आईएफटीएम विश्वविद्यालय, मुरादाबाद, उत्तर प्रदेश

IFTM University, Moradabad, Uttar Pradesh

NAAC ACCREDITED

SCHOOL OF BIOTECHNOLOGY

MASTER OF SCIENCE
(BIOTECHNOLOGY)

[II YEAR PROGRAM]

CHOICE BASED CREDIT SYSTEM (CBCS)
COURSE STRUCTURE AND SYLLABUS

[Applicable w.e.f. Academic Session: 2022-23]
[*As per CBCS guidelines given by UGC*]

IFTM UNIVERSITY

N.H.-24, Lodhipur Rajput, Delhi Road, Moradabad, Uttar Pradesh-244001 Website: www.iftmuniversity.ac.in

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SCHOOL OF BIOTECHNOLOGY

Study and Evaluation

Scheme of

Master of Science

(Biotechnology)

Choice Based Credit System (CBCS)

[Applicable w.e.f. Academic Session: 2022-23]

[As per CBCS guidelines given by UGC]

Summary

Programme:	**Master of Science (Biotechnology)**
Programme Level:	**Degree (Post Graduation)**
Duration:	**Two years (Four semesters) Fulltime**
Medium of Instruction:	**English**
Minimum Required Attendance:	**75%**
Maximum Credits:	**86**

IFTM UNIVERSITY, MORADABAD
MASTER OF SCIENCE (BIOTECHNOLOGY)

Preamble

Completion of graduation course in Biotechnology simply provides a platform for basic understanding of the subject. Inventions, innovations and technology have revolutionized and enriched the Biotechnology subject. Biotechnology has grown, extensively in last couple of decades. Many fundamental research fields from cell biology to molecular biology, from biochemistry to biophysics, from genetic engineering to stem cell research, from bioinformatics to genomics-proteomics, from environmental biology and to biodiversity, from microbiology to bioprocess engineering, from bioremediation to Insilco drug discovery etc. comes under the umbrella of Biotechnology.

School of Biotechnology, IFTM University offers the M.Sc. (Biotechnology) programme with an aim to professionally train students with an undergraduate degree in life science to provide services majorly in educational & research institutions, hospitals, quality control divisions of industries, food processing units and other related settings. These postgraduates are expected to be equipped to pursue research and to contribute to the knowledge building process in the same field.

Considering this, M.Sc. (Biotechnology) CBCS (2021-2022) programme is designed to provide through and updated knowledge of the subject which makes easy entry of the students in public private sector. Uniqueness of the course is of having 6 months mandatory dissertation work along with core courses (CC), Generic elective (GE), ability enhancement compulsory course (AECC), discipline specific elective (DSE) and skill enhancement courses (SEC).

Programme objectives: The programme aims to achieve the following objectives

- Utilize and implement their knowledge and innovative idea base that strongly influence existing archetype of agriculture, industry, healthcare and environment.
- Students will exhibit contemporary knowledge in Biotechnology and they will be eligible to serve in various sectors of pharmaceutical, cosmetic, food, and biotechnological industry.
- Students will be able to design research projects, conduct experiments, analyze and interpret data for investigating problems in Biotechnology and allied fields.
- Higher studies (Ph.D.) can be pursued in order to attain faculty/ research positions in State and Central Universities or Government Research Institute.
- Student will be able appear in various competitive examinations such as CSIR-NET, ICAR-JRF, GATE, ICMR-JRF, DBT-JRF and many other opens channels for promising career in research.
- Students can acquire a scientific position in research & development division of biotechnology Industries, pharmaceutical companies, bio fertilizer industry, aquaculture industries, crop production units, food processing industries, national bio-resource development firms etc.
- Entrepreneurship scheme/venture such as consultancy and training centers can be opened.
- Students will be able to understand the potentials, and impact of biotechnological innovations
- Impart their knowledge for finding sustainable solution to issues pertaining to environment, health sector, agriculture, etc.

PROGRAM OUTCOMES (PO):

Following Program Outcomes will be achieved:

PO1: Gain Scientific Knowledge: Apply the knowledge of basic and applied scientific fundamentals, leading to a deeper understanding of Biological Sciences.

PO2: Enhancement of Experimental Skills: Use of research-based knowledge and research methods including design of experiments and strategic solutions.

PO3: Numerical and Data Analysis: Numerical analysis, interpretation of data, and organized representation of the information to provide valid conclusions.

PO4: Science for society: Apply the scientific knowledge to assess societal health, safety and the consequent responsibilities relevant to the professional scientific practice.

PO5: Individual and teamwork: Think critically and work independently, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO6: Analytical Interpretation: In depth theoretical and empirical understanding of analytical instrumentation and protocols as well as the application of appropriate techniques and resources.

PO7: Scientific Communication: Communicate scientific content effectively with peers, educators, science community, and with society at large.

PO8: Environment and sustainability: Understand the impact of scientific processes in societal and environmental contexts, and demonstrate the knowledge, and need for sustainable development.

PO9: Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning.

PO10: Ethics and Values: Apply ethical principles and commit to professional ethics and responsibilities.

1. Eligibility

a. **Admission Criteria:** Admission to this course shall be carried out through merit.

b. **Qualifying Examination:** Undergraduate level with any discipline of life Science.

c. Marks 45% aggregate for general and OBC category and 40 % aggregate for SC/ST category.

2. Curriculum: M.Sc. courses shall be based on semester system which will be of two years duration, divided into two sessions and four semesters. Each session shall be of two semesters, Session- I shall comprise of two semesters i.e., semester-I and semester-II; Session-II shall comprise of two semesters i.e., semester-III and semester-IV. The academic will follow the pattern as mentioned below:

Academic Calendar	Classes
I and III Semester	August to December
II and IV Semester	January to May
Summer Vacation	June and July

3. Cancellation of Admission: If a student at any stage is found to have concealed any information or have furnished false documents or found to be indulged in gross indiscipline/ misconduct, his/ her admission shall be cancelled and fee deposited by the student shall not be refunded in any case.

Evaluation of Performance

1. **Programme:** Evaluation of performance of the students in a programme shall be a continuous process based on their performance in the class test, quizzes, assignments and the end semester examinations.

    a. **Theory papers in semester system (Maximum Marks: 100)**

    The evaluation will be done through two class test and one end semester examination. This will be in addition to quizzes, assignments, attendance, etc. Each class test will carry a weightage of 10 marks, and the end semester examination will carry a weightage of 70 marks. The remaining 10 marks will be awarded on the basis of attendance and performance in quizzes and assignments.

    b. **Practical in semester system (Maximum Marks: 100)**

    In each practical, the student will be required to carry out the number of experiments as specified in the syllabus. Each practical conducted will be assessed by the teacher based on the experiment done during the lab, submission of the practical file, and understanding of the experiment done, which will carry a weightage of 30 marks. There shall be an end semester practical examination with or without an external examiner which will carry a weightage of 70 marks.

2. **Project, Dissertation, Seminar etc.:** Project, Seminar, Dissertation, and other learning-oriented activities shall have associated maximum marks and credits, as stated in the syllabus.

3. **Examination:**

    a. The minimum Grade required to pass in each Theory & Practical paper is 'GRADE D'.

    b. A candidate, in order to pass, minimum CGPA of 4.50 is required in a particular academic year inclusive of both semesters of that academic. And maximum number of carryover paper permissible for promotion to next academic year are 05 theory/ practical / project papers.

    c. In case of audit paper, the minimum Grade required to pass is Grade D. However, the Grade obtained in audit paper shall not be included in SGPA.

Groups of CBCS:

The 07 groups of courses have been identified to provide student comprehensive exposure to a large number of areas, leading to the holistic development of an individual. These groups / clusters are as follows:

1. Core Courses- Theory (CC-T)
2. Core Courses- Practical (CC-P)
3. Discipline Specific Elective (DSE)
4. Generic Elective (GE)
5. Ability Enhancement Compulsory Courses (AECC)
6. Skill Enhancement Courses (SEC)
7. Project/Dissertation/Seminar

1. Core Courses- Theory (CC-T):

Core courses of M.Sc. Program will provide a holistic approach to Biotechnology graduates, giving them an overview of the field, a basis to build and specialize upon. These core courses are the strong foundation to establish technical knowledge and provide broad multi-disciplined knowledge can be studied further in depth during the elective phase.

The core courses will provide more practical-based knowledge. It will train the students to analyze, decide, and lead-rather than merely know-while creating a common student experience that can foster deep understanding of the subject. A wide range of core courses provides groundwork in the field of Biochemistry, Microbiology, Genetic Engineering etc.

We offer core courses in semester I, II, III during the M.Sc. Biotechnology. There will be 4 credits for each core course offered depending upon the course content.

2. Core Courses- Practical (CC-P):

These courses include various laboratories designed to provide the student solid foundation to the domain of Biotechnology. These courses are of 1 credit each.

3. Discipline Specific Elective (DSE):

Elective courses may be offered by the main discipline of study is referred to as Discipline Specific Elective. The University offer discipline related Elective courses of interdisciplinary nature like Cell Biology, Plant Biotechnology, Environmental Biotechnology etc. There will be 4 credits for each Discipline Specific Elective course offered depending upon the course content.

4. Generic Elective (GE):

An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective. This can be a core course offered in a discipline/subject which may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective. This course includes Biostatistics. This course is of 4 credits.

5. Ability Enhancement Compulsory Course (AECC):

These courses are actually Ability Enhancement Course (AEC) which is designed to develop the ability of students in Bioinstrumentations, Biosafety & IPR and other related courses where they might find it difficult to communicate at a higher level in their prospective job at a later stage due to lack of practice and exposure in the language etc. Students are motivated to learn the theories, fundamentals and technological aspects which can help them develop and sustain in the corporate environment and culture. These courses are of 4 credits each.

6. Skill Enhancement Courses (SEC):

These courses are designed to provide value-based and/or skill-based knowledge. Courses like Molecular Biology, Enzymology and Enzyme Technology will provide skill based technical knowledge for working in special units in industries and to develop them as entrepreneur. These courses are of 4 credits each.

7. Project/Dissertation/Seminar:

i. Project with a department faculty or in Government recognized research lab/ Institute(s)/ Research based industry. It is the exploration of a specific topic within a field by a post graduate student that makes an original contribution to the discipline.

ii. The students, who take up experiential projects in companies, where senior executives with a stake in teaching guide them, drive the learning. All students are encouraged to do some live project other than their regular classes.

