COURSES OF STUDIES

M.Sc. in Biotechnology

(2022-2024)

FAKIR MOHAN UNIVERSITY

Vyasa Vihar, Balasore-756089, Odisha

M.Sc. Biotechnology (Course Structure)

Semester-I	Core Papers Name	Mark (Internal + End Term)	Credit
Core Papers:			
Paper-BT-411	Cell Biology	**40 +60**	**04**
Paper-BT -412	Microbiology	**40 +60**	**04**
Paper- BT -413	Biomolecules and Enzymology	**40 +60**	**04**
Paper- BT -414	Biostatistics and Bioinformatics	**40 +60**	**04**
Paper- BT -415	Practical	**100**	**08**
Semester-II			
Paper- BT -421	Genetics and Molecular Biology	**40 +60**	**04**
Paper- BT -422	Immunology	**40 +60**	**04**
Paper- BT -423	Bioprocess Engineering and Technology	**40 +60**	**04**
Paper- BT -424	Biotechniques and Instrumentation	**40 +60**	**04**
Paper- BT -425	Practical	**100**	**08**
Semester-III			
Paper BT -531	Animal Biotechnology	**40 +60**	**04**
Paper- BT -532	Genetic Engineering	**40 +60**	**04**
Paper- BT -533	Plant Biotechnology	**40 +60**	**04**
Paper- BT -534	CBCS (Fundamentals of Biotechnology)	**40 +60**	**04**
Paper- BT -535	Practical	**100**	**08**
**********	Fakir Mohan Studies		**Non-Credit Course**
Semester-IV			
Paper- BT -541	Research Methodology, Scientific Communication Skills and Journal Paper Presentation	**200**	**08**
Paper- BT -542	Project Dissertation, Presentation and Grand Viva	**300**	**16**
	Grand Total	**2000**	**96**

***** At the beginning of the Third semester, the student will select a topic for project work in consultation with teacher assigned to him/her by the Department. The Dissertation work (Field work/Experiment work /Review work) be initiated at the beginning of Semester III. The student will compile the findings in the form of a project report which will be submitted to the Department during the 4th Semester Examination.

* The student will learn basic research methodology and scientific communication skills from the concern supervisor assigned for project dissertation work during 4th semester. Also, the student will choose and present a research paper.

Note: The underlined portions in the detailed syllabus of each paper are to be self-studied by the students.

MARKING/ EVALUATION PATTERN

During the 2022-24 admission sessions, Post-Graduate degrees offered by the University will follow a continuous evaluation system as per the marks distribution mentioned below.

<table>
<tr><th></th><th>Theory papers</th><th>Practical Papers</th><th>Journal Paper Presentation (in 4th Sem)</th><th>Dissertation Work (in 4th Sem)</th></tr>
<tr><td>Total marks per paper</td><td>100 Marks</td><td>100 Marks</td><td>200 Marks</td><td>300 Marks</td></tr>
<tr><td>Credit per paper</td><td>4</td><td>8</td><td>08</td><td>16</td></tr>
<tr><td rowspan="3">Internal Examination</td><td>Best of the two quizzes 10 Marks</td><td rowspan="3">---</td><td rowspan="3">---</td><td rowspan="3">---</td></tr>
<tr><td>Written (Mid Sem) 20 Marks</td></tr>
<tr><td>Presentation and Home Assignment 10 Marks</td></tr>
<tr><td rowspan="3">End Term Examination</td><td rowspan="3">60 Marks</td><td>Experiment 80 Marks</td><td>Quality of the research paper presented; understanding of objective, methodology and research outcome of the Journal paper: 100 Marks</td><td>Rationale and quality of project work: 150 Marks (based on the presentation)</td></tr>
<tr><td>Practical Record 10 Marks</td><td>Quality of presentation and communication skills: 50 Marks (based on the presentation)</td><td>Dissertation Report 100 Marks</td></tr>
<tr><td>Viva-Voce 10 Marks</td><td>Viva-Voce pertaining to research methodology, ethics and scientific communication: 50 Marks</td><td>Viva-Voce 50 Marks</td></tr>
<tr><td>Total no of papers in all semesters</td><td>12</td><td>3</td><td>1</td><td>1</td></tr>
<tr><td>Total marks</td><td>1200 Marks</td><td>300 Marks</td><td>200 Marks</td><td>300 Marks</td></tr>
<tr><td>Grand Total</td><td colspan="4">2000 Marks</td></tr>
<tr><td>Total Credits</td><td colspan="4">96</td></tr>
</table>

Scheme of Internal Evaluation (Theory):

Each theory paper consists of five units and irrespective of the credit hours assigned, will be of 100 marks, out of which, 40 will be internal marks (continuous evaluation) and 60 will be end term examination marks. There will be three components of internal evaluation – Quiz, Mid Term Written Test and Presentation & Home Assignment as per the details below:

<table>
<tr><th>Component</th><th>Unit(s)</th><th>Marks</th><th>Remarks</th></tr>
<tr><td>Quiz – I</td><td>I</td><td rowspan="2">10</td><td rowspan="2">Best of the two quizzes of 10 marks each will be considered</td></tr>
<tr><td>Quiz – II</td><td>II</td></tr>
<tr><td>Mid Term (Written)</td><td>III & IV</td><td>20</td><td rowspan="3">Students are required to make presentations and home assignments on selected topics preferably from the self-study section</td></tr>
<tr><td>Presentation & Home Assignment</td><td>All</td><td>10</td></tr>
<tr><td>Total</td><td>I – V</td><td>40</td><td></td></tr>
</table>

VALUE-ADDED/ ADD-ON COURSES

A student of M. Sc. in Biotechnology shall undertake one or more value-added courses of 2 – 4 credits each offered by the University and an online course of up to 4 credits under the MOOC

platform, preferably during the 2nd/ 3rd semester, the performance of which may be reflected in the final grade sheet issued by the University or in a separate report card issued for the purpose by the competent authority. Fees towards enrollment and examination of such courses have to be borne by the concerned candidate.

Guideline for Credit Transfer under Massive Open Online Courses Platform

Reference: Gazette of India (Extraordinary) Part-III, Section-4 No. 295, UGC (Credit Framework for Online Learning Courses through SWAYAM) Regulation, 2016, dated 19/07/2016.

Following modalities have been approved "to introduce the credit transfer policy in academic curriculum for the Massive Open Online Courses (MOOC's) offered through SWAYAM (Study Webs of Active-Learning for Young Aspiring Minds) Portal".

1. Students of M.Sc. Biotechnology programme are allowed to opt for credit transfer against the online course completed under SWAYAM platform during any semester of the programme enrolled except the last semester. The transferred credit against the online course completed will be in addition to the regular credits that are offered at the University/Department in physical mode.
2. Opting an online course under SWAYAM is purely optional depending on the necessity of an individual student and the programme in which he/she is enrolled. It must be noted that, online courses through SWAYAM should not be more than 20% of total courses offered in a particular semester of a programme.
3. The SWAYAM platform generally notify the list of the online learning Courses going to be offered in the forthcoming Semester during June and November every year, on its website https://swayam.gov.in.
4. After notification by SWAYAM, the students interested to register for few courses under SWAYAM platform offered by other reputed Universities should normally apply in advance (before commencement of the course) to the respective Head of the Department. Keeping in view of the academic requirements of the Degree, the Board of studies of the subject/Teachers council of the Dept. shall permit for credit transfer of the online course. While permitting the same the body must keep in view the following points: a) There is non-availability of similar course in the Department due to lack of suitable teaching staff b) The facilities for offering the elective papers (courses), sought for by the students are not on offer/scheme in the Institution, but are available on the SWAYAM platform. c) The courses offered on SWAYAM would supplement the teaching-learning process in the Institution. d) Online courses through SWAYAM should not be more than 20% of total courses offered in a particular semester of a programme.
5. It is the responsibility of the student attend the online course with own arrangement and he/she must fulfil all requirements of the online course to get the course completion certificate. The registration/examination fee of the course is to be borne by the student. After obtaining the certificate, the student must submit a verifiable copy of the certificate to concerned Head of the Department with an application requesting to transfer the credit.
6. Credit transfer applications received before examination form fill up of a particular semester will be verified at the Dept and the Head of the Dept/Coordinator will recommend to incorporate the transferred credit in the mark sheet issued to the student by Controller of Examination.

