NOIDA INTERNATIONAL UNIVERSITY

DEPARTMENT OF BIOTECHNOLOGY & MICROBIOLOGY

SYLLABUS OF COURSES TO BE OFFERED

POSTGRADUATE PROGRAMME (MICROBIOLOGY)

Choice Based Credit System (CBCS)

PEOs, POs & PSOs of M.Sc. Microbiology Programme

Programme Educational Objectives (PEOs): The Program Educational Objectives (PEOs) for the M.Sc. Microbiology program enlists the accomplishments that a graduate aims to attain within two years after graduation.

PEO1: To train graduates in basic and advanced areas of microbiology, Industrial Microbiology, Agriculture & Environmental Microbiology and other related subjects along with sensitizing them to the scope for research.

PEO2: To train microbiologists with apt skills to pursue careers both in academia as well as industry such as pharmaceutical, food and bioprocess industries.

PEO3: To empower the students with analytical and research skills, to nurture entrepreneurial endeavors and to prepare a competent generation of microbiologists, capable of excelling in careers of their choosing.

Programme Outcomes (POs):

PO1: Master of Science knowledge: Apply the knowledge of biotechnology, microbiology, biochemistry fundamentals, and bioinformatics to the solution of complex biological problems.

PO2: Design/development of solutions: Design solutions for complex biological problems and design protocols or processes that meet the specified needs with appropriate consideration for the public health and safety, conservation of biodiversity, better understanding of the microorganisms, and using bioinformatics tools for finding solutions of various crippling human/plant diseases with ethical, societal, and environmental considerations.

PO3: Modern Molecular Biology and Bioinformatics tools usage: Develop new technologies, protocols, resources, using modern molecular biology, biotechnology and bioinformatics tools and apply it to solve complex human health problems, plant stress tolerance and conserve floral

biodiversity of Himalayan region focusing on medicinally important plants with an understanding of the limitations of this region.

PO4: Post Graduate Student and society: Apply the classic and modern biological theoretical and practical knowledge gained to address societal, health, microbial and plant biodiversity studies, safety, ethical and cultural issues and the consequent responsibilities relevant to the professional up-gradation of the student and society as a whole.

PO5: Ethics: Apply ethical principles established by different government agencies and commit to research ethics, responsibilities and norms to undertake their current and future research and development.

PO6: Individual and team work: Be an independent thinker and researcher effectively as an individual, and as a member or leader of different teams, and in multidisciplinary research Institutions and Universities.

PO7: Life-long learning: Apply the discipline, ethics and knowledge obtained to engage in independent and life-long learning in their respective fields of interest wherever they go for further higher studies or jobs.

Programme Specific Outcome (PSOs): After the successful completion of M.Sc. Microbiology program, the students will able to:

PSO1: Get equipped with a theoretical and practical understanding of microbiology and appreciate how microbiology is applied in manufacture of industrial products

PSO2: Know how to source for microorganisms of industrial importance from the environment

PSO3: Identify techniques applicable for Improvement of microorganisms based on known biochemical pathways and regulatory mechanisms.

PSO4: Appreciate the diversity of microorganism and microbial communities inhabiting a multitude of habitats and occupying a wide range of ecological habitats.

PSO5: Understand in depth the occurrence, abundance and distribution of microorganism in the environment and their role in the environment and also get expertise on different methods for their detection, characterization and industrial applications.

PSO6: To move ahead in entrepreneurship endeavors in microbiology.

PSO7: Appear and successfully qualify the higher level examinations of various agencies, so as to get chance to do research from reputed institutes within country and abroad with sound fellowships.

