & Biological Networks: Systems Biology: Emergent property, Applications in health and diseases. Microarrays and its applications in systems biology. Connectivity maps (CMap) and Library of Integrated Network-based Cellular Signatures (LINCS) -definition and its uses. Biological Networks: Degree distribution, Clustering coefficient, Random networks, Scale-free networks, small-world effect.

Databases and softwares for Systems Biology: Introduction- databases: KEGG, EMP, MetaCyc. Expression databases and other databases related to systems biology. Cytoscape, visANT & CellDesigner.

Simulation of pathways: Metabolic network, Metabolic reconstruction, Flux Balance Analysis (FBA): Translating biochemical networks into linear algebra, Stoichiometric matrix, Elementary mode, Extreme pathways, Objective function, Optimization using linear programming. Genome-scale cellular models: Virtual Erythrocytes, Global human metabolic model (Recon 3D).

**Recommended Books:**

1. Mount. (2005) Bioinformatics - Sequence and Genome analysis. Cold Spring Harbor Laboratory Press.
2. Gupta and Prakash, S. (2013) QSAR and Molecular modelling Springer, I edition.
3. Leach, A. R. (2013) Molecular modelling: Principles and Applications, 2nd ed.
4. . Christopher J. Cramer (2004) Essentials of Computational Chemistry2nd Ed. Wiley.
5. Ramachandran, K. I. Deepa,G. and Namboori, K (2008) Computational Chemistry and Molecular Modelling: Principles and Application, Springer.
6. Schlick,T. (2010) Molecular modelling and simulations: An interdisciplinary guide. Springer
7. Bajorath JB (2004) "Chemoinformatics-Concepts, Methods, and Tools for Drug Discovery", Springer
8. Vogel H (2007) "Drug Discovery and Evaluation: Pharmacological Assays", Springer
9. Czechtizky W and Hamley P (2016) "Small Molecule Medicinal Chemistry: Strategies and Technologies", John Wiley & Sons
10. Introduction to Systems Biology: Design Principles of Biological Circuits by Uri Alon, Chapman & Hall/CRC, 2007.
11. Synthetic Biology: A Primer by P.S. Freemont & R.I. Kitney, Imperial College Press, 2012. Introduction to Systems Biology, S. Choi, Humana Press, 2007.
12. Linked – The New Science of Networks, Albert-László Barabási, Perseus Publishing, 2002.
13. Computational Drug Design: A Guide for Computational and Medicinal Chemists, by David C. Young, Wiley, 2009.
14. Computational Medicinal Chemistry for Drug Discovery, edited by Patrick Bultinck., Hans De Winter, Wilfried Langenaeker, Jan P. Tollenare, CRC press, 2003

| PROGRAM OUTCOMES 2023-24<br>**Name of the Program: Molecular Biology and Genetic Engineering** | |
|---|---|
| **No. of Courses: 29 (T-21, P-8= 29)** | |
| **PO1** | After successful completion the student will acquire in depth perceptive and will be able to critically evaluate, analyze and apply the basic and advanced concepts of molecular biology as well as genetic engineering pertaining to both prokaryotic and eukaryotic life. Develop out of the box thinking on emerging molecular biology knowledge base coupled with the genetic engineering technologies for environmental remediation, diagnosis of simple and complex diseases and providing treatment strategies for genetic disorders. |
| **PO2** | After successful completion the student will acquire necessary motor skills and hands on training in gene manipulation and associated technical expertise. Develop essential intellectual and technical capabilities for research design, implementation and research writing skills; acquire knowledge about product based research, IPR, biosafety and laboratory management to pursue the domain of molecular biology as well as genetic engineering at industrial and academic level. |
| **PO3** | After successful completion the student will exhibit skills that allow improvement not only at classroom discussions but also at various presentation platforms which include both oral and written assessment. |
| **PO4** | After successful completion the student will be competent to comprehend, analyze and utilize the new bioinformatics tools, analytical and reference software and database searching tools to identify, evaluate and communicate the research and innovations of the domain. |
| **PO5** | After successful completion the student will appreciate and apply the knowledge base of molecular biology and genetic engineering for a safer and cleaner environment and comprehend the impact of molecular and genetically engineered tools of sustainable improvement of the environment. |
| **PO6** | After successful completion the student will be able to assess the ethical principles involved in the research methodologies, publications and reporting of the scientific data and recognize the personal values in communicating scientific outcomes. |
| **PO7** | After successful completion the student will exhibit effective time management skills, resource management skills, organizational skills to implement the work plans within deadlines. Acquire leadership skills for the proper management and fulfillment of social and corporate responsibilities. |
| **PO8** | After successful completion the student will utilize the principles of scientific enquiry, thinking analytically, clearly and critically, while solving problems and making decisions during daily practice. Find, analyze, evaluate and apply information systematically and shall make defensible decisions. |
| **PO9** | After successful completion the student will be familiarized with the functioning of academic culture, assessing the problems to find the solutions using scientific methodologies, improvising feedback and learning skills according to the technological developments. Self-asses the ability to satisfy the need of the time. |