SELF SYUDY

25% of each unit of a theory paper is earmarked for self-study by students as per UGC directives. For completion of the portion in a particular semester, the course teacher is required to take one/ two introductory classes in the beginning, one/ two summarizing classes at the end and few doubt clearing classes in between, if required. Students are required to make presentation on selected topics from the self-study section during the class in order to assess their understanding of the subject and take remedial measures, if needed. The portion earmarked for self-study has been underlined in the syllabus.

REGULATION OF GENERAL ACADEMIC MATTERS

1. CREDIT HOURS

One credit shall signify the quantum of teaching imparted corresponding to one hour of theory class and one and half hours Laboratory/ Seminar/ Project work per week during a semester in respect of a particular course. For field study outside headquarters, one working day will be considered as three teaching hours. However, the field study should not exceed 15 days (including Sundays) in one semester. The minimum classes for different Credit Courses (theory) in each semester shall be as follows:

1- One Credit hour courses = 12 classes minimum
2- Two Credit hour courses = 24 classes minimum
3- Three Credit hour courses = 36 classes minimum
4- Four Credit hour courses = 48 classes minimum

The minimum credit hour requirement for the Master Degree shall be 96 (Ninety Six) credits and the residence required for Master Degree shall be continuous four semesters from the first date of registration and **the maximum time allowed to complete the Master Degree shall be 8 (Eight) semesters**.

2. CHOICE BASED PAPER,

The paper **BT- 534: Fundamentals of Biotechnology** offered by our Department which is to be opted by the students of other Departments/programme during third semester of the programme is a *Choice Based* Paper.

3. FAKIR MOHAN STUDIES PAPER

In the third semester of the programme, there will be a non-credit paper entitled "Fakir Mohan Studies" in which the performance of the students will be evaluated in terms of grade (Grade A= 70 % or more; B= 50 % or more but less than 70 %; C= 30 % or more but less than 50 %).

4. GRADE

The grade awarded to a student in any particular course shall be based on his/ her performance in all the tests conducted during a semester and shall be awarded at the end of the semester. The grade in each course is expressed in a numerical value in 10.00 scale. The marks of a student shall be converted to 10.00 point scale and the point scored thereby shall be called the 'grade point' in that course. Respective 'Grade Point Average' (GPA) and 'Overall Grade Point Average' (OGPA) shall be awarded at the end of each semester and all semester respectively. In order to pass in a semester examination **in P.G. Course** a candidate must secure a minimum 4.0 GPA (in aggregate for all theory papers) with a minimum of 3.00 GP in individual Theory (**Internal and Semester Examination combined, not separately)** and 4.0 GP in Practical. **In P.G. Courses, no separate pass mark for Internal Examination, but appearing in the Internal Examination is mandatory.**

If any student fails to appear the Internal Examination due to some valid reason or secures poor mark, he/she may apply to HOD for a Second Internal Examination who may allow this with approval of the Teachers' Council and this Examination would be open to all the students. The best mark secured by the student out of two Internal Examinations should be credited to the student and this should be forwarded by HOD to the Controller of Examinations. In all cases, the Internal Examinations should be completed well before the commencement of Semester Examination of the concerned Semester. Once the marks of a particular Internal Examination is forwarded by HOD to Controller of Examinations, it is final forever. Under no circumstances Internal Examination is permitted after the commencement of

Semester Examination of a particular Semester.

If a student fails in any paper in the Semester Examination, then he/she has to clear that paper by appearing the Semester Examination, not the Internal Examination, of that particular paper when University will conduct the said Examination in the next Academic Session in its due time. Under no circumstances any Special Examination will be held for any student after publication of the results of a particular Semester.

A student who seeks re-addition of his/her grade in a paper shall be allowed to do so by submitting an application to the controller of examinations along with a prescribed fee within 21 days of publication of said results. All such cases/complaints if any shall be disposed of by the Examination Committee within 21 days of last date of application and necessary corrections if any shall be reflected in the grade sheet.

The candidates shall have to appear in all the units (internal as well as end term examination) of a semester examination to be eligible to be declared pass provided he /she secures minimum pass grade. Provisional certificates will be issued only after passing all the four semester examinations.

4.1 GRADE POINT AVERAGE (G.P.A.)

Grade Point Average (GPA) of a semester shall be calculated as:

$$\text{GPA} = \frac{\sum[(\text{Credit in each course}) \times (\text{Grade point in that course})]}{\text{Total no. of Credits in that semester}}$$

Where, the summation is taken over all courses in a given semester. GPA shall be rounded up to 2 decimal points.

Example: In a semester, a candidate secured following Grade Points in five papers.

Paper Code	Credit hour	Maximum Marks	Mark Secured	Grade point
411	4	50	37	7.4
412	4	50	42	8.4
413	4	50	35	7.0
414	4	50	24	4.8
415	8	100	73	7.3

4.2 OVERALL GRADE POINT AVERAGE (O.G.P.A.)

It is the average of accumulated Grade Points of a student, worked out by dividing the cumulative total of Grade Points by the cumulative total of Credit Hours of the entire course covered and completed by a student during all the semesters. For the first semester of the programme the GPA and OGPA shall be the same.

$$\text{OGPA} = \frac{\sum[(\text{GPA of each semester}) \times (\text{Total Credits in that semester})]}{\text{Total no. of Credits of all the semesters}}$$

Where, the summation is taken over all semesters in a given programme. OGPA shall be rounded up to 2 decimal points. For merit lists in case of equality, the OGPA shall be calculated beyond two decimal places if necessary.

Example: A candidate secured following GPAs in four semesters

Semester	CH	GPA
First	24	7.49
Second	24	8.30
Third	24	7.85
Fourth	24	8.8

$$\text{GPA} = \frac{(24 \times 7.49) + (24 \times 8.30) + (24 \times 7.85) + (24 \times 8.8)}{96} = 8.11$$

4.3. CONVERSION OF GRADES TO MARKS AND CLASSIFICATION OF RESULTS UNDER COURSE CREDIT SYSTEM

The OGPA can be converted to percentage of marks in the following manner.

Percentage of Marks = OGPA × 10

A student after successful completion of all the semesters, Degree shall be awarded in the following manner.

OGPA	≥6.0	FIRST CLASS
OGPA	≥5.0 < 6.0	SECOND CLASS
OGPA	≥4.0 < 5.0	THIRD DIVISION
OGPA	<4.0	FAIL

5. REQUIREMENT FOR ATTENDENCE

A candidate shall be required to attend 75 % of lectures and practical classes during a semester. Condonation may be granted by the Teachers' Council only to the extent of 15 % in exceptional cases (Illness, accident, mishap in the family, deputation by University/Dept.). When a candidate has been deputed by the University to represent the University/ State for any activity, the lectures delivered during his/her absence for the purpose shall not be counted towards the calculation of attendance provided the student submits a certificate to that effect from the appropriate authority.

If a student is not allowed to fill up the examination form due to lack of attendance for a particular semester or he/she was not able to fill up the said form due to any other reasons then **it will be considered as discontinuance of course.** He/she has to take readmission in the same semester by depositing the requisite semester fee. He/she will study as per the current syllabus and should complete the course within **the maximum time allowed time of 8 (Eight) semesters from the date of first admission**. Discontinuous candidates shall not be considered in the merit list

6. FILLED UP THE FORM BUT ABSENT IN THE EXAMINATION

If a student has filled up the examination form and is unable to appear a semester examination in some or all papers the Academic Committee of the Department shall consider his/her case for admission into the next higher semester only in the following case.

(a) When he/she is hospitalized.

(b) When he/she is not able to appear in the examination due to serious illness or death of parents, brothers, sisters, spouse or children,

(c) When he/she is met an accident of serious nature;

(d) When the Department /University or any official directive deputes him.

(e) When he/she or his/her parents, brothers, sisters, spouse or children faces any natural calamity

A student failing to appear semester examination in some or all papers due to some valid reasons as mentioned above may be admitted to the next semester. Such a student shall produce sufficient proof in favour of his/her reason for not being able to appear in some or all papers of the semester Examination. Such cases shall be considered by the Teachers' Council of the Department for giving permission for admission into next semester. Such students shall appear the repeat the Semester Examination in the next academic session.