Summary of Credits

M.Sc. Biotechnology: Two Year (4-Semester) CBCS Programme			
Basic Structure: Distribution of Courses			
S. No.	**Type of Course**	**Credit**	**Total Credits**
1.	**Core Course-Theory (CC-T)**	6 Courses of 4 Credits each (Total Credit 6X4)	24
2.	**Core Course-Practical (CC-P)**	6 Courses of 1 Credits each (Total Credit 6X1)	06
3.	**Discipline Specific Elective (DSE)**	3 Courses of 4 Credits each (Total Credit 3X4)	12
4.	**Generic Elective (GE)**	1 Course of 4 Credit (Total Credit 1X4)	04
5.	**Ability Enhancement Compulsory Course (AECC)**	3 Courses of 4 Credits each (Total Credit 3X4)	12
6.	**Skill Enhancement Courses (SEC)**	2 Courses of 4 Credits each (Total Credit 2X4)	08
7.	**Project/Dissertation**	1 Course of 20 Credits (Total credit 1x20)	20
TOTAL			**86**

School of Biotechnology
Programme: Master of Science (Biotechnology)
CHOICE BASED CREDIT SYSTEM
Effective from Session 2022-23

Course Code	CBCS BASKET	Credits			
Core Courses- Theory (CC-T)		**L**	**T**	**P**	**C**
MSB101T	Biochemistry	3	1	0	4
MSB102T	Microbiology	3	1	0	4
MSB201T	Immunology & Immunotechnology	3	1	0	4
MSB202T	Microbial Technology	3	1	0	4
MSB301T	Genetic Engineering	3	1	0	4
MSB302T	Bioinformatics	3	1	0	4
Core Courses-Practical (CC-P)		**L**	**T**	**P**	**C**
MSB101P	Biochemistry Lab	0	0	2	1
MSB102P	Microbiology Lab	0	0	2	1
MSB201P	Immunology & Immunotechnology Lab	0	0	2	1
MSB202P	Microbial Technology Lab	0	0	2	1
MSB301P	Genetic Engineering Lab	0	0	2	1
MSB302P	Bioinformatics Lab	0	0	2	1
Discipline Specific Elective (DSE)		**L**	**T**	**P**	**C**
MSB103T	Cell Biology	3	1	0	4
MSB203T	Plant Biotechnology	3	1	0	4
MSB303T	Environmental Biotechnology	3	1	0	4
Generic Elective (GE)		**L**	**T**	**P**	**C**
MSB304T	Biostatistics	3	1	0	4
Ability Enhancement Compulsory Course (AECC)		**L**	**T**	**P**	**C**
MSB104T	Bioinstrumentation	3	1	0	4
MSB204T	Advanced Proteomics and Genomics	3	1	0	4
Elective MSB305T MSB306T MSB307T	Animal Cell Culture Principles of Nanobiotechnology IPR & Biosafety	3	1	0	4
Skill Enhancement Courses (SEC)		**L**	**T**	**P**	**C**
MSB105T	Molecular Biology	3	1	0	4
MSB205T	Enzymology and Enzyme Technology	3	1	0	4
Project/Dissertation		**L**	**T**	**P**	**C**
MSB481P	Dissertation	0	0	20	20

IFTM UNIVERSITY, MORADABAD

COURSE STRUCTURE
(CHOICE BASED CREDIT SYSTEM)
M.Sc. (BIOTECHNOLOGY)
SEMESTER: I

S.No.	Category	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
							Mid Term Exam			External Exam		
				L	T	P	CT	AS +AT	Total			
THEORY												
1.	CC-T	MSB101T	Biochemistry	3	1	0	20	10	30	70	100	4
2.	CC-T	MSB102T	Microbiology	3	1	0	20	10	30	70	100	4
3.	DSE	MSB103T	Cell Biology	3	1	0	20	10	30	70	100	4
4.	AECC	MSB104T	Bioinstrumentation	3	1	0	20	10	30	70	100	4
5.	SEC	MSB105T	Molecular Biology	3	1	0	20	10	30	70	100	4
PRACTICALS / PROJECT												
6.	CC-P	MSB101P	Biochemistry Lab	0	0	2	-	-	30	70	100	1
7.	CC-P	MSB102P	Microbiology Lab	0	0	2	-	-	30	70	100	1
TOTAL				**15**	**05**	**04**	**-**	**-**	**210**	**490**	**700**	**22**

SEMESTER: II

S.No.	Category	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
							Mid Term Exam			External Exam		
				L	T	P	CT	AS +AT	Total			
THEORY												
1.	CC-T	MSB201T	Immunology & Immunotechnology	3	1	0	20	10	30	70	100	4
2.	CC-T	MSB202T	Microbial Technology	3	1	0	20	10	30	70	100	4
3.	DSE	MSB203T	Plant Biotechnology	3	1	0	20	10	30	70	100	4
4.	AECC	MSB204T	Advanced Proteomics and Genomics	3	1	0	20	10	30	70	100	4
5.	SEC	MSB205T	Enzymology and Enzyme Technology	3	1	0	20	10	30	70	100	4
PRACTICALS / PROJECT												
6.	CC-P	MSB201P	Immunology & Immunotechnology Lab	0	0	2	-	-	30	70	100	1
7.	CC-P	MSB202P	Microbial Technology Lab	0	0	2	-	-	30	70	100	1
TOTAL				**15**	**05**	**04**	**-**	**-**	**210**	**490**	**700**	**22**

IFTM UNIVERSITY, MORADABAD
COURSE STRUCTURE
(CHOICE BASED CREDIT SYSTEM)
M.Sc. (BIOTECHNOLOGY)
SEMESTER: III

S.No.	Category	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
							Mid Term Exam			External Exam		
				L	T	P	CT	AS +AT	Total			
THEORY												
1.	CC-T	MSB301T	Genetic Engineering	3	1	0	20	10	30	70	100	4
2.	CC-T	MSB302T	Bioinformatics	3	1	0	20	10	30	70	100	4
3.	DSE	MSB303T	Environmental Biotechnology	3	1	0	20	10	30	70	100	4
4.	GE	MSB304T	Biostatistics	3	1	0	20	10	30	70	100	4
5.	AECC	Departmental Elective*	*Only 01 paper is to be chosen from the basket of the departmental electives having 03 papers, provided by the school	3	1	0	20	10	30	70	100	4
PRACTICALS / PROJECT												
6.	CC-P	MSB301P	Genetic Engineering Lab	0	0	2	-	-	30	70	100	1
7.	CC-P	MSB302P	Bioinformatics Lab	0	0	2	-	-	30	70	100	1
TOTAL				**15**	**05**	**04**	**-**	**-**	**210**	**490**	**700**	**22**

LIST OF DEPARTMENTAL ELECTIVES*		
Sr. no.	**Course Code**	**Course Name**
1.	MSB305T/ MSB306T/ MSB307T	Animal Cell Culture/ Principles of Nanobiotechnology/ IPR & Biosafety

IFTM UNIVERSITY, MORADABAD
COURSE STRUCTURE
(CHOICE BASED CREDIT SYSTEM)
M.Sc. (BIOTECHNOLOGY)

SEMESTER: IV

S. No.	Category	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
							Mid Term Exam			External Exam		
				L	T	P	CT	AS +AT	Total			
THEORY												
1.	CC-P	MSB481P	Dissertation	0	0	20	-	-	150	250	400	20
TOTAL				**0**	**0**	**20**	**-**	**-**	**150**	**250**	**400**	**20**

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Microbiology/Food Technology) I Year (I Semester)

MSB101T BIOCHEMISTRY

Objective(s): The objectives of this course:

- Is designed to introduce the students to the study of biological phenomena at the molecular level.
- Aims to make the students understand the fundamental chemical principles that govern complex biological systems.
- Have major focuses on disciplines within biology and chemistry to provide an advanced understanding of the core principles and topics of Biochemistry and their experimental basis.
- Enable students to acquire a specialized knowledge of the biological molecules and their structure.

UNIT I: (8 Sessions)

Carbohydrates: Composition; basic structure and function of carbohydrates, Mono-, di- ,oligo-saccharides, Glycosidic bonds; glycoproteins (O- linked and N- linked), glycolipids; Polysaccharides- Classification, Homopolysaccharides; Heteropolysaccharides; Metabolism- Glycolysis, TCA cycle, Gluconeogenesis, HMP pathway, Glycogenesis, Glycogenolysis.

UNIT II: (8 Sessions)

Proteins: Primary, Secondary, Tertiary and Quaternary structure of Proteins; Globular protein- Hemoglobin and Myoglobin; Fibrous protein- Collagen and Membrane Protein; ATP synthetase; Protein sequencing; Evolutionary divergence of organisms and its relationship to protein structure and function; Ramachandran plot; Protein folding.

UNIT III: (8 Sessions)

Fatty acids: General formula, nomenclature and chemical properties; Lipid classification- simple, complex; General structure and functions of major lipid subclasses - acyl glycerols, phosphoglycerides, sphingolipids, waxes, terpenes, steroids and prostaglandins & free fatty acids; Fatty acid oxidation (β oxidation of fatty acid); Regulation of fatty acid metabolism; Ketone bodies; Circulating lipids - chylomicrons. LDL, HDL and VLDL.

UNIT IV: (8 Sessions)

Nucleic Acids: Structure of purines, pyrimidines, nucleosides and nucleotides; Physical & biochemical properties of DNA; Types of DNA- A, B and Z DNA, their structure and significance; Physical & biochemical properties of RNA- tRNA, rRNA, mRNA and hnRNA; Primary, secondary, and tertiary structures of RNA; metabolism of Purines and Pyrimidines (*De-novo* and Salvage pathway).

UNIT V: (8 Sessions)

Fat soluble and water soluble vitamins: structure and function, Cofactors and coenzymes: structure and function; Coenzymes and their functions - NAD, $NADP^+$, FAD, FMN, lipoic acid, TPP, pyridoxal phosphate, biotin and cyanocobalamin; Hormones**:** Classification; site of formation, target organs; Mechanism of action of peptide and steroid hormones: Insulin, Glucagon, Epinephrine, Norepinephrin, Thyroid hormones, Testosterone, Estrogen, Progesterone, Pheromones; Hormonal regulation of metabolism by mineralocorticoids.

Course Outcomes:

At the end of the course students will be able to:
CO1: Understand in detail the structure and physicochemical properties and metabolism of carbohydrates

for skill development.
CO2: Understand in detail the structure, type and classification of protein for skill development.
CO3: Understand the nomenclature and chemical properties of Fatty acids and Lipids along with their metabolic pathways like β oxidation for skill development.
CO4: Understand the structure of Purines and Pyrimidines and their metabolism, types of DNA and properties of RNA for skill development.
CO5: Understand the difference between the water-soluble and fat-soluble vitamins and their key role in metabolism for skill development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes. Please write 3,2,1 wherever required. (Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	2	3	1	1	2	3	1	1
CO2	2	1	2	1	1	1	1	1	1	1
CO3	2	1	3	1	1	1	1	1	1	1
CO4	3	1	1	1	1	1	1	1	2	1
CO5	2	2	1	1	1	1	1	1	1	2

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	1	1
CO2	3	2	1
CO3	3	2	1
CO4	2	1	1
CO5	2	1	1

Suggested Readings:

1. D. Papachristodoulou, A. Snape, W. H. Elliott, Daphne C. Elliott. Biochemistry and Molecular Biology, V Ed.,Oxford University Press, 2014.
2. K. Trehan. Biochemistry, II Edition, New Age International, 2007.
3. D.L. Nelson, M. M. Cox. Lehninger Principles of Biochemistry, V Ed., CBS Publication, 2016.
4. D. Voet, C. W. Pratt, J.G. Voet, Principles of Biochemistry: International StudentVersion, IV Ed., Wiley, New York, 2012.
5. J.M. Berg, J.L., Tymoczko, L. Stryer. Biochemistry: VII Ed., W.H. Freeman Int. Edition, 2010.