NOIDA INTERNATIONAL UNIVERSITY
SCHOOL OF SCIENCES

Study & Evaluation Scheme for M.Sc. (Microbiology)

M.Sc. Microbiology 1st Year
SEMESTER-I

S.No	Course Code	Subject	Period			Evaluation Scheme				Subject Total	Credit
									External Exam		
			L	T	P	CA	TA	Total			
1	STPM-101	Microbial Physiology & Metabolism	4	0	0	20	20	40	60	100	4
2	STPB-102	Principles of Genetics	4	0	0	20	20	40	60	100	4
3	STPB-103	Diversity Of Prokaryotes And Eukaryotes	4	0	0	20	20	40	60	100	4
4	STPM-104	Bacteriology & Virology	4	0	0	20	20	40	60	100	4
5	STPB-105/ TC-1	Bioethics , Biosafety & IPR/ Technical Communication	2	0	0	20	20	40	60	100	2
Practical											
1	SPPM-101	Microbial Physiology & Metabolism Lab	0	0	2			25	25	50	2
2	SPPB-102	Principles of Genetics Lab	0	0	2			25	25	50	2
2	SPPB-103	Diversity Of Prokaryotes And Eukaryotes Lab	0	0	2			25	25	50	2
3	SPPM-104	Bacteriology & Virology Lab	0	0	2			25	25	50	2
Total										**700**	**26**
Note: List of Practical will be supplied at the Start of every Semester											

M.Sc. Microbiology 1st Year

SEMESTER-II

S.No	Course Code	Subject	Period			Evaluation Scheme				Subject Total	Credit
									External Exam		
			L	T	P	CA	TA	Total			
1	STPM-201	Biomolecules	4	0	0	20	20	40	60	100	4
2	STPB-202	Molecular Biology	4	0	0	20	20	40	60	100	4
3	STPB-203	Immunotechnology	4	0	0	20	20	40	60	100	4
4	STPB-204	Biostatistics, Computer Applications and Bioinformatics	4	0	0	20	20	40	60	100	4
5	STPM-205	"Seminar" Recent development in microbiology	2	0	0	15	10	25	75	100	2
Practical											
1	SPPM-201	Biomolecules	0	0	2			25	25	50	2
2	SPPB-202	Molecular Biology	0	0	2			25	25	50	2
3	SPPB-203	Immunotechnology	0	0	2			25	25	50	2
4	SPPB-204	Biostatistics, Computer Applications and Bioinformatics	0	0	2			25	25	50	2
Total										**700**	**26**
Note: List of Practical will be supplied at the Start of every Semester											

M.Sc. Microbiology 2nd Year
SEMESTER-III

S.No	Course Code	Subject	Period			Evaluation Scheme				Subject Total	Credit
									External Exam		
			L	T	P	CA	TA	Total			
1	STPM-301	Enzymology and Bioprocess Technology	4	0	0	20	20	40	60	100	4
2	STPM-302	Industrial & Food Microbiology	4	0	0	20	20	40	60	100	4
3	STPM-303	Genetic Engineering	4	0	0	20	20	40	60	100	4
4	STPM-304	Parasitology	4	0	0	20	20	40	60	100	4
5	STPB-305/ STPB-306	CBCS Genomics and Proteomics /Bioinformatics	2	0	0	20	20	40	60	100	2
Practical											
1	SPPB-301	Enzymology and Bioprocess Technology	0	2				25	25	50	2
2	SPPB-302	Industrial & Food Microbiology	0	2				25	25	50	2
2	SPPM-303	Genetic Engineering	0	2				25	25	50	2
3	SPPM-304	Parasitology Lab	0	2				25	25	50	2
Total										**700**	**26**
Note: List of Practical will be supplied at the Start of every Semester											

M.Sc. Microbiology 2nd Year
SEMESTER-IV

S.No	Course Code	Subject	Period			Evaluation Scheme				Subject Total	Credit
									External Exam		
			L	T	P	CA	TA	Total			
1	STPM-401	Environmental Microbiology	4	0	0	20	20	40	60	100	4
2	STPB-402	Clinical research and Entrepreneurship	4	0	0	20	20	40	60	100	4
Total										**200**	**8**
Note: List of Practical will be supplied at the Start of every Semester											