## PROGRAM MATRIX

## NAME OF THE PROGRAM: MOLECULAR BIOLOGY AND GENETIC ENGINEERING

### (H= High Correlation, M= Moderate Correlation and L= Low correlation)

| CO No. | Course Outcomes (COS) | Program Outcomes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Domain Specific Outcomes (PSO) | | | | | | Domain Independent (PO) | | |
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 |
| **SEMESTER- I** | | | | | | | | | | |
| **Course Name: CELL BIOLOGY (PROKARYOTES AND EUKARYOTES) (MMG1T01)** | | | | | | | | | | |
| **CO1** | Elucidate the cellular organization of the eukaryotic and prokaryotic cells | H | L | M | L | M | M | L | M | M |
| **CO2** | Explain cell cycle and signal transduction pathways | H | L | M | L | M | M | L | M | M |
| **Course Name: MOLECULAR BIOLOGY I (MMG1T02)** | | | | | | | | | | |
| **CO1** | Know the gene function, genomic organization | H | L | M | L | M | M | L | M | M |
| **CO2** | Know the process of DNA replication, transcription and translation in detail | H | L | M | L | M | M | L | M | M |
| **Course Name: GENETICS – I (Elective) (MMG1T03)** | | | | | | | | | | |
| **CO1** | Elucidate the genetic basis of inheritance and gene interaction. | H | L | M | L | M | M | L | M | M |
| **CO2** | Explain the chemical nature of the gene and importance of epigenetics. | H | L | M | L | M | M | L | M | M |
| **Course Name: INDUSTRIAL AND ENVIRONMENTAL BIOTECHNOLOGY- I (Elective) (MMG1T03)** | | | | | | | | | | |
| **CO1** | Explain the steps involved in complete Bioprocess engineering. | M | M | M | L | H | H | L | M | H |
| **CO2** | Explain how to manufacture the different cell lines and their use in biopharmaceuticals. | M | M | M | L | H | H | L | M | H |
| **CO3** | Interpret the effect of environmental pollution on climate change and biological system. | M | M | M | L | H | H | L | M | H |

| CO No. | Course Outcomes (COS) | Program Outcomes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Domain Specific Outcomes (PSO) | | | | | | Domain Independent (PO) | | |
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 |
| **Course Name: RESEARCH METHODOLOGY AND BIOSTATISTICS (MMG1T04)** | | | | | | | | | | |
| CO1 | Prepare the objectives and types of research. Apply inclusion, exclusion criteria and blinded trials with respect to clinical trial. | L | M | H | M | L | H | M | H | H |
| CO2 | Prepare the components of thesis writing. Distinguish between thesis components and journal components. | L | M | H | M | L | H | M | H | H |
| CO3 | Apply the methods of sampling, diagrammatic and graphical representation of data for analyzing the data. | L | M | H | M | L | H | M | H | H |
| CO4 | Use the measure of central tendency, deviation, correlation and regression for analysing and to inferring data. Illustrate on probability and theoretical distribution of data and also outline the hypothesis testing. | L | M | H | M | L | H | M | H | H |
| **Course Name: PRACTICAL 1 (MMG1P01)** | | | | | | | | | | |
| CO1 | Sterilize microbial growth media, culture the bacteria and measure their growth, stain them and identify them microscopically. | H | L | L | L | M | H | L | H | H |
| CO2 | Perform various immunotechniques use for research and pathology. | H | L | L | L | M | H | L | H | H |
| CO3 | Isolate DNA, RNA and check their purity. | H | L | L | L | M | H | L | H | H |
| **Course Name: PRACTICAL 2 (MMG1P02)** | | | | | | | | | | |
| CO1 | Solve the problems related to basic Mendelian genetics, Non Mendelian genetics and population genetics. | H | L | L | L | H | H | H | M | H |
| CO2 | Analyze the gene expression using assays and transformations in plants and bacteria respectively. | H | L | L | L | H | H | H | M | H |
| CO3 | Isolate industrially important microbes, develop bioreactors and isolate the related material. | H | L | L | L | H | H | H | M | H |
| CO4 | Develop biofertilizers, biopesticides and perform environmental monitoring for biological and physical factors. | H | L | L | L | H | H | H | M | H |