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://www.ncbi.nlm.nih.gov/books

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Microbiology/Food Technology) I Year (I Semester)

MSB102T MICROBIOLOGY

Objective: The objective of this course:

- Provides knowledge about the microbial world their morphology, difference from other living organisms, distribution and their specific roles in various fields of human life and industry.

UNIT I: (8 Sessions)
Introduction to Microbiology: Definition, Historical background & scope; Prokaryotes and eukaryotes, Difference between prokaryotic and eukaryotic organisms; Method of Microbiology- Pure culture techniques, sterilization techniques, Culture media and its types; microbial nutrition; Microbial growth and kinetics.

UNIT II: (8 Sessions)
Bacteria: General characteristics; Morphology and structure of bacteria; Gram positive and gram negative bacteria; Basic principle and techniques used in bacterial Classification; Types of vegetative, asexual and sexual reproduction in bacteria.

UNIT III: (8 Sessions) Viruses:
General characteristics; Morphology, Classification and structure of plant, animal and bacterial viruses; Cultivation of viruses, a brief account of Adenoviruses, Herpes, Retrovirus, Viroids and prions; Reproductive cycles: lytic and lysogenic.

UNIT IV: (8 Sessions)
Control of Microorganism: Antimicrobial Agents; Sulfa drugs, Antibiotics (penicillin and cephalosporin); Broad Spectrum Antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance of antibiotics.

UNIT V: (8 Sessions)
Microbial Ecology: Microbial flora of soil; Interaction among soil microorganisms; Nitrogen fixation; Symbiotic association-types, functions and establishment of symbiosis; *A. niger*, yeast, *Pseudomonades putida*.

Course Outcomes:

At the end of the course students will be able to:
CO1: Understand the historical concept of microbiology, various sterilization techniques, microbial nutrition, and microbial growth for skill development.
CO2: Learn about the structure and the classification of bacteria for skill development.
CO3: Learn about the structure and classification of the virus for skill development.
CO4: Understand the mechanism of sterilization, use and mode of action of various antibiotics for skill development, employability and entrepreneurship development.
CO5: Understand the microbial ecology including interaction among soil microbes, symbiosis, and nitrogen fixation for skill development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes. Please write 3,2,1 wherever required. (Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	1	1	1	1	2	1	1
CO2	2	2	1	1	1	1	1	1	1	1
CO3	1	2	3	3	1	1	1	1	1	1
CO4	1	1	1	3	1	1	1	1	1	1
CO5	1	1	1	1	3	2	1	1	3	1

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	1	1
CO2	3	1	1
CO3	3	1	1
CO4	3	2	1
CO5	3	3	1

Suggested Readings:

1. Pelczar Jr. M.J., Chan E.C.S. and Krieg R., Microbiology, McGraw Hill (1998).
2. Stainer R.Y., Ingraham J.L., Wheelis M.L. and Pamler P.R., General Microbiology, MacMillan (2003).
3. Powar & Dagniwala. Microbiology, Volume 1, Himalaya Publishing House Pvt. Ltd, 2012.
4. Tortora G.J., Funke B.R., and Case C.L., Microbiology, An Introduction, Pearson Education (2009).
5. Madigan, M., Martinko, J., Dunlap, P. and Clark, D., Biology of Microorganisms, Pearson Education (2015).

Website Sources:

- https://www.khanacademy.org/
- https://www.britannica.com/
- https://www.wikipedia.org/
- https://www.researchgate.net

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Microbiology) I Year (I Semester)

MSB103T CELL BIOLOGY

Objective(s): The objectives of this course:

- Will build on the knowledge of cell structure and function gained in the undergraduate course's students knowledge of how eukaryotic cells work at the molecular level.
- Provide an overview of cell structure and function at the molecular level, including the flow of information from genes to proteins, and regulation of cellular processes, signaling and proliferation in eukaryotic cells.
- Introduce some of the major ideas and experimental approaches in cell and molecular biology.

UNIT I: (8 Sessions)

Cell Basics: Discovery of cell; The Cell theory; Ultrastructure and functions of prokaryotic and eukaryotic cells. Membrane structure and function: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes. Structure and functions of Nucleus, with nuclear pore complex, Nucleolus, Endoplasmic reticulum, Golgi complex, Ribosome; Biogenesis of mitochondria and chloroplast.

UNIT II: (8 Sessions)

Cytoskeleton, Cell Motility and Cellular Interaction: Microtubules, microfilaments and intermediate elements; Cell motility - Amoeboid, ciliary and flagellar movements. Microvilli, Tight Junction, Desmosome; Connexon; Intercellular communication and Gap Junction.

UNIT III: (8 Sessions)

Cell Division and Cell Cycle: Mitosis -Mitotic Apparatus – centromere/kinetochore; Spindle microtubule; Metaphase chromosomal motion; Anaphase chromosomal movement. Meiosis- Meiotic division I and Meiotic division II; Cytokinesis in animal and plant cells; regulation and control of cell cycle.

UNIT IV: (8 Sessions)

Cell signaling: Extracellular Messengers & their receptors, G-protein- Coupled receptors their second messengers and signal transduction pathway-Specificity of G-protein coupled responses, Regulation of Glucose levels, Role of GPCRs in sensory perceptions. Protein Tyrosine Kinases- Receptor tyrosine kinases (RTKs), Dimerization, Protein Kinase activation, RTKs activates downstream signaling pathway, signaling by the insulin receptors; Calcium as an intracellular messenger: IP3 and Voltage-Gated Ca^{2+} Channels, Calcium binding Protein (calmodulin); light induced signal transduction (Plant transduction).

UNIT V: (8 Sessions)

Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, apoptosis.

Course Outcomes:

At the end of the course students will be able to:
CO1: Understand Cell structure and functions for skill development.
CO2: Understand the cell junctions maintaining the homeostasis and critical cell processes for skill development.
CO3: Understand the different stages of the cell cycle and cell division for skill development.
CO4: Know the different cell signaling pathways for skill development, employability and entrepreneurship development.

CO5: Understand cancer-related cell reproduction for skill development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes. Please write 3,2,1 wherever required. (Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	1	1	1	1	3	1	1	1
CO2	2	3	1	1	1	1	3	1	1	1
CO3	1	2	1	1	1	1	3	2	1	1
CO4	1	1	1	1	1	1	2	1	1	1
CO5	2	2	1	3	1	1	2	3	1	3

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	1	1
CO2	3	1	1
CO3	3	1	1
CO4	3	2	3
CO5	3	1	1

Suggested Readings:

1. Buchanan et al. Biochemistry & Molecular Biology of plants (2004)
2. Nelson & Cox Lehninger Principles of Biochemistry, (2005)
3. Karp,G.. Cell and Molecular Biology; Concepts & Experiments (2004).
4. Cooper,G.M. The Cell: A molecular Approach (2004)
5. deRobertis&dfRobertis. Cell & Molecular biology
6. Hughes &Mehnet. Cell proliferation and apoptosis (2003)
7. Albert's et al Molecular Biology of Cells, (2002), 4th Edition
8. Lodish et al. Molecular Cell Biology (2004)

Website Sources:

- https://www.edx.org/learn/cellular-biology
- https://www.coursera.org/courses?query=cell%20biology
- https://bscb.org/learning-resources/softcell-e-learning/
- https://www.mooc-list.com/tags/cell-biology
- https://nptel.ac.in/courses/102/103/102103012/

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Microbiology/Food Technology) I Year (I Semester)

MSB104T BIOINSTRUMENTATION

Objective(s): The objectives of this course:

- Is to provide principle of the various analytical techniques, which will be helpful in various applications in the field of life science like Molecular Genetics, Cell Biology, Genetic Engineering, Environmental Science and other fields.
- The student will learn to technical aspect of functioning of these bio instruments.

UNIT I: (8 Sessions)
Microscopic Techniques: Principles and Applications of Light, Phase Contrast, Fluorescence Microscopy; Scanning and Transmission Electron Microscopy; Confocal Microscopy; Advances of microscopy.

UNIT II: (8 Sessions)
Chromatography Techniques & Centrifugation Techniques: Theory and Application of Paper Chromatography, TLC, Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, GLC and HPLC; Density & Ultra Centrifugation.

UNIT III: (8 Sessions)
Electrophoresis Techniques: Theory and Application of PAGE, Agarose Gel Electrophoresis, Iso-electric Focusing, Immuno diffusion, Southern, Northern and Western Blotting.

UNIT IV: (8 Sessions)
Spectroscopic Techniques: Theory and Application of UV and Visible Spectroscopy, Fluorescence Spectroscopy, NMR, Atomic Absorption Spectroscopy, Raman Spectroscopy

UNIT V: (8 Sessions)
Radio-isotopic Techniques: Introduction to Radioisotopes and their Biological Applications; Radioactive Decay – Types and Measurement; Principles and Applications of GM Counter, Solid and Liquid Scintillation Counter; Autoradiography, Radiation Dosimetry.

Course Outcomes:

At the end of the course students will be able to:
CO1: Understand the principle and working of microscope for skill development, employability and entrepreneurship development.
CO2: Understand the concept of ultracentrifugation and its application for skill development, employability and entrepreneurship development.
CO3: Acquire knowledge of the various applications of electrophoresis for skill development, employability and entrepreneurship development.
CO4: Explain the principle, instrumentation, and application of spectroscopic instruments for skill development, employability and entrepreneurship development.
CO5: Understand the various radioisotopic techniques and their application in biology and medicine for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes. Please write 3,2,1 wherever required. (Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	1	1	3	1	1	3	1
CO2	3	2	1	1	1	3	1	1	2	1
CO3	3	3	1	1	1	2	1	1	2	1
CO4	2	3	1	1	1	3	1	1	3	1
CO5	1	3	2	3	1	2	3	2	3	1

CO-Curriculum Enrichment Mapping (Please √ wherever required)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	3	3
CO2	3	2	2
CO3	3	3	2
CO4	3	3	2
CO5	3	2	3

Suggested Readings:

1. Skoog & West Principle of Instrumental Analysis 4th Edn 1992.
2. Freilder. Physical Biochemistry: Application to Biochemistry and Molecular Biology, 2nd Edn 1983.
3. Keith Wilson & John Walker Principles and Techniques of Biochemistry and Molecular Biology:, 7th Edn., Cambridge University Press.
4. S. K. Sawhney & Randhir Singh., Introductory Practical Biochemistry 5th Edn, 2014.
5. G. R. Chatwal & S. K. Anand, Instrumental Methods of Chemical Analysis, Oscar publication, 2015.