S.No	Course Code	Subject	Project Report	Report Presentation	Viva Voce	Subject Total	Credit
1	STPM-403	Project	100	50	50	**200**	**8**

OVERALL CREDIT SCHEME

S. No.	SEMESTER	Theory Total	Practical Total	Subject Total	Total Credit
1	I	400	200	700	26
2	II	500	200	700	26
3	III	500	200	700	26
4	IV	200	200	400	16
			Grand Total	**2500**	**94**

Assessment method:

Assessment method	Theory				Practical	
	Internal assessment	Mid-term examination	End-term examination	Maximum Mark	Practical examination	Maximum Mark
Mark	20	20	60	100	50 Mark	50 Mark
%	20%	20%	60%	100%	100%	100%

M.Sc. Microbiology 1st Year

SEMESTER-I

MICROBIAL PHYSIOLOGY AND METABOLISM (STPM- 101)

L	T	P
4	0	2

Course Name: Microbial Physiology and Metabolism
Course Code: STPM-101
Course Credit Hour: 4 hrs
Total Contact hour: 60 hrs

Course Objective:

The major objective of this paper is to develop clear understanding of various aspects of microbial physiology along with diverse metabolic pathways existing in bacteria in relation to its survival and propagation, and to enable students to better understand courses taught later such as Microbial Pathogenicity and biotechnology-based courses.

Course Description:

In this course the major features of growth and metabolism of microorganisms including determination of growth curve environmental influence on the microbial growth and primary and secondary metabolism, and microbial relationships. In this course, we will explore the vast range of physiologies and metabolisms found throughout the microbial world.

Course Contents:

Unit I: Growth and cell division: Measurement of growth, growth physiology, cell division, growth yields, growthkinetics, steady state growth and continuous growth.

Unit II: Solute Transport: Primary and Secondary transport: Introduction, Kinetics, ABC transporters, Phospho-transferase system, Drug export systems, amino acid transport.

Unit III: Central Metabolic Pathways and Regulation: Glycolysis, PPP, ED pathway, Citric acid cycle: Branched TCA andReverse TCA, glyoxylate cycle. Utilization of sugars other than glucose and complex polysaccharides

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Unit IV: Nitrogen metabolism: Metabolism of amino acids: Amino acid biosynthesis and utilisation, lysine and glutamineoverproduction, stringent response, polyamine biosynthesis and regulation.**Metabolism of lipids and hydrocarbons:** Lipid composition of microorganisms, biosynthesis and degradation oflipids, lipid accumulation in yeasts, hydrocarbon utilization, PHA synthesis and degradation. **Metabolism of nucleotides:** Purine and pyrimidine biosynthesis,

regulation of purine and pyrimidine biosynthesis,inhibitors of nucleotide synthesis.

Unit V: Physiological Adaptations and Intercellular signaling: Introduction to two component system, regulatory systemsduring aerobic- anaerobic shifts: Arc, Fnr, Nar, FhlA regulon, response to phosphate supply: The Pho regulon Quorum sensing: A and C signaling system, sporulation in *Bacillus subtilis*, control of competence in *Bacillussubtilis.*Heat-Shock responses, pH homeostasis, osmotic homeostasis.

Course Learning Outcomes (CLOs):

Upon successful completion of the course, the student:
CLO1. Will be acquainted with methods of measuring microbial growth, calculating growth kinetic parameters with understanding of steady state and continuous growth.
CLO2. Will have gained an in-depth knowledge of primary, secondary and group translocation transport systems existing in bacteria, simultaneously learning membrane transport proteins and kinetics of solute transport.
CLO3. Will have learnt central metabolic pathways for carbon metabolism in bacteria enlisting differences with eukaryotic systems and their regulation in diverse physiological conditions. This allows students to apply the acquired knowledge in engineering metabolic pathways for developing industrially useful strains.
CLO4. Will have gathered understanding of inorganic and organic nitrogen assimilation and its regulation. Also knows role of glutathione in cellular redox regulation and biochemistry of glutamate overproducing strains.
CLO5. Will understand details Physiological Adaptations and Intercellular signaling and is conversant with intracellular signaling in bacteria in response to various nutritional and Physiological stresses.