7. PROCEDURE FOR REPEAT/IMPROVEMENT

7. 1. Repeat: A student may be allowed to repeat in any practical/theory papers in a semester, in which he /she has failed, within a period of eight semesters for P. G. Programmes from the date of first registration to the programme. Such students shall have to apply to the Head of the Department in plain paper before fifteen days of the commencement of the said examination. If allowed by the Head, he/she shall deposit the requisite fee, as notified by the Controller of Examinations, to appear the paper(s) during the conduct of the concerned examination by the University.

7.2. Improvement: After the publication of results, a student may be allowed to improve his/her performance in not more than 50 % of the theory papers in a semester, within eight

semesters from the first registration to the programme. Improvement is allowed only once for a particular semester for those papers only, in which a candidate has secured less than 50 % of marks. In such a case the highest mark secured in each paper will be considered for computing the mark.

Candidates appearing in repeat/improvement examination shall not be considered in the merit list.

8. PROMOTION TO THE NEXT SEMSTER

A student shall be admitted to the next higher semester only when he/she has appeared in all the papers of the previous semester examination. However, a student failing to appear semester examination in some or all papers due to some valid reasons may be admitted to the next semester as mentioned under section 6.

First Semester

BT-411 **CELL BIOLOGY** **4CH**

Course Objectives

The objectives of this course are to sensitize the students to the fact that as we go down the scale of magnitude from cells to organelles to molecules, the understanding of various biological processes becomes deeper and inclusive.

Unit-I: Dynamic organization of cell

Diversity of cell, sizes & shapes, Cell theory, Structure of prokaryotic and eukaryotic cells, internal organization of the cell – Cell Wall, cell membranes: structure of cell membranes and concepts related to compartmentalization in eukaryotic cells; intracellular organelles: endoplasmic reticulum and Golgi apparatus, lysosomes and peroxisomes, ribosomes, cellular cytoskeleton; mitochondria, chloroplasts and Cellular energy transactions; nuclear compartment: nucleus, nucleolus and chromosomes, Cell motility – cilia, flagella of eukaryotes and prokaryotes.

Unit-II: Chromatin structure and dynamics

The structure of DNA and RNA, Organization of genes and chromosomes, Structure of eukaryotic and prokaryotic chromosome; Chromatin organization, heterochromatin, euchromatin Operon, unique and repetitive DNA, Cell cycle-molecular events and model systems, Cell cycle regulation, checkpoints in cell cycle; Mitosis & Meiosis and cytokinesis.

Unit-III: Genome instability and cell transformation

Proto-oncogenes**,** viral and cellular oncogenes, tumor suppressor genes: structure, function and mechanism of action of pRB; structure, function and mechanism of action of p53 protein; oncogenes as transcriptional activators. Apoptosis and Programmed Cell Death: Morphology of apoptotic cells, mechanism of apoptosis, Physiology of apoptotic cells, Inhibition of Apoptosis, Assays for Apoptosis.

Unit-IV: Cellular signaling, transport and trafficking

Transport of nutrients, ions and macromolecules across membranes, molecular mechanisms of membrane transport; transport across mitochondria and chloroplasts; nuclear transport; intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior, intracellular protein trafficking, Protein localization, synthesis of secretory and membrane protein, receptor mediated endocytosis.

Unit-V: Cell differentiation& Development

Stem cells, their differentiation into different cell types and organization into specialized tissues; Cellular basis of differentiation and development– gametogenesis and fertilization, Development in Drosophila and Arabidopsis.

Course outcome

At the end of this course, the students will be able to:

- ✓ Understand the Structure and function of organelles in a cell. Cellular transport and protein trafficking, Cell signaling and cancer pathways, Techniques in cell biology and its applications.
- ✓ Understand the coordination of function of different cell organelles to develop a functional cellular structure
- ✓ Understand the process of cell division and growth.
- ✓ Explain the organization and structure of cellular control System
- ✓ How different genomes are packaged and organized
- ✓ Basic of structure of RNA and DNA
- ✓ Learn the concepts of cycle regulation and able to analyze and apply its diverse roles in cancer cell research

Books

1. Cell Biology byDe-Robertis Saunders, Singapore.
2. Reproduction in eukaryotic cells, Prescott DM, AcademicPress.
3. Developmental Biology, Gilbert SF, Sinauer Assoc.Inc.
4. Cell in Development and Inheritance, Wilson EB, McMillan, NewYork.
5. Molecular Biology of Cells, Alberts B etal.
6. Molecular Cell Biology, Lodisch et al.
7. Fertilisation, Longo FT, Chapman Hall,London
8. Cell by GMCooper.

BT-412 **MICROBIOLOGY** **4 CH**

Course Objectives

The objectives of this course are to introduce field of microbiology with special emphasis on microbial diversity, morphology, physiology and nutrition; methods for control of microbes and host- microbe interactions.

Unit-I: Microbial Diversity

Introductory Microbiology: History, Microbial evolution, modern approaches in taxonomy, ribotyping, ribosomal RNA sequencing; taxonomic nomenclature and Bergey's manual role of micro-organisms; classification of microorganisms, criteria for classification; Diversity of Microorganisms: Archea, Eukarya, algae, fungi, slime molds, protozoa and mycoplasma, extremophiles and unculturable microbes.

Unit-II: Microbial Characteristics

Principles of microbial nutrition; culture media for different microorganisms, culture collection and maintenance of cultures. Microbial growth: mathematical expression ofgrowth,growthcurve,factorsaffecting growth. Metabolic diversity among micro-organisms, photosynthesis in micro-organisms, fermentations, nitrogen metabolism and nitrogen fixation, Sterilization techniques; Chemotherapy/ Antibiotics: mode of action, resistance toantibiotics, antiviral and antifungal drugs.

Unit-III: Virology

Virus and bacteriophages, general properties of viruses, RNA phages, DNA viruses, RNA viruses, viral structure, taxonomy of virus, viral replication, retro-viruses, cultivation and identification of viruses; sub-viral particles – viroids and prions. Microbial Diseases caused viruses.

Unit-IV: Host-parasite relationship

Microflora of skin, oral cavity, gastrointestinal tract: entry of pathogens into the host and genesis. Microbial Diseases caused by bacteria and pathogenic fungi, Emerging and resurgent infectious diseases. Brief introduction to the life cycle and molecular biology of some important pathogens of AIDS, Malaria, Hepatitis and Tuberculosis. Microbial communication system: bacterial quorum sensing; microbial fuel cells; prebiotics and probiotics.

Unit-V: Microbial Genetics

Mutation and mutagenesis, Amestest; Recombination in Bacteria, Methods of genetic transfers–transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, Genetic systems of yeast and Neurospora, Extra chromosomal inheritance.

Course Learning Outcomes:

The students will be able to:

- ✓ Understand the differences between prokaryotic and eukaryotic cellular organization
- ✓ Understand the differentiate between Gram +ve and Gram –ve bacteria by performing the experiment
- ✓ Explain the physiology, metabolism of bacterial growth and host-parasite relationship
- ✓ Learn the concepts of bacterial genetics and recombination and be able to Analyze and apply it for
- ✓ genetic engineering and diverse industrial applications

Books

1. General Microbiology, Stainer, R.Y., Ingraham, J.L., Wheelis, M.L., and Painter, P.R. The McMillan Press Lte.
2. Brock Biology of Microorganisms, Madigan, M.T., Martinko, J.M. and Parker, J.Prentice-Hall.
3. Microbiology, Pelczar, M.J., Jr. Chan, E.C.S., and Kreig, N.R., Tata-McGraw-Hill.
4. Microbial Genetics, Maloy, S.R., Cronan, J.E.Jr., and Friefelder, D. Jones and Bartlett Publishers.
5. Microbiology, A Laboratory Manual, Cappuccion, J.G., and Sherman, N., Addison Wesley.
6. Microbiological Applications (A Laboratory Manual in General Microbiology), Benson, H.J., W.C.B., Wim C. Brown Publishers
7. Prescott's Microbiology

BT-413 BIOMOLECULES AND ENZYMOLOGY 4CH

Course Objectives

The objectives of this course are to build the knowledge of biochemical principles with specific emphasis on different metabolic pathways.