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://library.nitrkl.ac.in/

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Microbiology) I Year (I Semester)

MSB105T MOLECULAR BIOLOGY

Objective(s): The objectives of this course:

- Is to provide core principles of molecular biology and to impart knowledge to students about the importance of molecular genetics.
- Will help learners to understand the organization and structure of DNA and its properties.
- Will let the student have an in-depth knowledge on molecular mechanisms like Replication, Transcription, Translation, regulation of genetic expression and cancer biology.

UNIT I: **(8 Sessions)**

Nuclear organization: Nuclear membrane, chromosome structure. Proteins associated with nuclei. nucleosome model. Nuclear DNA content, C-Value paradox, Cot value and its significance in situ hybridization, Structural alteration in chromosome: Deletion, Duplication, Inversion & Translocation, heterozygote. Special types of chromosomes; Salivary gland and Lamp-brush chromosomes. Gene mutation: Types of mutations, Molecular mechanism of mutations. Polyploidy (aneuploids, autopolyploids and allopolyploids).

UNIT II: **(8 Sessions)**

DNA Replication: Mechanism of DNA replication (Prokaryotic and Eukaryotic), Enzymes involved in DNA replication (Helicases, DNA polymerase, Topoisomerase etc). Type of DNA repair. Regulation of telomere length. DNA recombination; site specific recombination.

UNIT III: **(8 Sessions)**

Transcription: Structure of bacterial RNA polymerase, Transcription events, and sigma factor cycle, Eukaryotic RNA polymerase, Promoter sequences, TATA box, Hogness Box, CAAT box, Enhancers, upstream activating sequences, Initiation and termination of transcription factor, RNA processing in Prokaryotes *Vs* Eukaryotes.

UNIT IV: **(8 Sessions)**

Translation: Prokaryotic and Eukaryotic translation, the translation machinery, Mechanisms of initiation, elongation and termination, Regulation of translation. Post-translational modifications and intracellular proteins transport. Control of gene expression in prokaryotes and eukaryotes, operon model- lac and trp operon, Autogenous regulation, Feedback inhibition, Lytic cascades and lysogenic repression.

UNIT V: **(8 Sessions)**

Genetic disease and diagnostics: Sex linked and autosomal diseases. Molecular Biology of Cancer- causes and genetics of cancer, Tumor suppressor genes and onco genes, anticancer agent (p53 and pRB). Tools in molecular biology- Fluorescent In-situ Hybridisation (FISH), DNA microarrays, Advantages and disadvantages of DNA microarrays.

Course Outcomes:

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

CO1: Describe the structural components of Nuclear membrane, chromosomal structure, DNA packaging, C-value and Cot value, Mutations involving chromosomal and gene mutations, Salivary and Lamp brush chromosomes for skill development.

CO2: Describe the mechanism of bacterial replication, Enzymes involved in DNA replication, Telomeric replication, Recombination and its mechanism and types of DNA repair mechanisms for skill development and employability.

CO3: Explain the structure of prokaryotic and eukaryotic RNA Polymerase, mechanism of transcription in prokaryotes and eukaryotes, significance of promoter sequences and RNA processing for skill development and employability.
CO4: Describe the molecular mechanisms of translation in prokaryotes and eukaryotes, regulation of translation, post-translational modifications of proteins, and mechanisms of regulation of gene expression in prokaryotes lac operon and trp operon, mechanisms of regulation of gene expression in eukaryotes, lytic cascades, and lysogenic repression for skill development.
CO5: Describe the genetic diseases-autosomal and sex-linked diseases, causes and genetics of cancer, the role of p53 and pRB in cancer, Tools in molecular biology- Fluorescent In-situ Hybridisation (FISH), DNA microarrays for skill development and employability.

Mapping Course Outcomes leading for the achievement of Programme Outcomes. Please write 3,2,1 wherever required. (Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	1	1	1	2	1	3	1
CO2	3	1	1	1	1	2	1	1	1	1
CO3	1	1	1	1	1	1	1	1	1	1
CO4	1	1	1	1	1	1	1	1	1	3
CO5	2	1	2	2	3	2	3	1	1	1

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	**1**	1
CO2	3	2	1
CO3	3	3	1
CO4	3	1	1
CO5	3	3	1

Suggested Readings:

1. Miglani G.S. Advance Genetics by Narosa Publishing House.
2. S.B. Primrose, R.Twyman. Principles of Gene Manipulation and Genomics, VII Ed., Wiley-Blackwell, 2006.
3. D.L. Nelson, M.M. Cox. LehningerPrinciples of Biochemistry, . V Ed., 2016.
4. J.D. Watson. A Passion for DNA: Genes, Genome &Society, Cold Spring Harbor Laboratory Press, 2000
5. Albert's et al. Molecular Biology of Cells, IVth Edition, 2002.
6. Lewin B. , Genes VII, 7th edition, Oxford University Press; 2000

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- https://thebiologynotes.com/microbial-genetics/
- https://www.sparknotes.com/biology/
- https://www.cliffsnotes.com/study-guides/biology/biochemistry-i/
- biological-information-flow/the-central-dogma-of-molecular-biology

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Microbiology/Food Technology) I Year (I Semester)

MSB101P BIOCHEMISTRY LAB

1.	Introduction of Laboratory Practices	
2.	Safety Measures	
3.	Do and Don't	
4.	About Equipment and Accessories and Working	
5.	To study of the properties of carbohydrates. Experiment: I A Molish Test Experiment: 1 B. Benedict's Test;	Experiment 1
6.	2A: To estimate given amount of protein by Folin-Lowry method. 2B: To estimate the protein content in the given sample by Biurret methods.	Experiment 2
7.	3A: Qualitative test for the presence of fatty acid by titrametric methods. 3B: Estimation of cholesterol by Liebermann-Buchard reaction.	Experiment 3
8.	To learn technique SDS-PAGE and to separate protein according to their molecular size.	Experiment 4
9.	Estimation of total carbohydrates by Anthrone's methods.	Experiment 5
10.	To detect whether given sample is protein or non-protein.	Experiment 6
11.	To detect the presence of amino acid from a given sample by Ninhydrin Test or Xanthoproteic acid Test.	Experiment 7
12.	Test to distinguish ketoses from aldoses sugars (Seliwanoff's test)	Experiment 8

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Microbiology/Food Technology) I Year (I Semester)

MSB102P MICROBIOLOGY LAB

1.	Introduction of Laboratory Practices	
2.	Safety Measures	
3.	Do and Don't	
4.	About Equipment and Accessories and Working	
5.	Working Principle and structural components of simple microscope.	Experiment 1
6.	Working Principle and structural components of compound microscope.	Experiment 2
7.	Basics Working and Principle of Autoclave	Experiment 3
8.	Basics Working and Principle of Biological Safety Cabinet (Laminar Air Flow Chamber)	Experiment 4
9.	Study of Sterilization methods and equipments.	Experiment 5
10.	To prepare and sterilize the nutrient broth media.	Experiment 6
11.	To prepare and sterilize the nutrient agar media (NAM) and to prepare nutrient agar slants.	Experiment 7
12.	To isolate and enumerate microorganisms from soil sample by spread and streak plate methods.	Experiment 8
13.	To isolate and enumerate microorganisms from soil sample by serial dilution method.	Experiment 9
14.	To isolate the microorganisms from mixed culture by sub-culturing technique.	Experiment 10
15.	To stain bacterial cell by simple staining method.	Experiment 11

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. Biotechnology I Year (II Semester)

MSB201T IMMUNOLOGY & IMMUNOTECHNOLOGY

Objective(s): The objectives of this course:

- Is to learn the structure and function of the immune system both at the molecular and cellular level.
- To understand the cause and mechanism of immune system pathologies and dysfunctions.
- To learn immunological techniques and their applications in basic & clinical research, and in Immunodiagnosis.

UNIT I: (8 Sessions)

Introduction to Immunology: Brief history of immunology, Innate and Acquired immunity, Organization & structure of Lymphoid organs. Hematopoiesis, Cells of immune system, Characteristic of T & B lymphocytes, lymphocyte trafficking, humoral and cell mediated immune response, Inflammation.

UNIT II: (8 Sessions)

Antigen and antigenicity: Types of Antigens, Super antigens, Factors affecting the immunogenicity, Haptens and adjuvant, ABO blood group antigens, Epitopes. Structure, functions and characteristics of different classes of antibodies, Antigenic Determinants on Immunoglobulins.

UNIT III: (8 Sessions)

Immune response: Structure and function of Major histocompatibility complex (MHC), Exogenous and Endogenous pathways of antigen processing and presentation, Complement system, Structure, function and application of Cytokines, Mechanism of T-cell & NK cells mediated lysis, Regulation of immune response, Immunological tolerance.

UNIT IV: (8 Sessions)

Antigen and antibody interactions: Cross reactivity, precipitation reactions, agglutination; serological techniques – ELISA, RIA, compliment fixation and western blotting; Immunoprecipitation; FACS; Production of monoclonal antibodies (Hybridoma Technology); Vaccines.

UNIT V: (8 Sessions)

Immunity to Microbes and diseases: Immunity against infectious agents- Influenza, Mycobacterium tuberculosis, Plasmodium falciparum; Hyper-sensitivity, Autoimmunity, Tumor immunology, AIDS, Transplantation immunology.

Course Outcomes:

At the end of the course students will be able to:
CO1: Outline, the key mechanisms and cellular players of innate and adaptive immunity, as well as inflammation. Describe the characteristics and roles of different types of T cells & B cells in adoptive immune response for skill development, employability and entrepreneurship development.
CO2: Describe in details the properties of antigens, haptens and adjuvants. Explain the structure, properties and functions of antibodies for skill development and employability.
CO3: Outline key events and cellular players in antigen processing & presentation, pathways of complement protein activation, mechanisms that regulate immune responses and maintain tolerance for skill development and employability.
CO4: Apply basic techniques for identifying antigen-antibody interactions. Understand the principles

vaccination & types of vaccines; production and application of monoclonal antibodies for skill development.
CO5: Understand the mechanisms of cell mediated cytotoxicity and immune response against infectious diseases. Also explain the basis of hypersensitivity, autoimmunity, transplantation, tumor immunology for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes. Please write 3,2,1 wherever required. (Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	1	1	1	1	3	1	3	1
CO2	3	3	3	1	1	1	1	1	1	1
CO3	2	1	1	1	1	2	3	1	1	1
CO4	2	1	1	3	1	1	1	3	1	1
CO5	3	1	1	2	1	1	1	1	1	3

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	3	2
CO2	3	2	1
CO3	2	3	1
CO4	3	1	1
CO5	3	3	1

Suggested Readings:

1. Abul K. Abbas, Andrew H. H. Lichtman, Shiv Pillai, Basic Immunology (Function and Disorder of Immune System), 4th Edition; Elsevier Publisher.
2. Thomas J. Kindt, Barbara A. Osborne, Richard A. Goldsby, Kuby Immunology, 6th Edition; Publisher: W H Freeman & Co.
3. Roitt's Immunology, P.J. Delves, S. J. Martine, D.R. Burton, I.M. Roitt, 12th Edition. Wiley-Blackwell.
4. C.Verman Roa, Immunology. II Edition. Narosa Publishing House-2006
5. Fahim Halim Khan. The Element of Immunology. Pearson Eduction. 2009.