Text Books:

- GM Cooper, Cell: A Molecular approach, 8th edition, Oxford University Press, 9781605358635, 1605358630, 2018
- deRobertis and deRobertis, Cell and Molecular Biology, 8th edition, Lea & Febiger, 9780812110128

Reference Books:

- G. Karp, Cell and Molecular, Biology, 6th Edition, John Wiley & Sons, 9780470578858, 0470578858
- B Alberts et al Molecular Biology of the Cell. 6th edition, Garland Science, Taylor and Francis group, 9781317563754, 1317563751

Online links for study and reference materials:

www.biologydiscussion.com
www.khanacademy.org
https://www.ncbi.nlm.nih.gov/pmc

PRINCILPLES OF GENETICS - (STPB-102)

L	T	P
4	0	2

Course Name: Principles of Genetics **Course Code:** STPB-102
Course Credit Hour: 4 hrs **Total Contact hour:** 60 hrs

Course Objective:

The objective of this course is to build knowledge on the fundamentals of genetics, heredity, or inheritance. To build the foundation on the understanding of biological principles.

Course Description:

This course provides a detailed understanding of Mendelian and non-Mendelian inheritance; various techniques and methodologies that decipher genetic recombination and gene mapping.

Course Contents:

Unit I: Mendelian principles & Extensions: Dominance, segregation, independent assortment. Co-dominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

Unit II: Concept of gene and Gene mapping methods : Gene Concept, Allele, Multiple alleles, Pseudoallele, Complementation tests, Benzer's work on rII locus in T4 phases. Linkage maps, Tetrad analysis, Three- Point Test cross, Cytological basis of crossing over, Interference and Coincidence, Crossing over and Chiasma formation, Factor affecting recombination frequencies, Mapping with molecular markers, Mapping by using somatic cell hybrids, Development of mapping population in plants.

Unit III: Genetics of Sex Determination and Differentiation: Sex-linked, Sex- limited and Sex-influenced traits in Drosophila and Human beings, Theories of Sex-determination- Chromosomal theory, environmental theory and genic balance theory, Sex- determination in dioeciously plants, Sex reversal and Gynandromorphs, Human sex anomalies (Klinefelter's Syndrome and Turner's Syndrome), brief idea of Dosage Compensation and Lyon's hypothesis.

Unit IV: Extra chromosomal inheritance and Biochemical Genetics: Criteria for extra-chromosomal inheritance, Inheritance of Mitochondrial and chloroplast genes, plastid inheritance in Mirabilis, iojapa in corn, Kappa particles in Paramecium, Coiling in snails, male sterility in

plants. Inborn errors of Metabolism in man, eye transplantation in Drosophila, Biochemical mutations in *Neurospora*, Biosynthetic pathways and Biochemical mutations.

Unit V: Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.

Course Learning Outcomes (CLOs):
After successful completion of the course the students:

CLO 1. Will have knowledge of Mendelian, non- Mendelian inheritance and an insight of Gene concept and alleles

CLO 2. Will have an understanding of various methods employed in Gene mapping

CLO 3. Insight of differentiation of sex in plants and animals and various diseases associated with improper differentiation of sex. Evaluate difference between extra-chromosomal inheritances from chromosomal inheritance.