Unit-I: Biomolecules

Carbohydrate – Classification, structure, general properties and functions of polysaccharides and complex carbohydrates; amino sugars, proteoglycans and glycoproteins. Lipids – Classification, structure, properties and functions of fatty acids, essential fatty acids, fats, phospholipids, sphingolipids, cerebrocides, steroids, bile acids, prostaglandins, lipoamino acids, lipoproteins, proteolipids, phosphatidopeptides, lipopolysaccharides. Proteins – Peptide synthesis: chemical and Merrifield synthesis. Primary (peptide conformation, N- and C- terminal, peptide cleavage), Secondary (α-helix, sheet, random coil, Ramachandran plot), Tertiary and Quaternary structures of proteins. Nucleic acids – Nucleosides and nucleotides, Structure and function of nucleotides. Primary, secondary and tertiary structure of nucleic acids.

Unit-II: Bioenergetics

Chemical foundations of Biology: Water- chemical properties, function as medium of cellular reactions and activities. pH and buffers, Solution: Methods of expressing the concentration (Molality, Molarity, Normality etc.). Bioenergetics-basic principles; equilibria and concept of free energy; ATP as energy currency, oxidation of carbon fuels; glycolysis and gluconeogenesis; Citric acid cycle; Oxidative phosphorylation.

Unit-III: Role of vitamins, cofactors& secondary metabolites in metabolism

Vitamins and Coenzymes: Structure and functions of thiamine, riboflavin, nicotinic acid, Pentathenic acid, pyridoxine, lipoic acid, Biotin, Folic acid, Ascorbic acid and Vitamin A. General characteristics and function of Plant and Animal hormones; Heterocylic compounds and secondary metabolites in living systems- pigments and isoprenoids

Unit-IV: Enzyme Kinetics

Chemical nature, Nomenclature, Classification, Mechanism of enzyme catalysis, Activation energy, Enzyme specificity, Enzyme substrate interaction, factors affecting enzyme activity, Enzyme kinetics, Michaelis – Menton's Equation, Lineweaver–Burkplot,kineticsofmulti-substratereaction,Differenttypesofenzyme inhibitions.

Unit-V: Enzyme regulation

Regulatoryenzyme,covalentmodulationandnon-covalentmodulationofregulatory enzyme, Aspartate transcarbmylase, glycogen phosphorylase, Models of enzyme catalysis, chymotrypsin, hexokinase, carbonic anhydrase, restriction enzyme, ribozymes, biochemistry of ribozyme; hammerhead, hairpin and other ribozymes, strategies for designing ribozymes, applications of ribozyme, isozymes.

Course Learning Outcomes:

The students will be able to

- ✓ Explain structure, function and metabolism of bio molecules
- ✓ Understand the concept of pH and biological buffer system
- ✓ Explain coordinate regulation of metabolic pathways
- ✓ Learn to Analyze and apply theoretical knowledge of biochemistry for designing of new biochemistry research project

Books

1. Essentials of Molecular Biology, David Friefilder, Jones and Bartlett Publications. Proteins – Structure and Molecular Properties, TE Creighton, WH Freeman and Company.
2. Genes VH, B. Lewin, Oxford UniversityPress.
3. Introduction to Protein Structure, C. Branden and J. Tooze, Garland Publishing, New York.
4. Encyclopedia of Molecular Biology, J. Kendrew, Blackwell Scientific Publications, Oxford.
5. Physical Chemistry of Macromolecules, Tanford, C., John Wiley andSons.
6. Introduction to Biophysical Chemistry, R.B. Martin, McGraw Hill, NewYork.
7. Biophysical Chemistry, Cantor, W.H.Freeman.
8. Protein Structure, MaxPeruz.

BT-414 BIOSTATISTICS AND BIOINFORMATICS 4CH

Course Objectives

The objectives of this course are to provide theory and practical experience of the use of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.

Unit-I: Basics of Biostatistics-I

Types of biological data (ordinal scale, nominal scale, continuous and discrete logical systems data), frequency distribution and graphical representations (bar graph, histogram, box plot and frequency polygon), cumulative frequency distribution, Measures of Arithmetic Mean, median, mode, range.

Unit-II: Basics of Biostatistics-II

Standard Deviation, Coefficient of Variation, Correlation, Covariance, calculation of covariance and correlation, General Concepts of regression, and Regression Coefficients, Standard error of estimate. Tests of significance (F, Z and t-test); chi-square tests, ANNOVA.

Unit-III: Computer Applications

MS-Word, MS- Excel, MS-Power Point: Creating presentations and adding effects; Web browsing for information search using Academic search Engines: PubMed, Science Direct, Google Scholar, E-journal and E-Library – Public Library of Science (PLOS), Directory of Open Access Journals, INFLIBNET.

Unit-IV: Introduction to Bio-informatics and different tools

World Wide Web, Introduction to data structures and database concepts, NCBI, PubMed, Entrez databases, UniProt, SwissProt, Data mining. Database sequence searching from Nucleotide and protein databases -Blast and different types of blast, submitting DNA sequences to databases. Fasta format for sequence alignment, Sequence analysis, pairwise alignment, Multiple sequence alignment, generating motifs and profiles, local and global alignment, Needleman and Wunsch algorithm, Smith Waterman algorithm

Unit-V: Application of Bioinformatics

Predicting phylogenetic relationships, protein structure prediction & engineering, Homology modelling and docking, Protein structure prediction. Internet tools for DNA sequence translation; Restriction enzyme mapping; primer designing, Insilco PCR, Web tools for drawing plasmid map.

Course Learning Outcomes:

The students will be able to:

- ✓ Understand the basics of Moments, Skewness and kurtosis by moments.
- ✓ Remember and understand the Probability and Probability Distribution.
- ✓ Understand the Statistical Quality Control, Correlation and regression analysis.
- ✓ Learn to understand, analyze, and apply The Testing of Hypothesis and Analysis of variance.
- ✓ Understand and remember about biological databases and its application in various sectors.
- ✓ Remember, understanding and creating sequence alignment by applying appropriate algorithms.
- ✓ Create phylogenetic trees by applying and evaluating suitable methods.
- ✓ Analyze, apply, and create protein structure and perform drug designing.

Books

1. Fundamentals of Biostatistics by Veer BalaRastogi
2. Basic Biostatistics by G B N Chainy, P. K. Mohanty and G. Mishra
3. Fundamentals of Biostatistics by Bernard Roser
4. Misra, B.N. and M.K. Misra. 1983. Introductory Practical Biostatistics
5. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Andreas D. Baxevanis, B.F. Francis Ouellette (John Wiley andSons)
6. Introduction to Bioinformatics by Arthur M.Lesk
7. Biostatistics: Basic concepts & methodology for Health Sciences, W.W.Daniel & C L Cross

BT-415 **PRACTICAL** **8CH**

(Practical pertaining to theory paper BT-411, BT-412, BT-413, BT-414)

1. Microscopy
2. Microtomy.
3. Mitosis and meiosis.
4. Preparation of liquid and solid media for the growth of micro-organisms.
5. Isolation and maintenance of organisms by plating, streaking, and serial dilution methods, slants and stab cultures, storage of microorganisms.
6. Isolation of pure cultures of bacteria from soil and water.
7. Cryopreservation and thawing.
8. Growth; growth curve, measurement of bacterial populations by turbidometry and serial dilution methods. Effects of temperature, pH, carbon and nitrogen sources on growth.
9. Measurement of doubling time.
10. Microscopic examination of bacteria, yeast and moulds and study of organisms by Gram stain, acid fast stain and staining for spores.
11. Assay of antibiotics and demonstration of antibiotic resistance.
12. Biochemical characterization of selected microbes.
13. Determination of absorption maxima of bromophenol blue, potassium dichromate solution.
14. Validation of Beer-Lambert Law.
15. Quantitative estimation of Protein, Sugars, Lipids by spectrophotometer.
16. Quantitative estimation of Amino acids.
17. Determination of activity of different enzymes.
18. Preparation of Buffers.
19. Karyotyping
20. Using NCBI and Introduction and use of various genome databases
21. Sequence information resource: using NCBI, EMBL, GenBank, Entrez, Swiss- Prot/TrEMBL, UniProt
22. Similarity search using tools like BLAST and interpretation of results
23. Multiple sequence alignment usingClustalX2
24. Phylogenetic analysis of protein and nucleotide sequences
25. Use of different protein structure prediction databases (PDB, SCOP,CATH)
26. Homology modelling of proteins
27. Demonstration of apoptosis of DNA laddering

Course Learning Outcomes:

The students will be able to:

- ✓ Understand the preparation of different concentration of solutions
- ✓ Understanding the preparation of biological buffers and identify its properties
- ✓ Explain the basic principle of spectrophotometer used to analyze the concentration of unknown solution
- ✓ Identify the unknown biomolecule by applying its properties
- ✓ Understanding the preparation of different types of media used in microbial cultivation
- ✓ Explain the basic knowledge of isolation procedure of microbes form different natural sources
- ✓ Analyzing the number of bacteria in the original solution

Second Semester

BT- 421 GENETICS & MOLECULAR BIOLOGY 4CH

Course Objectives

The objectives of this course are to take students through basics of genetics and molecular biology covering prokaryotic and higher eukaryotic domains.