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- https://www.wikipedia.org/
- https://www.ncbi.nlm.nih.gov/books
- https://www.springer.com/gp/biomedical-sciences/immunology
- https://onlinelibrary.wiley.com/doi/book/10.1002/9781119998648

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Microbiology) I Year (II Semester)

MSB202T MICROBIAL TECHNOLOGY

Objective: The objective of this course:

- Is designed to impart knowledge of various modern tools and techniques used to adapt microorganism for specific needs or opportunities, finding or developing suitable microorganism with highly complex challenge.

UNIT I: **(8 Sessions)**

Microbial Fermentation: Introduction to submerged and solid-state fermentation, Component parts of fermentation processes, Range of fermentation processes, Industrial important microbial product- Primary and secondary metabolites.

UNIT II: **(8 Sessions)**

Fermentation media: Synthetic and complex media; Media components- Carbon sources, Nitrogen sources, Inducers, Minerals, Antifoam; Raw material availability-agricultural and industrial waste; pretreatment of raw materials- physical, chemical and biological.

UNIT III: **(8 Sessions)**

Isolation and preservation of industrially important microbes: Isolation of different types of mutants for production of primary and secondary metabolites- Auxotrophic mutants, resistant mutants, revertant mutants, recombinant microorganisms; preservation techniques- cryopreservation, lyophilization.

UNIT IV: **(8 Sessions)**

Concept of overproduction of metabolites: Different regulatory mechanisms involved in controlling the catabolic and anabolic processes of microbes: Induction, catabolite repression, crab tree effect, feedback inhibition and feedback repression.

UNIT V: **(8 Sessions)**

Production of industrially important products: Ethanol, Citric acid, Penicillin, Baker's yeast, High fructose corn syrup (HFCS).

Course Outcomes:

At the end of the course students will be able to:
CO1: Develop an understanding of fermentation and its types -solid and submerged fermentation for skill development, employability and entrepreneurship development.
CO2: Know the raw materials for industrial fermentation and the pretreatment process for skill development and employability.
CO3: Isolate and preserve the industrially important microbes for skill development, employability and entrepreneurship development.
.
CO4: Understand the metabolic pathways and their role in product formation for skill development.

CO5: Understand the techniques of production of industrially important products-ethanol, citric acid, penicillin, etc. for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes. Please write 3,2,1 wherever required. (Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	1	1	3	1	1	3	1
CO2	3	3	2	1	1	3	2	3	1	1
CO3	2	3	3	2	3	1	1	1	1	1
CO4	3	2	3	2	2	1	1	1	3	3
CO5	3	3	2	1	3	2	1	3	1	3

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	3	3
CO2	3	3	1
CO3	3	2	2
CO4	3	1	1
CO5	3	2	1

Suggested Readings:

1. Cruger and ACruger; A text of Industrial microbiology, Sinaeur Associates, 1990.
2. PF STANBURY, S. Hall, A Whitaker and Stephen J Hall. Principle of Fermentation Technology. Elsevier, 2013
3. Y.H Hui et al.Handbook of Food and Beverages Fermentation Technology, 2003
4. Fermentation Microbiology and Biotechnology, A.R. Allman, Mansi E1-Mansi, C.F.A. Bryce, Arnold L. Demain.
5. Linda Harvey. Practical Fermentation Technology Brain McNeil (Editor), 2008.
6. Greed, Prescott and Dunn's, Industrial Microbilogy, 4th Edition, CBS Publishers, 1987.

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- https://www.ncbi.nlm.nih.gov/books

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. Biotechnology I Year (II Semester)

MSB203T PLANT BIOTECHNOLOGY

Objective(s): The objectives of this course:

- Designed to impart knowledge of various modern tools and techniques used to adapt plants for specific needs or opportunities.
- To combat situations that combine multiple needs and opportunities are common for example, a single crop may be required to provide sustainable food and healthful nutrition, protection of the environment, and opportunities for jobs and income.
- Finding or developing suitable plants is typically a highly complex challenge.

UNIT I: (8 Sessions)

Plant Tissue Culture: Cleaning, sterilization, sterile handling of tissue culture of Plant; Nutritional requirement for in vitro culture; Concept of cellular totipotency, single cell culture, micro propagation, somoclonal variation and its application for plant improvement; Somatic embryogenesis; Anther and ovule culture; Haploid and double-haploid production:

UNIT II: (8 Sessions)

Protoplast Culture: Isolation, fusion and culture; Somatic hybridization; Selection system for hybrids; Cybrid production and their application in crop improvement; Cryobiology of plant cell culture and establishment of gene banks; Production of virus free plants using meristem culture:

UNIT III: (8 Sessions)

Genetic Engineering in Plant: Ti and Ri plasmid and viral vectors (CaMV based vectors, Gemini virus, TMV based vectors); Mechanism of DNA transfer; Role of virulence Genes; Use of 35S promoters; Genetic markers; Use of reporter genes; Methods of nuclear transfer, particle bombardment, electroporation, microinjection, transformation of monocots, transgene stability and gene silencing; Herbicide , insect and salt resistance , Plant DNA fingerprinting - Hybridization and PCR based markers (RFLP, SSRs, RAPD, QTLS , SCARS , AFLP etc.):

UNIT IV: (8 Sessions)

Transgenic plants: Commercial status and public acceptance; Bio-safety guidelines for research involving GMO's, benefits and risks; Socio economic impact and ecological consideration of GMO's; Gene flow; IPR and IPP; Patenting of biological material.

UNIT V: (8 Sessions)

Biological nitrogen fixation and biofertilizers: Molecular mechanism of nitrogen fixation, genetics of nif gene; Plant diseases- general account, biological control of pests and disease; Biopesticides; Seed production technique; Plant cell culture for the production of useful secondary metabolites pigments, perfumes, flavor, pharmacologically significant compounds, biodegradable plastics.

Course Outcomes:

At the end of the course students will be able to:
CO1: Understand the method of culturing reproductive structures - anther, microspores, embryos, endosperm, ovule, and ovary cultures and methods to produce haploids for skill development and employability.
CO2: Understand the basics of plant tissue culture and application of plant tissue culture in crop improvement for skill development, employability and entrepreneurship development.

CO3: Understand the basic knowledge of genetic engineering of plants using several genetic engineering tools for skill development and employability.
CO4: Understand the ethics and government regulations that are there for the safe introduction of GMOs for skill development, employability and entrepreneurship development
CO5: Learn methods to conserve germplasm under In vitro. Production of Secondary metabolites production through cell culture for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes. Please write 3,2,1 wherever required. (Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	3	3	3	1	1	2	1
CO2	3	2	2	2	2	2	3	3	1	1
CO3	3	2	3	1	1	1	1	1	1	1
CO4	1	1	1	1	1	1	1	1	3	2
CO5	3	3	3	1	3	3	1	2	1	1

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	2	2	1
CO2	3	3	1
CO3	3	3	1
CO4	3	2	2
CO5	3	2	2

Suggested Readings:

1. Hammond, John, Peter McGarvey, and Vidadi Yusibov, eds. Plant biotechnology: new products and applications. Vol. 240. Springer Science & Business Media, 2012.
2. Stewart Jr, C. Neal, ed. Plant biotechnology and genetics: principles, techniques and applications. John Wiley & Sons, 2012.
3. Bhojwani, Sant Saran, and Maharaj K. Razdan. Plant tissue culture: theory and practice. Vol. 5. Elsevier, 1986.
4. HS Chawla. Introduction to plant biotechnology. Science Publishers, 2002.

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- https://www.ncbi.nlm.nih.gov/books

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. Biotechnology/Microbiology, I Year (II Semester)

MSB204T ADVANCED PROTEOMICS AND GENOMICS

Objective(s): The objectives of this course:

- Is to appraise students with basic concepts of protein structure and function, protein characterization and purification, functional and structural genomics.
- To build up expertise in students with modern techniques of proteomics and genomics so that they can apply it in basic and applied science research.

UNIT I: (8 Sessions)

Introduction and scope of proteomics: Site Directed Mutagenesis- Subtilizin, Advance Protein Folding Methods, Molecular Chaperons, Post Translational Modifications, Glycosylation Vs protein confirmation, protein separation techniques; Polyacrylamide gel electrophoresis & isoelectric focusing (IEF); 2D Gel Electrophoresis, PAGE for protein analysis and identification.

UNIT II: (8 Sessions)

Gene variation and Genome mapping methods: Physical, genetic and molecular markers in mapping (RFLP, RAPD and AFLP,); single nucleotide polymorphisms (SNPs), Expressed sequence Tags (ESTs): Gene Annotation & Gene disease association.

UNIT III: (8 Sessions)

Protein engineering: Protein chips and functional proteomics; clinical and biomedical application of proteomics; proteomics industry, SCP (Single Cell Protein).

UNIT IV: (8 Sessions)

General introduction and scope of Genomics: Types of PCRs and its applications, DNA sequence analysis methods: Sanger's Dideoxy method and Fluorescence methods, DNA footprinting and DNA fingerprinting.

UNIT V: (8 Sessions)

Gene prediction and annotation: Comparative Genomics; DNA microarrays and DNA chips, DASH, Molecular Becons; Genome databases; Structural Genomics; Principles, tools and applications of gene manipulation for modern food (GM Food) production; Significance of GM foods

Course Outcomes:

At the end of the course students will be able to:
CO1: Understand the scope of proteomics, protein folding, gel electrophoresis, and post-translation modification for skill development.
CO2: Construct physical and genomic mapping, the role of SNPs and ESTs in gene identification for skill develpement..
CO3: Know biomedical application of proteomics and principle and design of protein chip for skill development, employability and entrepreneurship development.
CO4: Produce multiple copies of genes using PCR, and develop the concept of DNA foot printing and fingerprinting for skill development, employability and entrepreneurship development.
CO5: Compare and predict gene, Principle, and construction of DNA microarray and tools used for gene manipulation for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes. Please write 3,2,1 wherever required. (Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	1	1	1	1	1	1	1	1
CO2	3	1	2	1	3	2	1	1	1	1
CO3	2	2	3	1	1	2	3	1	1	1
CO4	3	3	3	1	3	2	3	1	1	1
CO5	1	1	2	1	2	3	1	1	1	1

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	1	1
CO2	3	1	1
CO3	2	2	3
CO4	3	1	3
CO5	3	3	1

Suggested Reading:

1 Cantor and Smith, Genomics, john Wiley & Sons, 1999.
2 Introduction to Genomics- Arthur M Lesk, Oxford University Press, 2007.
3 R M Twyman, Principles of Proteomics, BIOS Scientific Publishers, 2004
4 L. Stryer, Biochemistry, W. H. Freeman and Co., New York, 2007
5 NPTEL- Phase-II, Proteomics and Genomics by Dr.Vikas Kumar Dubey, IIT, Guwahati

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://www.ncbi.nlm.nih.gov/books

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Food Technology) I Year (II Semester)

MSB205T ENZYMOLOGY AND ENZYME TECHNOLOGY

Objective(s): The objectives of the course:

- Provide a deeper insight into the fundamentals of enzyme structure, function and kinetics of enzymes and techniques employed in enzymes purification and characterizations are also emphasized in this course.
- Will introduce students to the theory as well as applications of enzyme technology in various industries.
- Serves to provide an awareness of the current and possible future applications of enzyme technologies.