CLO 4. Biochemical changes that lead to difference in inheritance of characters & their expression

CLO 5. Various techniques involved in studying human genetics and their quantification

Text Books:

- P. K. Gupta, GENETICS. Rastogi Publication. 9788171338429, 8171338429
- Strickberger M. W., Genetics. Mac Millan Publishing Co., 9780024180902

Reference Books:

- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., "Molecular Biology of the Gene", 5th Ed., Pearson Education, 9780321762436, 0321762436

Online links for study and reference materials:
www.biologydiscussion.com
www.khanacademy.org
https://www.ncbi.nlm.nih.gov/pmc

DIVERSITY OF PROKARYOTES AND EUKARYOTES - (STPB-103)

L	T	P
4	0	2

Course Name: Diversity of Prokaryotes and Eukaryotes **Course Code:** STPB-103
Course Credit Hour: 4 hrs **Total Contact hour:** 60 hrs

Course Objective:

The primary objective of the course is to build a strong foundation in the area of prokaryotic cell structure, division, survival and propagation. The course will enable students to understand the taxonomical classification, phenotypic and biochemical identification of food associated molds, yeasts, yeast-like fungi and bacteria.

Course Description:

This course introduces students to the diversity among prokaryotes and eukaryotes. It will make student familiar with various aseptic techniques and isolation methods. This course will introduce the host pathogen interaction.

Course Contents:

UNIT I: Beginnings of Microbiology; Contributions of Lister, Koch and Pasteur; Microscopy-brief account of various types and their applications.

Methods in microbiology: Pure culture techniques, theory and practice of sterilization, Principles of microbial nutrition, culture media.

UNIT- II

Microbial Systematics and Taxonomy: Approaches to bacterial taxonomy, Classification including ribotyping; Ribosomal RNA sequencing, characteristics of primary domains; taxonomy, nomenclature and Bergey's manual (Introduction).

UNIT- III: Prokaryotic diversity: Bacteria: Purple and green bacteria, cyanobacteria, Mycobacteria, rickettsias, chlamydias and mycoplasms. Archaea: Archaea as earliest life forms: halophiles, methanogens, hperthermomphilic archaea, thermoplasma. Eukarya: An introduction to protista, algae, fungi and slime molds.

UNIT – IV: Metabolic diversity among microorganisms: Pathways of glucose dissimilation in aerobic and anaerobic microbes, fermentation (alcoholic and acidic), nitrogen metabolism, nitrogen fixation.

UNIT – V: Microflora of human (skin, oral cavity, gastrointestinal tract) entry of pathogens into the host, types of toxins (exo-, endo-) and their structure, mode of actions-infectious disease transmission; virulence and pathogenesis. Chemotherapy/antibiotics: antimicrobial agents, sulfa drugs, antibiotics: broad-spectrum antibiotics, mode of action.

Course Learning Outcomes (CLOs):

CLO1. Demonstrate theory and practical skills in microscopy and their handling techniques and staining.
CLO2. Procedures and understand the basic microbial structure and function and study the comparative characteristics of prokaryotes and eukaryotes and also Understand the structural similarities and differences among various physiological groups of bacteria/archaea.
CLO3. Know various Culture media and their applications and also understand various physical and chemical means of sterilization and general bacteriology and microbial techniques for isolation of pure cultures of bacteria, fungi and algae.
CLO4. Master aseptic techniques and be able to perform routine culture handling tasks safely and effectively.
CLO5. Understand the microbial transport systems and the modes and mechanisms of energy conservation in microbial metabolism – Autotrophy and heterotrophy and know the various Physical and Chemical growth requirements of bacteria and get equipped with various methods of bacterial growth measurement.

Text Books:

- J. Willey, L. Sherwood, C. J. Woolverton, Prescott's Microbiology. 10th edition. McGraw Hill Education. 2017. ISBN No. 9780073375267, 0073375268
- M. Madigan, K. Bender, D. Buckley, W. Sattley, D. Stahl. Brock Biology of Microorganisms. 15th Edition. Pearson Education. 2018. ISBN No. 9781292018317, 1292018313

Reference Books:

- Ricardo Cavicchioli, Archaea Molecular and Cellular Biology. American Society of Microbiology. 2007. ISBN No. 1555813917, 9781555813918
- D. White, J. Drummond, C. Fuqua, The Physiology and Biochemistry of Prokaryotes. 4 th Edition. Oxford University Press. 2011. ISBN No. 9780195393040, 019539304X.