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|---|---|---|---|---|---|---|---|---|---|---|
| | | Domain Specific Outcomes (PSO) | | | | | | Domain Independent (PO) | | |
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 |
| **SEMESTER II** | | | | | | | | | | |
| **Course Name: BIOCHEMISTRY (MMG2T01)** | | | | | | | | | | |
| CO1 | Explain the structure and function of biomolecules like carbohydrates, lipids, proteins. | H | L | L | L | M | H | L | M | H |
| CO2 | Elucidate the metabolism of carbohydrate, lipids and amino acids and vitamins. | H | L | L | L | M | H | L | M | H |
| CO3 | Interpret the importance of enzymes and its regulation. | H | L | L | L | M | H | L | M | H |
| **Course Name: MOLECULAR BIOLOGY II (MMG2T02)** | | | | | | | | | | |
| CO1 | Explain the different Recombination and horizontal gene transfer methods. | H | L | M | L | M | H | L | H | H |
| CO2 | Know the DNA damage repair mechanisms. | H | L | M | L | M | H | L | H | H |
| CO3 | Explain the gene expression regulation mechanism. | H | L | M | L | M | H | L | H | H |
| CO4 | Explain Molecular genetics in Humans | H | L | M | L | M | H | L | H | H |
| **Course Name: GENETICS II (Elective) (MMG2T03)** | | | | | | | | | | |
| CO1 | Elucidate the Importance of Population, Evolutionary, Developmental and behavioral genetics. | H | L | M | L | M | M | L | M | M |
| CO2 | Learn the concept of Plant breeding, Eugenetics and chromosome mapping in humans. | H | L | M | L | M | M | L | M | M |

| CO No. | Course Outcomes (COS) | Program Outcomes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Domain Specific Outcomes (PSO) | | | | | | Domain Independent (PO) | | |
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 |
| **Course Name: INDUSTRIAL & ENVIRONMENTAL BIOTECHNOLOGY II (Elective) (MMG2T03)** | | | | | | | | | | |
| CO1 | Explain about different types of Bioreactors and their control of bioprocess parameters. | M | M | M | L | H | H | M | H | H |
| CO2 | Explain about the different steps involved in development of Bioprocess. | M | M | M | L | H | H | M | H | H |
| CO3 | Explain about different Downstream processing steps required for final protein product formation. | M | M | M | L | H | H | M | H | H |
| CO4 | Explain about the Industrial scale production of different type of chemicals and their modifications. | M | M | M | L | H | H | M | H | H |
| **Course Name: PRACTICAL 3 (MMG2P02)** | | | | | | | | | | |
| CO1 | Estimate protein, carbohydrate, lipid content in the sample using biochemical methods and perform experimentations related to enzymology. | H | L | M | L | M | H | L | L | M |
| CO2 | Learn to file patent, develop entrepreneurship or startup idea, and understand the process of biosafety assessment of GMOs in India. | M | H | H | M | M | H | H | M | H |
| CO3 | Search various databases related to Nucleic acid and protein according to the need of analysis, Analyze sequences, align sequences and generate phylogenic tree. | M | M | H | H | L | H | H | M | H |
| CO4 | Perform spectrometric, chromatographic and microscopic techniques. | M | L | M | L | H | H | H | M | H |
| **Course Name: PRACTICAL 4 (MMG2P03)** | | | | | | | | | | |
| CO1 | Perform Micropropagation, haploid production and various plant tissue culture methods | H | L | M | L | M | H | M | H | M |
| CO2 | Prepare media for animal cell culture, culturing cells and checking viability | H | L | M | L | M | H | M | H | M |
| CO3 | Performing in vitro recombination using bacterial DNA. | H | L | M | L | M | H | M | H | M |