Unit-I: Introduction to Genetics

An overview on Mendelian & Non-Mendelian inheritance, Linkage & crossing over, sex linked inheritance, gene mapping (in *E.Coli* &*Drosophilae*), Mutation- types and significance, Structure & numerical variation in chromosomes, meiotic behaviour and genetic consequences in structural heterozygotes, Polygenic inheritance, multiple alleles, evidences of DNA as genetic material, Gene concept, and one gene-one polypeptide hypothesis.

Unit-II: Replication

DNA polymerases, Prokaryotic and Eukaryotic DNA replication; DNA repair, Recombinase enzyme, Recombination: Homologous Recombination: Holiday Model, RecA and other recombinases, Site specific recombination: FLP / FRT and Cre/Lox combination.

Unit-III: **Transcription**

Prokaryotic transcription, Eukaryotic transcription, RNA polymerases, General and specific transcription factors, mechanisms of transcription regulations, transcriptional and post-transcriptional modifications.

Unit-IV: **Translation**

Prokaryotic and Eukaryotic translation, the translation machinery, universal genetic codes, degeneracy of codons, Wobble hypothesis; mechanisms of initiation, elongation and termination, regulation of translation, co-and post- translational modifications of proteins.

Unit-IV: Cell Signaling

Signaling molecules and cell- surface receptors, G-protein coupled receptors, TGF-β and Smads, Cytokine receptors and JAK-STAT pathway, Receptor Tyrosine kinases and Ras, MAP kinase pathways, Toll and IMD pathway in innate immunity, Pathways that involve signal-induced protein cleavage, Phosphoinositides as signal transducers.

Course Learning Outcomes

The students will be able to understand:

- ✓ Understand the genetic basis of heredity, Mendelian and non- Mendelian modes of inheritance.
- ✓ Understand basics of cytogenetics, extra-chromosomal inheritance, linkage and cytoplasmic inheritance
- ✓ Explain the different types of sex determination system in different organisms
- ✓ Learn the concepts of gene and allele frequencies and able to analyze and apply the Hardy-Weinberg equilibrium for population genetics.
- ✓ Various Molecular Biology processes like replication, transcription, translation Control and regulation of various processes
- ✓ The process of DNA replication and repair mechanisms.
- ✓ The process of transcription, translation and post-translation.
- ✓ Regulation mechanism in various scientific fields, and creating new techniques.
- ✓ Mechanisms for isolation of DNA from different Sources

- ✓ The basis of visualization of nucleic acid by electrophoresis.
- ✓ The importance of conserved domain for evolutionary identification
- ✓ Analyze the protein structure and sequences of its gene to modify its function according to the need

BOOKS

1. Molecular Biology Lab Fax, T.A. Brown (ed), Bios Scientific Publishers Ltd., Oxford, 1991.
2. Molecular Biology of the Gene (4^{th} edition), J.D. Watson, N.H. Hopkins,J.W.Roberts,J.A.SteitzandA.M.Weiner,theBenjamin/CummingsPub.Co.Inc.,California,1987.
3. Molecular Cell Biology (2^{nd}Edition), J. Darnell, H. Lodish and D. Baltimore, Scientific American Books Inc USA1994.
4. Molecular Biology of the Cell (2^{nd} edition), B. Alberts, D. Bray, J. Lewis, M. Raff. K. Roberts, and J.D. Watson, Garland Publishing Inc., New York,1994.
5. Gene VI (6^{th} edition), Benjamin Lewin, Oxford University Press, U.K.,1988.
6. Molecular Biology and Biotechnology, A Comprehensive Desk Reference, R.A. Meyeres (ed.), VCH Publishers Inc., New York,1995.
7. Genomes, T.S. Brown.

BT- 422 IMMUNOLOGY 4CH

Course Objectives

The objectives of this course are to learn about structural features of components of immune system as well as their function. The major emphasis of this course will be on development of immune system and mechanisms by which our body elicits immune response. This will be imperative for students as it will help them to predict about nature of immune response that develops against bacterial, viral or parasitic infection.

Unit-I: Fundamental concepts and overview of the immune system

Introduction, Phylogeny of immune system, Innate and acquired immunity, Clonal nature of immune response, Organization and structure of lymphoid organs, Cells of the immune system: Hematopoiesis and differentiation, B-lymphocytes, T-lymphocytes, macrophages, dendritic cells, natural killer and lymphokine activated killer cells, eosinophil, neutrophils and mast cells.

Unit-II: Antigen-antibody interactions

Nature and biology of antigens: immunogens, haptens and super antigens. Immunoglobulins: Basic structure and function, Hybridoma technology and monoclonal antibodies, Antigen-antibody interactions, Antigen processing and presentation

Unit-III: Immunogenetics

Major histocompatibility Complex, BCR and TCR generation of diversity. Regulation of immune response, generation of humoral and cell mediated immune responses, Activation of B and T – lymphocytes, T-cell regulation, MHC restriction, Immunological tolerance.

Unit-IV: Cell mediated Immune responses

Cytokines and their role in immune regulation, Complement System, Cell-mediated cytotoxicity: Mechanism of T cell and NK cell mediated lysis, antibody-dependent cell- mediated cytotoxicity, macrophage mediated cytotoxicity, lymphocyte trafficking, Hypersensitivity.

Unit-V: Clinical immunology

Immunity to infectious agents (intracellular parasites, helminthes and viruses), Tumour immunology, AIDS and other immune-deficiencies, Vaccines, Autoimmunity, Transplantation immunology.

Course Learning Outcomes

The students will be able to:

- ✓ Understand about immune system and its types.
- ✓ Understand Cellular and molecular basis of immune system.
- ✓ Understand Antigen antibody reaction and autoimmunity
- ✓ Understand Animal models in immunology
- ✓ Understand the structure of antibody and its Functions
- ✓ Create new technologies for the production of MABs and hybridoma technology in various applications.
- ✓ Analyze, apply, and create immunological techniques for better understanding of immune disorders.

BOOKS

1. Kuby Immunology, 4th edition, R.A. Goldsby, Thomas J. Kindt, Barbara A. Osborne (Freeman).
2. Immunology, A Short Course, 4th Edition, Eli Benjamin, Rcchard Coico, Geoffrey Sunshine(Wiley-Liss).
3. Fundamentals of Immunology, William Paul.
4. Immunology by Roitt and others.

BT- 423 BIOPROCESS ENGINEERING ANDTECHNOLOGY 4CH

Course Objectives

The objectives of this course are to educate students about the fundamental concepts of bioprocess technology and its related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnology industry.

Unit-I: Bioreactor design and analysis

Introduction to bioprocess engineering, Bioreactors, Types of specialized bioreactors (CSTR, Bubble Column, Airlift, Tower, fluidized, Packed Bed, photo bioreactors etc.), Measurement and control of bioprocess parameters, stability of microbial reactors, Media for industrial fermentation, Air and media sterilization, Isolation, preservation and maintenance of industrial microorganisms, analysis of mixed microbial populations, Kinetic of microbial growth and death.

Unit-II: Fermentation processes

Analysis of batch, fed-batch and continuous bioreactions, Solid State fermentation; biotransformation; Enzymatic Bioconversion; Enzyme and whole cell immobilization and their industrial applications; large scale animal and plant cell cultivation.

Unit-III: Downstream processing and product recovery

Downstream processing: Introduction removal of microbial cells and solid matter, foam separation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, membrane process, drying and crystallization, effluent treatment: DOC and COD treatments and disposal of effluents.