UNIT I: (8 Sessions)

Introduction to Enzymes: Holoenzyme, apoenzyme, prosthetic group. Interaction between enzyme and substrate – lock and key model, induced fit model; Features of active site, activation energy, enzyme specificity and types.IUB system of classification and nomenclature of enzymes. Isolation and purification of enzymes from plants, animals and microbes; Enzyme activity; Unit of enzyme activity- definition and importance.

UNIT II: (8 Sessions)

Enzyme Kinetics: Kinetics of single substrate reactions; Derivation of Michaelis-Menten equation, turnover number; Determination of Km and Vmax (LB plot, ED plot), Importance of Km & Vmax; Multi-Substrate reaction mechanisms. Deactivation Kinetics. Specific activity.

UNIT III: (8 Sessions)

Factor Affecting Enzyme Activity, Catalysis and Regulation: Factors affecting the velocity of enzyme catalyzed reaction: enzyme concentration, temperature, pH, substrate concentration, inhibitors and activators, Acid-base and nucleophilic catalysis, Role of metal ions in enzyme catalysis; Enzyme Inhibition: irreversible; reversible (competitive, uncompetitive and non-competitive inhibition); Allosteric regulation of enzymes, concerted and sequential model.

UNIT IV: (8 Sessions)

Structure and Function of Enzymes: Lysozyme, chymotrypsin, DNA polymerase, RNase, proteases; Lipases, papain, ribonuclease, trypsin, carboxypeptidase, phosphorylase; Multi enzyme complexes-pyruvate dehydrogenase and fatty acid synthetase.

UNIT V: (8 Sessions)

Enzyme Immobilization, Reactors and Biosensors: Adsorption, Matrix entrapment, Cross linking, Encapsulation, Covalent binding and their examples; Advantages and disadvantages of different immobilization techniques; Enzyme Reactors – Stirred tank reactors (STR), Continuous Flow Stirred Tank Reactors (CSTR), Packed-bed reactors (PBR), Fluidized-bed Reactor (FBR); Membrane reactors. Biosensors – glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors.

Course Outcomes:

At the end of the course students will be able to:
CO1: Understand the concept of enzymes and their support groups, along with the different theories that support the working of enzymes, classification as well as how enzymes could be purified from different sources for skill development.
CO2: Understand the working mechanism of enzymes by different mathematical equations for skill development.
CO3: Understand the physical factors that affect the activity and catalysis of enzymes and how the working of enzymes is regulated (inhibitions) for skill development and employability.
CO4: Understand the structure and function of different enzymes involved in replication and other metabolic activities for skill development.
CO5: Understand the commercial applicability of enzymes, the process of immobilization, enzymes as biosensors, and their bioprocessing in enzyme reactors for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Programme Outcomes. Please write 3,2,1 wherever required. (Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	3	1	1	1	1	1	1	1
CO2	3	1	1	1	1	3	1	2	1	1
CO3	3	2	1	1	1	2	1	1	2	1
CO4	3	1	1	3	1	1	1	1	1	1
CO5	1	1	1	3	1	3	2	1	1	3

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	**1**	1
CO2	3	1	1
CO3	3	2	1
CO4	3	1	1
CO5	3	3	3

Suggested Readings:

1. Alan Fersht: Structure and Mechanism in Protein Science, 2nd ed. W.H. Freeman & Co.
2. Nicolas Price & Lewis Stevens: Fundamentals of Enymology, 2nd edition, Oxford Univ. Press, New York, NY.
3. Trevor Palmer: Understanding Enzymes, Second Edition, J. Wiley & Sons, New York.
4. Donald Voet& Judith Voet: Biochemistry, J. Wiley & Sons, New York
5. Geoffrey Zubay (1993): Biochemistry, 3rd edition, Wm. C. Brown, Oxford
6. Berg, Tymoczo and Stryer: Biochemistry, 7th Edition., W.H.Freeman,2010
7. Nicolas Price & Lewis Stevens: Fundamentals of Enymology, 2nd edition, Oxford Univ. Press, New York, NY.

Website Sources:

- https://www.omicsonline.org/scholarly/enzyme-technology-journals-articles-ppts-list.php
- https://www.britannica.com/science/enzyme
- https://www.sciencedirect.com/book/9780444641144/advances-in-enzyme-technology
- http://www.biologydiscussion.com/enzymes/enzyme-technology/enzyme-technology-application-and-commercial-production-of-enzymes/10185
- http://www.biologymad.com/studentswork/12%20-%20etnotes.pdf
- https://www.kth.se/dib/enzyme-technology-1.783173
- http://www1.lsbu.ac.uk/water/enztech/whither.html
- https://bmcbiotechnol.biomedcentral.com/articles/sections/protein-and-enzyme-technology
- http://www.odofin.com/enzyme%20technology.htm
- https://www.thesciencenotes.com/enzyme-technology/

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. Biotechnology, I Year (II Semester)

MSB201P IMMUNOLOGY & IMMUNOTECHNOLOGY LAB

1	Introduction of Laboratory Practices	
2	Safety Measures	
3	Do and Don't	
4	About Equipment and Accessories and Working	
5	Identification of blood group by simple agglutination method.	Experiment 1
6	To enumerate the total number of RBCs and WBCs in the blood sample.	Experiment 2
7	To Perform Ouchterlony double diffusion.	Experiment 3
8	To perform Sandwich ELISA by using microtiter plate reader.	Experiment 4
9	To perform Counter current immunoelectrophoresis.	Experiment 5
10	To perform the precipitation technique by single radial immunodiffusion.	Experiment 6
11	To perform the technique of Immunoprecipitation to precipitate of the antigen-antibody complex by using Protein A beads.	Experiment 7
12	To isolate the peripheral blood mononuclear cells from whole blood by density gradient centrifugation method and determine the viability of cells by Trypan blue exclusion assay.	Experiment 8
13	To Extract genomic DNA from Blood lymphocytes	Experiment 9
14	Widal test	Experiment 10

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. Biotechnology/Microbiology, I Year (II Semester)

MSB202P MICROBIAL TECHNOLOGY LAB

1	Introduction of Laboratory Practices	
2	Safety Measures	
3	Do and Don't	
4	About Equipment and Accessories and Working	
5	To study different growth phases of bacterial population and plot a bacterial growth curve.	Experiment 1
6	To produce ethanol under submerged conditions using *Saccharomyces cerevisiae.*	Experiment 2
7	To purify ethanol produced under submerged conditions.	Experiment 3
8	To immobilize microbial cells using sodium- alginate gel entrapment method.	Experiment 4
9	To produce amylase enzyme under solid state fermentation and submerged state fermentation.	Experiment 5
10	Extraction of protein and estimation of its concentration by Lowry's method	Experiment 6
11	To perform western blotting technique to detect specific protein.	Experiment 7
12	To extract and analyze genomic DNA from leaves by CTAB method.	Experiment 8
13	To perform southern blotting for the detection of a specific DNA fragment.	Experiment 9

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. Biotechnology II Year (III Semester)

MSB301T GENETIC ENGINEERING

Objective(s): The objectives of this course:

- Is to introduce students to basic molecular biological concepts and techniques used in the fields of biotechnology and genetic engineering.
- This course will give students the insight into the so called recombinant DNA technology which includes group of techniques used for controlling gene expression, manipulating gene structure and gene containment.
- Is to make learners understand designing and engineer novel life forms with such techniques.

UNIT I: **(8 Sessions)**

Introduction: Historical background; Restriction enzymes and modifying enzymes; Restriction mapping; Construction of chimaeric DNA- staggered cleavage, Addition of poly dA and dT tails; Blunt end ligation; Gene cloning.

UNIT II: **(8 Sessions)**

Cloning and Expression Vectors: Vehicles for gene cloning- Plasmids; Bacteriophages, Cosmids, Phagemids, shuttle vectors; Plant and animal viruses as vector- Ti plasmid, TMV, adeno virus vector, vaccinia vector, retroviral vector; High capacity cloning vectors- YAC, BAC, PAC, MAC, Baculoviruses vectors; Promoters and expression cassettes.

UNIT III: **(8 Sessions)**

Concept of Genomics: Whole genome sequencing and functional genomics; Applications of genomics and Proteomics with special reference to Arabidopsis and Rice; Molecular probes; Labeling of probes; Radioactive vs. Non-radioactive labeling; Uses of molecular probes; Polymerase Chain Reaction- basic principle; Modified PCR (Inverse PCR, Anchored PCR, PCR for mutagenesis, asymmetric PCR, RTPCR, PCR walking); Applications of PCR in biotechnology; Gene cloning Vs. Polymerase chain reaction; Ligase chain reaction and its application in biotechnology.

UNIT IV: **(8 Sessions)**

Isolation Sequencing and Synthesis of Genes: Methods of gene isolation; Construction and screening of genomic and cDNA libraries; Chromosome walking; Chromosome jumping, Transposon tagging; Map based cloning; Chemical synthesis of genes.

UNIT V: **(8 Sessions)**

Molecular Markers and DNA Chip Technology: Molecular-Markers-types and Applications; Construction of molecular maps (genetic and physical maps); DNA chip Technology & Microarrays.

Course Outcomes:

At the end of the course students will be able to:
CO1: Develop the concept of Genetic engineering and the role of restriction enzymes in genetics for skill development and employability.
CO2: Understand the cloning techniques, cloning vectors like plasmid, cosmids, bacteriophages, etc for skill development.
CO3: Develop the concept of Genome sequencing, use of the molecular probe, and Polymerase Chain Reactions in genomics for skill development, employability and entrepreneurship development.

CO4: Isolate the gene and construct the genomic libraries for skill development.
CO5: Construct the molecular map and working of Microarray for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Program Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1				2	2			
CO2	3	2				2			2	
CO3		1				3	3		3	3
CO4		2	3			3	3			
CO5	1	3	3						1	

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	2	
CO2	3		
CO3	3	3	1
CO4	3		
CO5	3	3	3

Suggested Readings:

1. Gilmartin P.M., Bowler C. Molecular Plant Biology (Vol. I and II), Oxford University Press, 2002.
2. Primerose S.B, Twyman R.. Principles of Gene Manipulation, VII Ed., Wiley-Blackwell, 2006
3. Green M.R., Sambrook J. Molecular Cloning: A Laboratory Manual (Vol I/II/III), IV Ed., 2014.
4. Watson J.D. A Passion for DNA: Genes, Genome &Society, Cold Spring Harbor Laboratory Press, 2000.