| CO No. | Course Outcomes (COS) | Program Outcomes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Domain Specific Outcomes (PSO) | | | | | | Domain Independent (PO) | | |
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 |
| **SEMESTER III** | | | | | | | | | | |
| **Course Name: GENETIC ENGINEERING AND NANOTECHNOLOGY (MMG3T01)** | | | | | | | | | | |
| CO1 | Explain the importance of different Molecular tools used in Genetic Engineering. | M | L | L | L | H | H | H | H | H |
| CO2 | Explain the importance of DNA, RNA and protein synthesis along with the hybridization and sequencing methods. | M | L | L | L | H | H | H | H | H |
| CO3 | Explain the characterization of nanomaterials and applications of Nanotechnology. | M | L | L | L | H | H | H | H | H |
| CO4 | Explain the Bioethics relevant to Indian context. | M | L | L | L | H | H | H | H | H |
| **Course Name: BIOINFORMATICS AND BIOPHYSICAL TECHNIQUES (MMG3T02)** | | | | | | | | | | |
| CO1 | Explain the importance of bioinformatics databases, tools and resources. | M | L | L | H | H | H | L | L | H |
| CO2 | Explain the use of Bioinformatics to analyses the biological data. | M | L | L | H | H | H | L | L | H |
| CO3 | Explain the use and applications of Microscopy and spectrometry techniques. | M | L | L | H | H | H | L | L | H |
| CO4 | Explain the applications of Biophysical techniques in industries and research laboratories | M | L | L | H | H | H | L | L | H |
| **Course Name: PLANT AND ANIMAL TISSUE CULTURE (MMG3T03)** | | | | | | | | | | |
| CO1 | Learn the basic plant tissue culture techniques from different sources. | M | L | L | L | H | H | H | H | M |
| CO2 | Learn the concept of Transgenic plants production. | M | L | L | L | H | H | H | H | M |
| CO3 | Explain the Animal tissue culture, its advanced culture techniques and applications. | M | L | L | L | H | H | H | H | M |
| CO4 | Explain the applications of Animal Biotechnology. | M | L | L | L | H | H | H | H | M |

| CO No. | Course Outcomes (COS) | Program Outcomes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Domain Specific Outcomes (PSO) | | | | | | Domain Independent (PO) | | |
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 |
| **Course Name: MOLECULAR DIAGNOSTICS – I (Elective) (MMG3T04)** | | | | | | | | | | |
| CO1 | Explain about different gene and signal amplification techniques. | H | M | M | M | H | H | M | M | H |
| CO2 | Explain the basic and advanced nucleic acid sequencing methods. | H | M | M | M | H | H | M | M | H |
| CO3 | Explain about the molecular diagnostics methods and their use in different disease conditions. | H | M | M | M | H | H | M | M | H |
| CO4 | Explain about the different models used in molecular diagnosis. | H | M | M | M | H | H | M | M | H |
| **Course Name: PLANT GENETIC ENGINEERING I (Elective) (MMG3T04)** | | | | | | | | | | |
| CO1 | Elucidate techniques of plant breeding, Suspension culture, Haploid plant production, Protoplast culture and other plant tissue culture techniques. | H | L | L | M | H | H | M | M | H |
| CO2 | Explain the different Plant transformation technology and its applications. | H | L | L | M | H | H | M | M | H |
| CO3 | Interpret the Molecular marker aided breeding, metabolic engineering and industrial production. | H | L | L | M | H | H | M | M | H |
| CO4 | Elucidate techniques of plant breeding, Suspension culture, Haploid plant production, Protoplast culture and other plant tissue culture techniques. | H | L | L | M | H | H | M | M | H |
| **Course Name: BIOINFORMATICS - I (Elective) (MMG3T04)** | | | | | | | | | | |
| CO1 | Explain types of data available from the most common sequence and structure databases. | L | L | M | H | L | H | L | H | H |
| CO2 | Explain the theories underlying sequence searches and alignment; | L | L | M | H | L | H | L | H | H |
| CO3 | Demonstrate the different approaches of creating phylogenetic trees and evaluating them. | L | L | M | H | L | H | L | H | H |
| CO4 | Analyze the nucleotide sequence and structure with various bioinformatics tools | L | L | M | H | L | H | L | H | H |

| CO No. | Course Outcomes (COS) | Program Outcomes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Domain Specific Outcomes (PSO) | | | | | | Domain Independent (PO) | | |
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 |
| **Course Name: PRACTICAL 5- MOLECULAR DIAGNOSTICS (MMG3P01)** | | | | | | | | | | |
| CO1 | Amplify, isolate and identify specific gene and proteins related to specific disease. | H | L | L | M | L | H | H | M | H |
| CO2 | Perform bioethical survey and analyze the data for output. | H | L | L | M | L | H | H | M | H |
| CO3 | Analyzing immunohistographs using software and analysis done using cancer database for prognosis and survival. | H | L | L | H | L | H | H | M | H |
| **Course Name: PRACTICAL 5- PLANT GENETIC ENGINEERING (MMG3P01)** | | | | | | | | | | |
| CO1 | Perform Micropropagation, haploid production of Plants | M | L | L | L | H | H | L | L | M |
| CO2 | Isolate, quantitatively and qualitatively analyze plant DNA | M | L | L | L | H | H | L | L | M |
| CO3 | Perform various plant tissue culture methods and their callus induction | M | L | L | L | H | H | L | L | M |
| CO4 | Transgene formation using genetic engineering | M | L | L | L | H | H | L | L | M |
| **Course Name: PRACTICAL 5- BIOINFORMATICS (MMG3P01)** | | | | | | | | | | |
| CO1 | Use various tools related to Genomics and proteomics | M | L | L | H | L | H | L | H | H |
| CO2 | Search various databases related to Nucleic acid and protein according to the need of analysis | M | L | L | H | L | H | L | H | H |
| CO3 | Analyze sequences, align sequences and generate phylogenic tree | M | L | L | H | L | H | L | H | H |