Unit-IV: Industrial production of food &chemicals

Alcohol (ethanol), acids (citric, acetic and gluconic), solvents (glycerol, acetone, butanol), antibiotics (Penicillin, streptomycin, tetracycline), amino acids (lysine, glutamic acid), single cell protein, Use of microbes in mineral beneficiation and oil recovery, Introduction of food technology, Elementary idea of canning and packing, Sterilization and pasteurization of food products, Technology of typical food/food products (bread, cheese, idli), Food preservation.

Unit-V: Metabolic Engineering

Microbes for production of industrial enzymes, Biofuel, Flavanoids, biodegradable plastics; Metabolic engineering of Plant Secondary metabolites (phenyl propanoid pathway, shikimate pathway); Metabolic engineering of Animal cells for production of therapeutic proteins, antibodies and vaccines.

Course Learning Outcomes

The students will be able to understand:

- ✓ Design of Fermenter/ bioreactors
- ✓ Mass transfer, KLa concept and significance in bioprocess.
- ✓ Designing of media Sterilization and monitoring of process variables
- ✓ Strain Improvement and importance.
- ✓ Downstream processing methods
- ✓ Biological and kinetic concepts underlying bioprocesses engineering
- ✓ Explain procedures for the design and control of bioreactors the basic upstream processing principles
- ✓ Apply the bioprocess engineering in different industries for the benefit of mankind

BOOKS

1. Biochemical Engineering, Aiba, S., Humphrey, A.E. and Millis, N.F., University of Tokyo Press, Tokyo.
2. Biochemical Engineering Fundamentals, Baily, J.E. and Ollis, D.F., McGraw-Hill Book Co., New York.
3. Bioprocess Technology: Fundamentals and Applications, KTH, Stockholm.
4. Bioprocess Engineering: Basic Concepts, Shuler, M.L., and Kargi, F., Prentice Hall, Englewood Cliffs.
5. Principles of Fermentation Technology, Stanbury, P.F., Whitaker, A., Pergamon Press, Oxford.
6. Bioreaction Engineering Principles, Nielson, J. and Villadsen, J., Plenum Press.
7. Biochemical Engineering, Lee, J.M., Prentice Hall Inc.
8. Modern Industrial Microbiology and Biotechnology, Okafor, N, Science Publishers, New Hampshire 03748, USA.
9. Metabolic Engineering: Principles and Methodologies, Stephanopoulos, G.N; Aristidou, A.A and Nielsen, N., Academic Press

BT-424 BIOTECHNIQUES&INSTUMENTATION 4CH

Course Objectives

This course is broad-based in nature encompassing several new technologies that current experimental researchers are employing to probe complex system biology questions in life-sciences. The objectives of this course are to teach basics of the new principles to students so as to appreciate current-day research tool-kit better.

Unit-I: Basic instrumentation

pH measurements by method of pH indicators and potentiometric methods, Centrifugation Techniques: Principle and application of High speed centrifuges, Continuous flow centrifuge, Density gradient centrifuge, Analytical ultracentrifugation, Bomb Calorimetry: Principle, experimental arrangement and its applications.

Unit-II: Microscopy

Light Microscope, lenses and microscopes, Phase Contrast, fluorescence microscopy, Confocal microscope, SEM, TEM, fluorescent in situ hybridization(FISH), biosensors, flow cytometry.

Unit-III: Spectroscopy

The principle, instrumentation and application of the ultraviolet and visible spectrometry, Fluorescence Photometry, Infra-red-spectroscopy. Atomic Absorption Spectroscopy (AAS): The principle, differences, instrumentation and application of Flame emission spectroscopy and Absorption spectroscopy, Mass spectrometry for proteins & peptide analysis. MS data with specific protein sequences.

Unit-IV: Chromatography Techniques

The principle, experimental techniques, qualitative and quantitative analysis, applications of Adsorption Chromatography, Ion exchange chromatography, Paper chromatography, Thin layer chromatography (TLC), Gas liquid chromatography (GLC), High performance liquid chromatography(HPLC), Affinity chromatography.

Unit-V: Electrophoresis & Radiology

Principle, methods of measurement and applications of paper and cellulose Acetate electrophoresis, Thin layer Electrophoresis, Polyacrylamide Gel Electrophoresis (PAGE), Two dimensional gel electrophoresis for separation of total cellular proteins, and Agarose Gel Electrophoresis; Blotting Techniques; Radioactivity and instruments for measurement of radiation such as Geiger–Müller counter & Liquid Scintillating counter.

Course Learning Outcomes:

The students will be able to:

- ✓ Understand the theory and practice of bio-analytical techniques
- ✓ Understanding the instrumentation used in Biotechnology
- ✓ Familiarity with working principals, tools and analytical techniques
- ✓ Analyze the limitations and creative use of techniques for solving of research problem
  Understanding the instrumentation used in Biotechnology
- ✓ Understand the theory and practice in Microbiology, cell culture, immunology
- ✓ Understand the theory and practice of bio-analytical techniques
- ✓ Familiarity with working principals, tools and techniques of analytical techniques
- ✓ Analyze the limitations and creative use of techniques for solving of research problem

BOOKS

1. Instrumental methods of analysis by Willard *et al*.
2. Practical Biochemistry: Principles and Techniques by Wilson and Walker
3. Principles and Techniques of Biochemistry and Molecular Biology By Wilson and Walker
4. Laboratory Manual of Biotechnology by S.K. Bhatnagar and Deepika Abrol, S.Chand &Co.

BT- 425 **Practical** **8CH**

(Practical pertaining to theory paper BT-421, BT-422, BT-423, BT-424)

1. Isolation of plant genomic DNA
2. Isolation of bacterial genomic DNA
3. Agarose Gel Electrophoresis
4. Quantitation of DNA
5. Isolation of proteins from plants/microbes
6. Separation of proteins through SDS-PAGE
7. Native PAGE
8. Chromatography (Paper/ TLC/ Column)
9. Preparation of metaphase chromosomes from cultured cells.
10. Blood film preparation and identification of cells.
11. Lymphoid organs and their microscopic organization.
12. Radial immunodiffusion
13. Purification of IgG from serum.
14. ELISA
15. Hapten conjugation and quantization.
16. Immunodiagnostics (demonstration using commercial kits).
17. Isolation of industrially important microbes
18. Scale up from frozen vial to agar plate to shake flask culture.
19. Estimation of Specific growth rate (μ) from growth curve
20. Measurement of residual substrates.
21. Estimation of BOD
22. Estimation of COD
23. Isolation of Industrial enzyme from microbes and plants.

Course Learning Outcomes

The students will be able to

- ✓ Understand and conduct different Sterilization techniques, microbial methods, Organ Culture methods, Bioprocess developments.

Third Semester

BT-531 ANIMALBIOTECHNOLOGY 4CH

Course Objectives

The objectives of this course are to introduce students to the principles, practices and application of animal biotechnology and animal genomics, genetic transformation and molecular breeding of animals.

Unit-I: Basics of Animal cell culture

Equipment and materials for animal cell culture technology, Primary and established cell line cultures, Introduction to the balanced salt solutions and simple growth medium, A brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium, Role of carbon dioxide, Role of serum and supplements, Serum and protein-free defined media and their applications, Measurement of viability and cytotoxicity, Biology and characterization of cultured cells, measuring parameters of growth.

Unit-II: Basic techniques of mammalian cell culture

Disaggregation of tissue and primary culture; maintenance of cell culture; cell separation, Scaling-up of animal cell culture, Cell synchronization, Cell cloning and micromanipulation, Cell transformation.

Unit-III: Application of animal cell culture

Stem cell cultures, embryonic stem cells and their applications, Somatic cell genetics, Origin and maintenance of cancer stem cells; Stem cell therapies; Organ and histotypic cultures, Three dimensional culture and tissue engineering

Unit-IV: Animal Reproductive Biotechnology

Structure of sperm and ovum; cryopreservation of sperms and ova of livestock, artificial insemination, super ovulation, embryo recovery and in vitro fertilization. Culture of embryos, cryopreservation of embryos, embryo transfer technology, transgenic manipulation of animal embryos, applications of transgenic animal technology.

Unit-V: Vaccinology

History of development of vaccines, introduction to the concept of vaccines, Vaccines based on routes of administration: parenteral, oral, mucosal; Live attenuated and inactivated vaccine; Subunit Vaccines and Toxoids; Peptide Vaccine. conventional methods of animal vaccine production, recombinant approaches to vaccine production, modern vaccines. Vaccination and immune response.