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://www.ncbi.nlm.nih.gov/books
- https://www.nature.com/

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Microbiology) II Year (III Semester)

MSB302T BIOINFORMATICS

Objective: The objective of this course:

- Is to introduce the field of bioinformatics to study the tools and databases in homology identification, structure visualization and designing new drug molecules**.**

UNIT I: (8 Sessions)

Introduction to Bioinformatics: Introduction and application of bioinformatics, Classification of biological databases, Biological database retrieval system, sequence and molecular file format.

UNIT II: (8 Sessions)

Sequence analysis: Types of sequence alignment, Dot matrix analysis: Dynamic programming algorithm (Needleman Wunsch and Smith Waterman), Heuristic methods (BLAST and FASTA), Scoring matrices-PAM and BLOSUM.

UNIT III: (8 Sessions)

Protein structure prediction: Protein databases, **P**rotein identification and characterization, Primary structure analysis and prediction, Secondary structure analysis and prediction, Microarray Data Analysis.

UNIT IV: (8 Sessions)

Protein modeling and visualization: Method of protein modeling, Homology modeling, Fold recognition, Ab–initio modeling, Protein classification and protein structure visualization databases and tools

UNIT V: (8 Sessions)

Evolutionary analysis and molecular phylogeny: Concept of phylogeny, Types of tree, Distance based methods (UPGMA and NJ algorithm), Character based methods (maximum parsimony and maximum likelihood) phylogenetic software-PHYLIP, PAUP, tree viewing software.

Course Outcomes:

At the end of the course students will be able to:
CO1: Gain knowledge of various biological databases and sequence formats for skill development and employability.
CO2: Identify the homologous protein and DNA sequences for skill development and employability.
CO3: Study various protein modelling methods for skill development and employability.
CO4: Understand the visualization and characterization of protein structures for skill development.
CO5: Establish the phylogenetic relationship between DNA and protein sequence for skill development and employability.

Mapping Course Outcomes leading for the achievement of Program Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	2	1	2	3	1	1	2	2
CO2	1	2	1	1	2	2	3	2	1	2
CO3	3	2	1	2	1	1	3	1	1	1
CO4	2	1	1	1	2	2	2	2	1	2
CO5	3	2	2	1	2	1	2	3	1	1

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	1	**3**	2
CO2	3	2	1
CO3	3	2	2
CO4	2	2	2
CO5	3	1	1

Suggested Readings:

1. N. Gautham. Bioinformatics databases and Algorithms, Alpha Science Publishers, 2006.
2. Lark. Introduction to Bioinformatics, IV Ed., Oxford Press, 2014.
3. Orpita Bosu, Simminder Kaur Thukral,Bioinformatics: Database, Tools, Algorithms,Oxford University Press, 2007

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- https://pubmed.ncbi.nlm.nih.gov/
- www.ncbi.nlm.nig.gov
- http://www.bic.nus.edu.sg/

IFTM University, Moradabad
Masters of Science (M.Sc.), Programme
M.Sc. Biotechnology II Year (III Semester)

MSB303T ENVIRONMENTAL BIOTECHNOLOGY

Objective(s): The objectives of this course:

- Provides basic knowledge and introduction to the various aspects of environmental biotechnology to students.
- It gives students an understanding of how science and the scientific method work to address environmental problems.
- The student will become familiar with the Earth's major systems (ecosystems and biogeochemical cycles), how they function and how they are affected by human activity (population growth, air, water and soil pollution, ozone depletion, global warming, and solid waste disposal)

UNIT I: **(8 Sessions)**

Introduction to significance of Environmental studies: Ecosystem, Structure and Functions of an Ecosystem, Energy flow in ecosystem, Ecology succession, Causes of ecology succession, Food chain, Food web, Ecological Pyramids, Biogeochemical cycles- Carbon cycle, Nitrogen cycle and Sulfur cycle, Applications and Scope of Environment Biotechnology.

UNIT II: **(8 Sessions)**

Global Phenomenon & Their Management: Global Warming, Greenhouse effect, Ozone layer Depletion, Acid Rains, Bioconversion, Bioaccumulation, Bio-concentration, Biomagnifications, Biodegradation.

UNIT III: **(8 Sessions)**

Biofuels: Energy from biomass, bioethanol, Biodiesel, Biogas, Bio fertilizers- Bacterial, Algal, fungal. Earthworms as Bio fertilizers. Bio pesticides- categories and mode of applications.

UNIT IV: **(8 Sessions)**

Bioremediation: Principle and agents of bioremediations, *in-situ* and *ex-situ* bioremediation. Bioremediation of organic, inorganic and agrochemicals. Phytoremediation: Bio absorption of heavy metals, bio methylation, bioleaching and their types. Bio-drainage.

UNIT V: **(8 Sessions)**

Sewage and Waste water treatment: Physical chemical and biological characteristics of waste water. Primary, secondary and tertiary waste water treatment, Biological treatment systems; activated sludge processing, trickling filter, treatment processes, case studies of industrial waste water treatment in pulp and paper industries, tanning, distillery, dye and antibiotics industrial waste water.

Course Outcomes:

At the end of the course students will be able to:
CO1: Understand the Structure and Functions of an Ecosystem and the scope of Environment Biotechnology in the Ecosystem for skill development and employability.

CO2: Understand the various global phenomenon & describe the existing and emerging technologies to manage them for skill development and employability.
CO3: Understands the emerging needs of Biofuels, Biofertilizers, and Biopesticides for skill development, employability and entrepreneurship development.
CO4: Understand bioremediation its application and its limitations skill development, employability and entrepreneurship development.
CO5: Understand the environmental issues including Primary, secondary, and tertiary wastewater and industrial effluents treatment skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Program Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3		2	3	1	1	1	3	1	2
CO2	3	1	2	2	1	3	3	3	2	1
CO3	2	1	1	3	1	1	2	2	3	2
CO4	2	1	2	2	1	2	1	1	1	3
CO5	3	3	3	1	2	3	2	3	2	2

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	2	3	1
CO2	2	2	1
CO3	2	2	2
CO4	2	2	2
CO5	2	2	2

Suggested Readings:

1. G. Tchnobanoglous, F.L. Burton, H.D. Stensel. Waste Water Engineering: Treatment and Reuse, IV Ed., Metcalfe and Eddy Inc., 2003.
2. S.K. Dhameja. Environmental Engineering and Managnent, S.K. Kataria & Sons, New Delhi, 2014.
3. P.D. Sharma, Ecology & Environment, Twelfth ed., Raastogi Publications, 2015.
4. Pradipta Kumar Mohapatra, Environmental Biotechnology, First ed. I.K. International Pvt. Ltd., 2006.

Website Sources:

- https://ocw.mit.edu/courses/environment-courses/
- https://www.researchgate.net/publication/282367631_The_Role_of_Bioreactors_in_Industrial_Waste water_Treatment
- https://ebnet.ac.uk/
- https://onlinecourses.swayam2.ac.in/cec19_bt03/preview
- https://online-learning.tudelft.nl/courses/industrial-biotechnology/

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Microbiology) II Year (III Semester)

MSB304T BIOSTATISTICS

Objective(s): The objective of this course:

- Is to study advance statistical science and its application to problems of human health and disease, with the ultimate goal of advancing statistics and analyzing data from research problems.
- It helps to design data collection plans, analyze data appropriately and interpret and draw conclusions from those analyses.

UNIT I: **(8 Sessions)**

Biostatistics: Definition and applications of Biostatistics, Concept of variables in biological systems, Collection, classification, Tabulation, Graphical and diagrammatic representation of numerical data. Diagrams (Bar & Pie), Histogram, Frequency curve and frequency polygon.

UNIT II: **(8 Sessions)**

Measures of central tendency: Mean, Median, Mode, Arithmetic, Geometric & Harmonic mean, Measures of dispersion, Variability and changes, Quartile deviation, Mean deviation, Standard deviation, Standard error, Coefficient of variations, Skewness and Kurtosis.

UNIT III: **(8 Sessions)**

Probability and distributions: Random experiment, Events, Sample space, mutually exclusive events, Independent and dependent events; Various definitions of probability, addition and multiplication theorems of probability, Random variables (discrete and continuous), Probability density function and its properties. Binomial, Poisson and Normal distributions.

UNIT IV: **(8 Sessions)**

Correlation and Regression analysis: Relation between two variables, scatter diagram, definition of correlations, curve fitting, principles of least squares, Two regression lines, Karl Pearson's coefficient of correlation, Rank correlation, Tied ranks.

UNIT V: **(8 Sessions)**

Introduction to Test of Significance & Hypothesis: Concept of population and sample, random samples, Sampling distribution of mean and standard error, z and t-test, Chi- square test for goodness of fit, independence of attributes, and homogeneity of samples, interrelation between t-test and F-Test & ANOVA.

Course Outcomes:

CO1: Demonstrate knowledge of the properties of parametric, semi-parametric and nonparametric testing procedures in Biostatistics for skill development.
CO2: Remember restate the principal concepts about biostatistics and collect data relating to variable which will be examined for skill development.
CO3: Understand and interpret the concepts of descriptive statistics from these data for skill development.
CO4: Understand and be able to address ethical, regulatory and practical aspects of human subject research including human subject's protections for skill development.
CO5: Be capable of self-directed learning of unfamiliar statistical methods and written and oral presentation of results/findings for skill development and employability.

Mapping Course Outcomes leading for the achievement of Program Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	2	1	2	1	2	2	1	1
CO2	3	2	1	1	3	1	2	1	1	1
CO3	3	1	2	2	3	2	2	3	2	1
CO4	3	1	2	1	1	2	1	2	2	3
CO5	3	1	1	1	2	2	2	1	3	3

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	1	2	1
CO2	3	1	3
CO3	3	1	2
CO4	3	1	1
CO5	3	2	1

Suggested Readings:

1. George W and Willian G., Statistical Methods, IBH Publication
2. Zar, J, Biostatistics, Prenticw Hall, London R. Rangaswami, A Text Book of Agricultural Statistics, New Age International Publication.
3. Methods in *Biostatistics* by B. K. *Mahajan*
4. Fundamentals of Applied *Statistics S.C. GUPTA* & V.K. KAPOOR

Website Sources:

- www.pdfdrive.com
- www.dmi.gov.in
- www.yourarticlelibrary.com
- onlinecourses.nptel.ac.in
- en.wikipedia.org

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. Biotechnology II Year (III Semester)

MSB305T ANIMAL CELL CULTURE

Objective(s): The objectives of this course:

- Is to acquire the necessary practical skills for the isolation, maintenance, propagation and manipulation of mammalian cells for *in vitro* studies.
- To educate the specific skills for cells/tissue culture laboratory work, and to provide the student with information on the applications of tissue culture in modern laboratory settings.

UNIT I: (8 Sessions)

Requirement of Tissue Culture Laboratory: An introduction; Concept of aseptic technique; Safety consideration in cell culture laboratory; Detection of contamination and remedy.

UNIT II: (8 Sessions)

Culture of Animal Cell: Media requirement for mammalian cell culture; Primary Cell Culture - Disruption and dispersion of tissue, Cell propagation; Growth cycle; Development of cell lines; Culture of Stem cells; Preservation and storage of cells;

UNIT III: (8 Sessions)

General Cell Culture Techniques: Monolayer culture techniques; Suspension cell culture technique; Concept of Bioreactors for mass culture of mammalian cells; Harvesting and purification for end product recovery.