| CO No. | Course Outcomes (COS) | Program Outcomes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Domain Specific Outcomes (PSO) | | | | | | Domain Independent (PO) | | |
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 |
| **SEMESTER IV** | | | | | | | | | | |
| **Course Name: RECOMBINANT DNA TECHNOLOGY (MMG4T01)** | | | | | | | | | | |
| CO1 | Learn about the recombinant DNA technology and its use in DNA modification and gene cloning | M | L | L | L | H | H | L | H | H |
| CO2 | Learn different techniques used for RDT | M | L | L | L | H | H | L | H | H |
| CO3 | Perform in vitro recombination using bacterial DNA | M | L | L | L | H | H | L | H | H |
| **Course Name: IMMUNOLOGY (MMG4T02)** | | | | | | | | | | |
| CO1 | Learn to differentiate between innate and adaptive immune system | H | L | L | L | M | H | L | M | H |
| CO2 | Understand the immunological response. | H | L | L | L | M | H | L | M | H |
| CO3 | Learn about the immune system, antigen representation and immune cell activation | H | L | L | L | M | H | L | M | H |
| CO4 | Explain various immunological techniques | H | L | L | L | M | H | L | M | H |
| **Course Name: IPR, ENTERPRENEURSHIP, BIOSAFETY, QA AND QC (MMG4T03)** | | | | | | | | | | |
| CO1 | Understand the basics of patent application filing and the applications of IPR in India and abroad and learn to file the patent application. | L | H | H | M | M | L | H | M | M |
| CO2 | Understand the issues and concerns related to biotechnological inventions for filing patents | L | H | H | M | M | L | H | M | M |
| CO3 | Get motivated for entrepreneurship development. | L | H | H | M | M | L | H | M | M |
| CO4 | Understand the procedure for biosafety and QA QC rules | L | H | H | M | M | L | H | M | M |

| CO No. | Course Outcomes (COS) | Program Outcomes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Domain Specific Outcomes (PSO) | | | | | | Domain Independent (PO) | | |
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 |
| **Course Name: MOLECULAR DIAGNOSTICS - II (Elective) (MMG4T04)** | | | | | | | | | | |
| CO1 | Understand the biology of the diseases- infection caused by bacteria, virus, fungi, protozoa etc. | H | M | M | M | H | H | M | M | H |
| CO2 | Understand different genetic disorders and its diagnosis. | H | M | M | M | H | H | M | M | H |
| CO3 | Understand different metabolic disorders and its diagnosis. | H | M | M | M | H | H | M | M | H |
| CO4 | Understand different Plant diseases, its diagnosis and methods to control the diseases caused by different pathogens. | H | M | M | M | H | H | M | M | H |
| **Course Name: PLANT GENETIC ENGINEERING II (Elective) (MMG4T04)** | | | | | | | | | | |
| CO1 | Elucidate gene Cloning, Somatic Embryogenesis and in vitro Pollination and fertilization. | H | L | L | M | H | H | M | M | H |
| CO2 | Interpret the Genetic resources, germplasm conservation and production of secondary metabolites through cell culture technique and the genetic engineering for crop improvement | H | L | L | M | H | H | M | M | H |
| **Course Name: BIOINFORMATICS - II (Elective) (MMG4T04)** | | | | | | | | | | |
| CO1 | Explain basic principle of experimental methods for determination of macromolecule structure and use of different type of protein prediction tools. | L | L | M | H | L | H | L | H | H |
| CO2 | Explain how drug works | L | L | M | H | L | H | L | H | H |
| CO3 | Understand the different drug designing approaches. | L | L | M | H | L | H | L | H | H |
| CO4 | Explain Biological networks and software's for their analysis. | L | L | M | H | L | H | L | H | H |