Course Learning Outcomes

The students will be able to understand:

- ✓ Concept and different types in Animal Cell Culture.
- ✓ Various methods of cell separation
- ✓ Scope of animal cell culture.
- ✓ Use of molecular biology techniques genetically engineer the animals to improve sustainability, productivity and suitability for pharmaceutical, agricultural and industrial applications.

BOOKS

1. Culture of Animals Cells 3rd Edition, R. Ian Freshney, Wiley-Liss.
2. Animal Cell Culture – Practical approach, ed., John, R.W. Masters, Oxford.
3. Cell growth and Division: A Practical Approach, ed., R. Basega, IRL, Press.
4. Cell Culture Lab Fax, eds., M. Butler and M. Dawson, Bios Scientific Publications Ltd., Oxford.
5. Animal Cell Culture Techniques, eds, Martin Clynes,Springer.
6. Methods in Cell Biology, Vol.57, Animal Cell Culture Methods, eds., Jenni P. Mather and David Barnes, Academic Press.

BT– 532 GENETICENGINEERING 4CH

Course Objectives

The objectives of this course are to gaining knowledge on gene manipulation using genetic engineering methods and its importance in plant, animal and environmental biotechnology. Understanding the principle behind different enzymes and vectors used in recombinant DNA technology.

Unit- I: Introduction and tools for genetic engineering

Scope of Genetic Engineering, Basic techniques in gene analysis: nucleic acid purification and yield analysis, nucleic acid blotting; Restriction enzymes, modification enzymes, DNA Ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers and adaptors; Gene-cloning vectors: Plasmids, bacteriophages, phagemids, cosmids and Preparation of ordered cosmid libraries, artificial chromosomes (YAC & BAC).

Unit-II: PCR Methods & Generation of Libraries

Polymerase chain reaction: Primer designing, thermostable polymerases, PCR product purification and cloning (TA and T-blunt vector), variants of PCR, RT-PCR, Real-time PCR, Applications of PCR. Cloning a gene: Genomic libraries, cDNA libraries, directional cDNA cloning, PCR-based libraries, subtraction libraries, Alternative strategies of gene cloning: Cloning interaction genes one–two – and –three hybrid systems, screening f or the clones by nucleic acid hybridization, Immuno screening and function based screening, phage display.

Unit-III: Gene manipulation and expression of Recombinant Genes

Creating mutations: Primer-extension mutagenesis, strand selection methods, cassette mutagenesis, PCR-based mutagenesis, creating random mutations in specific genes, protein engineering. Expression strategies for heterologous genes: Expression vector design, codon optimization, host engineering, *in vitro* transcription and translation, expression in *E. coli*, expression in yeast, expression in insect cells, expression in higher-eukaryotic cells, Processing of recombinant proteins: Purification and refolding, characterization of recombinant proteins, stabilization of proteins.

Unit-IV: Genome Analysis

Genome sequencing projects: Genomic mapping, genetic mapping, physical mapping, nucleotide sequencing (manual, automated, NGS including sequencing by synthesis and pyrosequencing), human genome project; Global changes in gene expression: Differential display, Microarrays, Protein arrays, ChIPs with everything), genome-wide two hybrid screens. Molecular markers in genome analysis: RFLP, RAPD, AFLP analysis, SSR, CAPS, SCAR, STS, SNP

Unit-V: Transgenic technologies& GMO

Targeted gene replacement, chromosome engineering, antisense and RNA interference, knock-out analysis; Gene therapy: Vector engineering, Strategies of gene delivery, gene replacement / augmentation, gene correction, genome editing by CRISPER-CAS. Biosafety regulations: Definition of GMOs and LMOs, role of institutional biosafety Committee, RCGM, GEAC for GMO application in food and agriculture, environmental release of GMOs, risk analysis and assessment, international agreements and national regulation relating to GMO Intellectual Property Rights

Course Learning Outcomes

The students will be able to understand:

- ✓ Various natural and laboratory based modifications of DNA.
- ✓ How molecular damage is repaired.
- ✓ Tools creating DNA constructs.
- ✓ Various protein expression strategies.
- ✓ about the use of enzymes in genetic engineering and Explain gene cloning, transformation and transfection and techniques used in genetic engineering
- ✓ And Explain genomic and cDNA library construction for cloning and scopes and applications of genetic engineering and Apply theoretical knowledge of genetic engineering for development of new recombinant DNA molecules

BOOKS

1. Molecular Cloning: A Laboratory Manual, J. Sambrook, E.F., Fritsch and T. Maniatis. Cold Spring Harbor Laboratory Press, New York,2000.
2. DNA Cloning: A Practical Approach, D.M. Glover and B.D. Hames, IRL Press, Oxford, 1995.
3. Molecular and Cellular Methods in Biology and Medicine, P.B. Kaufman, W.Wu.D. Kim and L.J. Cseke, CRC Press, Florida,1995.
4. Methods in Enzymology, Guide to Molecular Cloning Techniques, Vol.152, S.L. Berger and A.R. Kimmel, Academic Press Inc., San Diego,1996.
5. Methods in Enzymology, Vol. 185.
6. Gene Expression Technology. D.V. Goeddel, Academic Press Inc. San Diego,1990.
7. DNA Science : A First Course in Recombinant Technology, D.A. Mickloss and G.A. Freyer, Cold Spring Harbor Laboratory Pres, New York,1990.
8. Molecular Biotechnology, 2nd edition, S.B. Primrose, Blackwell Scientific Publishers, Oxford, 1994.
9. Milestones in Biotechnology, Classic Papers on Genetic Engineering, J.A.Daviesand W.S. Reznik off, Butterworth-Heinemann, Boston, 1992.
10. Route Mapsin Gene Technology, M.R.Walker and R.Rapley, Blackwell Science Ltd., Oxford, 1997.
11. Genetic Engineering: An Introduction to Gene Analysis and Exploitation in Eukaryotes, S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford, 1998.
12. Molecular Biotechnology-Click.

BT-533 PLANTBIOTECHNOLOGY 4CH

Course Objectives

The objectives of this course are to making students understand about the basics of plant science. Equip students with culture techniques and scope of plant biotechnology. Providing knowledge on genetic engineering in the improvement of plants for human welfare.

Unit I: Plant Tissue culture

Introduction to cell and tissue culture, tissue culture as a technique to produce novel plants and hybrids, Tissue culture media (composition and preparation), Initiation and maintenance of callus and suspension culture; single cell clones, Cryopreservation, slow growth and DNA banking for germ plasm conservation.

Unit-II: Micropropagation

Organogenesis; somatic embryogenesis; transfer and establishment of whole plants in soil, Shoot-tip culture; Rapid clonal propagation and production of virus-free plants, Embryo culture and embryo rescue, Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, hybrids Biotransformation, Anther, pollen and ovary culture for production of haploid plants and homozygous lines,

Unit-III: Plant Transformation technology

The basis of tumor formation, hairy root, features of T1 and R1 plasmids, mechanisms of DNA transfer, role of virulence genes, use of T1andR1asvectors, binary vectors, use of 35Sand other promoters, genetic markers, use of reporter genes, reporter gene with introns, use of scaffold attachment regions, methods of nuclear transformation, viral vector and their applications, multiple gene transfer, vector less or direct DNA transfer, In planta transformation. Chloroplast transformation: Advantages, vectors, success with tobacco and potato.

Unit-IV: 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, RIP antifungal proteins, thionines, PR proteins, nematode 28esistance abiotic stress post-harvest losses, long shelf life of fruits and flowers, use of ACC synthase, poly-galactrunase, ACC oxidase; promoter trapping, activation tagging; Transgene stability and gene silencing; terminator gene technology; male sterile lines, bar and barnase systems, carbohydrate composition and storage, ADP glucose pyrophosphatase.

Unit-V: Molecular Breeding and Application

Introduction to conventional plant breeding, Molecular marker-aided breeding and marker-assisted selection; QTL mapping: Choice of mapping population (Traits, phenotyping, Genetic diversity, population structure), Types of QTL mapping (Bi- parental and GWAS), linkage analysis and map construction; Fine mapping of QTLs; map-based cloning of QTLs; Application of mapped QTLs in marker-aided breeding programs. Arid and semi-arid plant biotechnology, Green house technology.