Online links for study & reference materials:
https://www.khanacademy.org/
https://swayam.gov.in/
https://nptel.ac.in/

BACTERIOLOGY AND VIROLOGY – (STPM-104)

L	T	P
4	0	2

Course Name: Bacteriology and Virology **Course Code:** STPM-104
Course Credit Hour: 4 hrs **Total Contact hour:** 60 hrs

Course Objective:

Microbiology and Virology - Amidst the current conditions of the global pandemic, we all know the importance of scientists who are capable of learning and implementing the measures required for handling such microorganisms capable of affecting human life. With the advancement in technologies such as electron microscopy and other visual aids, more and more research and studies along with other productive activities are possible in the field of "Microbiology and Virology".

Course Description:

This course focus on the basis of Bacteriology and virology. It basically covers the ultastructure of bacterial, biochemical testing (IMVIC TESTS). It also covers the basis of microbial genetics as well as Classification and replication of viruses.

Course Contents:

Unit I: Introduction to Bacteriology: Introduction and history of bacteriology, Morphology and Ultra structure of bacteria: cell wall, L-form, cell wall synthesis, cell membranes- structure, composition and properties. **Introduction to bacterial structure:** Capsule, flagella, Pilli, gas vacuoles, chromosomes, magnetosomes, endospore, capsules and s-layers, cytoskeleton structure in bacteria, Reserve food materials in bacteria (PHB, Phosphate granules, oil droplets and sulphur inclusions) and bacterial chemo taxis. **Bacterial taxonomy and nomenclature:** Concept of species and hierarchical taxa, DNA base homology, 16s rRNA and DNA hybridization. General features of Rickettisae, Mycoplasma, and Actinomycetes.

Unit II: Preservation and Maintenance of Bacteria: Low temperature storage, mineral oil, cryopreservation, lypholization, soil and glycerol stocks. **Bacterial Genetics:** General account of prokaryotic genome and plasmid, Conjugation: F-factor, sex Pilli, Hfr cells, mechanism and its role in development of multi drug resistance. Transduction: Lytic cycle, temperate phage, lysogenic cycles, mechanism of transduction, abortive transduction. Transformation and its mechanism.

Unit III: History and development of Virology: History of virology, general characteristics of Viruses, morphological variations, envelope, capsids and nucleic acids of viruses, replication and

classification of viruses, viroids, prions. **Isolation and preservation of Viruses:** Methods of isolation of Viruses, criteria for purification or purity of Viruses, preservation of viruses. **Assay of Viruses:** Biophysical properties of viruses, plaque, pock method and direct count method, Haemagglutination.

Unit IV: Bacteriophages: Types, general properties of bacteriophage, detailed description of lambda phage, M13 phage and T phage. One step growth.

Course Learning Outcomes (CLOs):

CLO1. Understand the basic concept of bacteriology, Morphology and Ultra structure of bacteria and its importance.
CLO2. Discuss the general account of prokaryotic genome and plasmid, Conjugation: F-factor, sex Pilli, Hfr cells, mechanism and its role in development of multi drug resistance.
CLO3. Describe the basic characteristics of general characteristics of Viruses, morphological variations, envelope, capsids and nucleic acids of viruses, replication and classification of viruses, viroids, prions.
CLO4. Discuss the basic concept of bacteriophage, detailed description of lambda phage, M13 phage and T phage. One step growth.

Text Books:

- Black, J.G. (2011) Microbiology: principle and exploration. 7th edition, Wiley publications.
- Cann, A (2011) Principle of molecular Virology. Academic press London
- Microbiology and Parasitology PMFUMicrobiology and Parasitology PMFU B. S. Nagoba, ASHA PICHARE M.B.B.S. M.D. (MICROBIOLOGY)B. S. Nagoba, ASHA PICHARE M.B.B.S. M.D.