UNIT IV: (8 Sessions)

Measurement of growth and viability of Animal Cells: Cytotoxicity – In vitro limitation; Determination of IC_{50} value; Assay based on cell proliferation- Microtitration Assays (MTT assay) and its application.

UNIT V: (8 Sessions)

Application of Animal Cell Culture: Requirement for mammalian expression system-Commonly used cell lines, Vectors, Methods of transfection in animal cells. Application of mammalian expression system - Cells based vaccines.

Course Outcomes:

At the end of the course students will be able to:
CO1: Understand the importance of sterility and good aseptic technique and minimal contamination for skill development, employability and entrepreneurship development.
CO2: Perform supportive tasks relevant to cell culture, including preparation of media, cryopreservation, and recovery. Apply practical skills to primary cell culture and sub-culture of animal cells, assessment of cell growth, and development of cell lines for skill development and employability.
CO3: Understand the principles of cell culture techniques; and implementation of the principle of bioreactor design and product recovery for skill development, employability and entrepreneurship development.
CO4: Understand the principles of cell-based assay and determine toxicity limits of cytotoxicity assay. Students will critically evaluate cell cultures constraints and possibilities as an in vitro model for skill development.
CO5: Describe the details about the requirement for mammalian expression system and students will learn the applications and future perspectives of animal cell culture for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Program Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	1	2	1	1	1	3	1
CO2	3	2	1	2	1	2	3	1	2	2
CO3	2	1	3	2	3	3	2	2	2	1
CO4	2	3	2	1	1	1	3	1	3	1
CO5	1	3	3	2	1	3	3	2	2	1

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	3	3
CO2	3	2	1
CO3	3	3	1
CO4	3	2	1
CO5	3	3	2

Suggested Readings:

1. R. Ian Freshney. Culture of Animal Cells: A Manual of basic Technique and Applied Applications, VI Ed., Published Online, ISBN: 9780470649367, 2011.
2. J.P Mather, P.E Roberts. Introduction to Cell and Tissue Culture (Theory and Technique), Springer Science & Business Media, 2007.
3. M. Butler. Animal Cell Culture &Technology: The Basic from background to bench, II Ed., BIOS Scientific Publishers, 2004.

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://www.ncbi.nlm.nih.gov/books

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology) II Year (III Semester)

MSB306T PRINCIPLES OF NANOBIOTECHNOLOGY

Objective(s): The objectives of this course:

- Understand the principles of Nanobiotechnology and characterization of nano-structured materials.
- Equipments towards the cutting-edge areas of Nanobiotechnology.
- Encourage innovations and promote translational research to address various theranostics applications.

UNIT I: **(8 Sessions)**

Nanoscales: What is meant by Nanoscale – Nanoscale Processes – Physical and Chemical Properties of Materials in the Nanoscales - Nanoscale Measurements.

UNIT II: **(8 Sessions)**

Properties and Measurements of Nanomaterials: Optical Properties – Absorption and Fluroscence – Microscopy measurements – SEM –TEM - AFM and STM. Confocal imaging

UNIT III: **(8 Sessions)**

Nanobiology: Properties of DNA and motor proteins – Measurements of Conductivity of DNA nanowires and angular properties of motor -- Lessons from Nature on making nanodevices.

UNIT IV: **(8 Sessions)**

Bioconjugation of Nanomaterials To Biological Molecules: Reactive Groups on biomolecules (DNA & Proteins) -Conjugation to nanoparticles (ZnS- Fe_3O_4) - Uses of Bioconjugated Nanoparticles. Nano Drug Delivery: Various Drug Delivery Systems – aerosol - Inhalants - Injectibles – Properties of Nanocarriers – Efficiency of the Systems.

UNIT V: **(8 Sessions)**

Biosensors and microelectronic devices: Sensors-piezoelectric sensors, optical sensors, ampeomteric sensors and macro mechanical structures and their functioning, immuno-nanotechnology.

Course Outcomes:

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

CO1: Understand the fundamentals of nanoscience, nanotechnology and biology within detailed knowledge of different nanomaterial types and properties for skill development, employability and entrepreneurship development.

CO2: Capable to learn various tools and techniques for characterization of nanomaterials for skill development and employability.

CO3: Learn the structural and functional principles of biomolecular interactions to nanomaterials, factors involved and their significance in designing nanomaterials for devices for skill development, employability and entrepreneurship development.

CO4: Acquire the knowledge to incorporate nanotechnology in the existing technology for developing different drug delivery systems like aerosol, inhalants, injectables etc. for skill development.

CO5: Acquire the knowledge for designing diagnostic tools and equipment like biosensors, microelectronic devices for various applications in health science for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Program Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	1	2	2	3	1	3	2
CO2	3	2	1	1	2	1	2	2	2	1
CO3	2	3	2	2	1	2	1	1	1	1
CO4	2	2	2	2	1	3	1	3	3	2
CO5	1	2	3	1	2	3	1	2	2	2

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	2	1
CO2	3	2	1
CO3	3	3	3
CO4	3	1	1
CO5	3	2	2

Suggested Readings:

1. Christ of Niemeyer, Chad Mirkin, Nanobiotechnology- concepts, applications and perspectives, First ed., Wiley- VCH publishers, 2004.
2. Donald Martin, Nanobiotechnology of biomimetic membranes, Springer, 2007
3. Physical Chemitry by P. W. Attkins, Oxford Press.
4. Introduction to Modern Colloid Science by Robert J. Hunter, Oxford University Press.
5. Nanoscale Materials in Chemistry by Kenneth J. Khabhunde (ed.) Wiley Interscience.
6. Thermodynamics and Statistical Mechanics by A N Tikhonov, Peter Theodore Landsberg.
7. Thermodynamics and Statistical Mechanics by John M. Seddon, J. D. Gale.
8. Physical Chemistry, 1st Edition by David H. Ball, Brookes Cole.

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://www.ncbi.nlm.nih.gov/books
- https://www.masterclass.com

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Microbiology) II Year (III Semester)

MSB307T IPR & BIOSAFETY

Objective(s): The objectives of this course:

- Concentrates on technology, knowledge and business management aspect of intellectual property, including patenting aspect.
- Provide knowledge on biosafety and risk assessment of products, ethical issues in biological research.

UNIT I: **(8 Sessions)**

Introduction: Introduction to Intellectual Property; Types of IP; Importance of IPR; Patents- Patent file procedure, Patentable and Non-Patentable items Trademarks, Copyright and Related rights, Industrial Design; Geographical indications; Protection of biotechnological inventions; Patent file procedure.

UNIT II: **(8 Sessions)**

Agreement and Treaties: TRIPS, World Intellectual Property Rights Organization (WIPO). GATT, Patent cooperation treaty, WTO- Objective- Structural format of WTO - Economic Impact of WTO - Benefits of WTO; Compulsory licensing.

UNIT III: **(8 Sessions)**

Rights and Protection: Infringement or violation, remedies against infringement- civil and criminal; Indian Patent Law (1970); Various laws in India- licensing and technology transfer.

UNIT IV: **(8 Sessions)**

Bioethics: Ethical aspects of Genetic Engineering: Genetically modified food and crops,; Stem cell research: Hematopoietic stem cell and Embryonic stem cell; NGO for bioethics; Ethical issues and biosafety.

UNIT V: **(8 Sessions)**

Biosafety: Good laboratory practices (GLP); Biosafety guideline and regulation; Roles of institutional biosafety committee, RCGM, GEAC etc.; Biosafety levels, Cartegena protocol;

Course Outcome:

At the end of the course students will be able to:
CO1: Understand the concept of IPR and its types in detail for skill development.
CO2: Describe the agreements and treaties related to IP for skill development, employability and entrepreneurship development.
CO3: Explain the rights and protection of IP.
CO4: Understand the ethical issues and ethical aspects of genetic engineering for skill development, employability and entrepreneurship development.
CO5: Learn the role, different committees and guidelines for biosafety for skill development, employability and entrepreneurship development.

Mapping Course Outcomes leading for the achievement of Program Outcomes
Please write 3,2,1 wherever required
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	2	1	1	2	2	2	1	3
CO2	2	2	2	1	2	2	1	2	1	3
CO3	1	1	2	3	2	1	1	2	2	3
CO4	2	2	1	1	1	2	1	2	1	3
CO5	3	3	2	1	2	1	2	1	2	3

CO-Curriculum Enrichment Mapping (Please write 3,2,1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	**Employability**	**Entrepreneurship Development**
CO1	3	2	2
CO2	2	2	1
CO3	3	3	2
CO4	3	2	1
CO5	3	3	3

Suggested Readings:

1. Bioethics and Biosafety: M K Satheesh
2. Biotechnology and Patent Protection: Beier FK, Crespi RS and Straus
3. Intellectual Property Rights on Biotechnology: Singh K
4. Regulatory Framework for GMOs in India: Ministry of Environment and Forest, Govt. of India
5. Cartagena Protocol on Biosafety: Ministry of Environment and Forest, Govt. of Inida
6. Bioethics: Shaleesha A Stanley

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://library.nitrkl.ac.in/
- https://www.researchgate.net
- https://www.wipo.int/

IFTM University, Moradabad
Masters of Science (M.Sc.), Programme
M.Sc. Biotechnology II Year (III Semester)

MSB301P GENETIC ENGINEERING LAB

1	Introduction of Laboratory Practices	
2	Safety Measures	
3	Do and Don't	
4	About Equipment and Accessories and Working	
5	Isolation and enumeration of microorganisms from soil by serial dilution agar plating method	Experiment 1
6	To extract the genomic DNA from Plant Leaves	Experiment 2
7	Electrophoresis of extracted DNA	Experiment 3
8	To perform restriction digestion of λ- DNA with EcoR1 & HIND-III enzymes and electrophoresis of digested DNA.	Experiment 4
9	To perform ligation of Lambda (λ) Hind III digest.	Experiment 5
10	To transform plasmid DNA into bacteria.	Experiment 6
11	To amplify a specific DNA fragment by Polymerase Chain Reaction using random primers.	Experiment 7
12	Isolation and purification of plasmid DNA.	Experiment 8

IFTM University, Moradabad
Masters of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Microbiology)

MSB302P BIOINFORMATICS LAB

1	Introduction of Laboratory Practices	
2	Safety Measures	
3	Do and Don't	
4	About Equipment and Accessories and Working	
5	Introduction to various biological databases.	Experiment 1
6	To study various file formats of NCBI.	Experiment 2
7	To Identify all the possible open reading frames in a sequence.	Experiment 3
8	To compute the various physical and chemical parameters of a protein.	Experiment 4
9	To learn how to retrieve structural data of a protein using PDB database.	Experiment 5
10	To identify the 10- homologues sequences of P68871 of various origins. Find the conserved region existing between them comment on the same	Experiment 6
11	To perform blast of given sequences.	Experiment 7
12	Comment on the evolutionary relationship between the sequences	Experiment 8