Course Learning Outcomes

The students will be able to understand:

- ✓ The Methods for developing transgenic plants
- ✓ Transgenic methods to improve algal, fungal and plant productivity
- ✓ Importance of secondary metabolites and production in plants
- ✓ Molecular approaches used for plant breeding and trait selection
- ✓ Concept of molecular farming and the derived products

BOOKS

1. J. Hammound, P. McGarvey and V. Yusibov, eds, Plant Biotechnology; Springer Verlag,2000.
2. T-J Fu, G. Singh, and W.R. Curtis, eds., Plant Cell and Tissue Culture for the Production of Food Ingredients, Kluwer Academic/Plenum Press,1999.
3. H.S. Chawla, Biotechnology in Crop Improvement, International Book Distributing Company,1998.
4. R.J. Henry, Practical Application of Plant Molecular Biology, Chanman and Hall,1997.
5. P.K. Gupta, Elements of Biotechnology, Rastogi and Co., Meerut,1996.

BT-534 CBCS (FUNDAMENTAL OF BIOTECHNOLOGY) 4CH

Course Objectives

- To give an introduction about the biotechnology

UNIT-I: Concept of Biology

Origin of life, cell (Prokaryotic and eukaryotic, unicellular and multi cellular) Cellular organization, tissue, organ and organ system

UNIT-II: Genetics and Molecular Biology

Gene, Chromosome, DNA, RNA, Central Dogma, Molecules of life (Protein, Carbohydrate and lipids), Genetics-heredity, Mendel and Mendelian principles chromosomal aberration, common hereditary diseases.

UNIT-III: Applied Microbiology

Culture & Maintenance of microbes, Microbial diseases of Plants and Animals, Antibiotics and Chemotherapy, Virus-Types, structure and life cycle, Antiviral drugs

UNIT-IV: Immunology

Immune system (Innate and Adaptive). Cells of immune system, Antigen and Antibody, autoimmune diseases, HIV, Vaccines.

UNIT-V: Recent Advancement in Biosciences and Biotechnology

Genetic engineering, Application of Biotechnology in health and agriculture, Bt. Cotton, stem cells, gene therapy, GMO, synthetic cells, IPR, Bioethics.

Course outcome

At the end of this course,

- ✓ The students get trained in basic aspects of biotechnology.

BT-535 **PRACTICAL** **8CH**

(Practical pertaining to theory paper BT-531, BT-532, BT-533)

1. Preparation of tissue culture medium and membrane filtration,
2. Surface sterilization
3. Organ culture
4. Callus propagation, organogenesis, transfer of plants to soil.
5. Protoplast isolation and culture.
6. Anther culture, production of haploids.
7. Cytological examination of regenerated plants.
8. Agrobacterium culture, selection of transformants, reporter gene (GUS)assays.
9. Cell fusion with PEG
10. Bacterial culture and antibiotic selection media.
11. Preparation of competent cells and Bacterial transformation.
12. Isolation of plasmid DNA.
13. Quantization of nucleic acids.
14. Restriction mapping of DNA.
15. Construction of restriction map of plasmid DNA.
16. PCR
17. Hybridization of self-pollinated plants for development of F_1/ BC_1F_1/ BC_2F_1 generation
18. Foreground and background selection of plants using molecular markers
19. Study of Genetic diversity parameters of population
20. Association mapping
21. Cloning in plasmid vectors.
22. Gene expression of *E. coli* and analysis of gene product.
23. Reporter gene assay(Gus/CAT/□-GAL)
24. Isolation of industrially important microorganisms for microbial processes.

Course Learning Outcomes

The students will be able to

- ✓ Understand and conduct different Sterilization techniques, microbial methods, Organ Culture methods, Bioprocess developments

Fourth Semester

BT-541 Research Methodology, Scientific Communication Skills and Journal Paper Presentation 8CH
Course objective:

Enabling the students in acquire knowledge in methodologies used to do research, use framework of these methodologies for understanding effective lab practices and scientific communication and appreciate scientific ethics. Acquiring the skills necessary to read and evaluate original research articles. Most of the course will involve the discussion of current issues in the domain of biotechnology. Presenting technical reports.

PART – A (To be covered by assigned supervisor through classes/ discussion/ assignment)

Introduction to Research methodology

Research: Definition, Importance of research, Characteristics of research, Types of research (basic, applied, qualitative, quantitative, analytical, etc); Features of translational research – Concept of laboratory to market (bench to public) – Industrial R&D.

Research process – Selection and formulation of research problem, Research questions, Research design – Formulation of Hypothesis, Review of Literature, Framing Research objective.

Preparation for research

Choosing a mentor, lab and research question; maintaining a lab notebook; Good lab practices; method of storing chemicals, solvents and glassware, procedures for maintenance of stock, handling of instruments; handling and storage of biological material, laboratory waste management and disposal; lab safety and management of personnel, facilities, buildings and equipment.

Process and skill of communication

Concept of effective communication- setting clear goals for communication; determining outcomes and results; initiating communication; avoiding breakdowns while communicating; creating value in conversation; barriers to effective communication; non-verbal communication-interpreting non-verbal cues; importance of body language, power of effective listening; recognizing cultural differences.

Presentation skills - formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness.

Scientific communication

Types of research report: Dissertation and Thesis, editorial, research paper, review article, short communication, conference presentation etc.; Scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts;

Publishing scientific papers - Assessment of Quality of Journals, peer review process and problems, recent developments such as open access and non- blind review; plagiarism, software for plagiarism; ethical issues; scientific misconduct.

PART – B: Journal Paper presentation

The student will select a research paper and will have in-depth study of the objective, methodologies and research outcome of the paper. The student will give a PowerPoint presentation of the paper.

Course Learning Outcomes:

The students will be able to:

- ✓ Understand scientific approaches in cultivating research; develop methodologies and its ethical implication.
- ✓ Read, write, understand, critically analyze scientific literatures and imply them in designing hypothesis and experiments.
- ✓ Understand the importance of business in research development, rationale for IPR and patents.
- ✓ Survey the changes and updating of selected topic to know the current research of particular area
- ✓ Analyze and compile the data of selected topic and interpret the impact on the society and environment Compile the report of the study and present to the audience following the ethics.
- ✓ Develop presentation skills.

Suggested Reading Books for PART-A:

1. Leedy, P. D., & Ormrod, J. E. (2015). *Practical research: Planning and design*. Pearson.
2. Pruzan, P. (2016). *Research methodology: the aims, practices and ethics of science*. Springer.
3. Booth, W. C., Booth, W. C., Colomb, G. G., Williams, J. M., Colomb, G. G., & Williams, J. M. (2003). The craft of research. University of Chicago press.
4. Thomas, C. G. (2021). Research methodology and scientific writing. Springer Nature.
5. Illingworth, S., & Allen, G. (2020). Effective science communication. IOP Publishing Limited.
6. Aines, R. D., & Aines, A. L. (2019). Championing science. University of California Press.
7. Resnik, D. B. (2005). The ethics of science: An introduction. Routledge.
8. C.R. Kothari: Research Methodology- Methods and Techniques (New Age International Publishers)

BT-542 Project Dissertation and Grand Viva 12 CH

Course Objectives

The course aims at:

Acquiring skills to formulate research problems and setting hypothesis, designing experiments to address the research problem, analyze collected data, presenting results, prepare and present in form of technical report.

The student will select a topic for project work in consultation with teacher assigned to him/her by the Department. The Dissertation work will be initiated at the beginning of Semester III. The student will compile the findings in the form of a project report which will be submitted to the Department during the 4th Semester Examination. The student has to present the findings of the work through Power Point presentation.

Course Learning Outcomes

The students will be able to:

- ✓ Understand the basic knowledge of research ethics and biosafety Level
- ✓ Create research plans/ideas with the help of relevant literature and execute and achieved it in limited time frame
- ✓ Analyzing the research data and find significance by correlating it with the present problems/challenges
- ✓ Apply the knowledge and capability required for independent work as a Master of Science in Biotechnology
- ✓ Survey the changes and updating of selected topic to know the current research of particular area
- ✓ Analyze and compile the data of selected topic and interpret the impact on the society and environment
- ✓ Compile the report of the study and present to the audience following the ethics.
- ✓ Develop an understanding to review, and compile the data and also developed the presentation skills.