Reference Books:

- Davis, B.D Delbecco. R. Eisen, H.N Ginsberg, H.S and Wood, W.B (2007) Microbiology, IInd edition. Vol. II. Harper and Row
- Flint S.J; Enquist, L.W; Skalka, AMK (2004) Principles of Virology; molecular biology; pathogenesis and control, ASM press
- Paniker, CJK (2013) A textbook of Microbiology, 9th edition, University Press
- Stainer, R.Y, Ingraham, J.L, Wheelis, M.L, and Painter, P.R (2013). General Microbiology, MacMillan Press Ltd. UK

Online links for study & reference materials:
https://europe.microbiologyconferences.com
https://nptel.ac.in/courses/102103041/18

CBCS** BIOETHICS, BIOSAFETY & IPR - (STPB-105)

L	T	P
2	0	0

Course Name: Bioethics, Biosafety and IPR
Course Code: STPB-105
Course Credit Hour: 2 hrs
Total Contact hour: 30 hrs

Course Objective:

To apprise the students of the various societal, governance and regulatory issues in biotechnology with special emphasis on ethics, safety and intellectual property rights. Through this course, the students develop a perspective on the importance of these aspects in the success of biotechnology products and services in the market. At the end of the course, they should be able to apply this perspective and the specific principles, laws, regulations etc., in academic and industrial settings for regulatory oversight and enforcement.

Course Description:

This course is mainly focused on the Bioethics, Biosafety and Intellectual Property Rights which includes basic concept of patents, patent regime (in India and abroad) registration aspects and other details.

Course Contents:

Unit I: Biotechnology and social responsibility, public acceptance issues in biotechnology, issues of access, ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs private funding, biotechnology in international relations, globalization and development divide.

Unit II: Introduction to bioethics: Social and ethical issues in biotechnology. Principles of bioethics. Ethical conflicts in biotechnology- interference with nature, unequal distribution of risk and benefits of biotechnology, bioethics vs business ethics.

Unit III: Biosafety: Definition of bio-safety, Biotechnology and bio-safety concerns at the level of individuals, institutions, society, region, country and world with special emphasis on Indian concerns. Biosafety in laboratory institution: laboratory associated infection and other hazards, assessment of biological hazards and level of biosafety. Bio safety regulation: handling of recombinant DNA products and process in industry and in institutions (Indian context).

Unit IV: Introduction to IPR: IPR, forms of IPR and Intellectual property protection. Concept of property with respect to intellectual creativity, Tangible and Intangible property. WTO: agency

controlling trade among nations, WTO with reference to biotechnological affairs, TRIPs. WIPO, EPO.

Course Learning Outcomes (CLOs):

CLO1. The students shall get an adequate knowledge on patent and copyright. This provide further way for developing their idea or innovations.
CLO2. Identify the role of regulatory committees in controlling the risk.
CLO3. Students should get enough information on ethical issues linked to research on animal models, transgenics, clinical trials.
CLO4. Students to consider Intellectual Property (IP) as a career option as IP Counsel/Patent Examiner/Patent agent.

Text Books:

- Singh K K (2015). Biotechnology and Intelectual Property Rights: Legal and Social Impliocations, Springer India.
- Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S. 2008. IPR, Biosafety and biotechnology Management. Jasen Publications, Tiruchirappalli, India.

Reference Books:

- Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
- Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
- V Sreekrishna, 2017. Bioethics and Biosafety in Biotechnology by New Age International publishers.

Online links for study & reference materials:
http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf
https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf

M.Sc. Microbiology 1st Year
SEMESTER-II

BIOMOLECULES (STPB-201)

L	T	P
4	0	2

Course Name: Biomolecules
Course Code: STPB-201
Course Credit Hour: 4 hrs
Total Contact hour: 60 hrs

Course Objective:

This course deals with characteristics, properties and biological significance of the biomolecules of life.

Course Description:

This course introduces students to the general families of biomolecules that comprise the science of biochemistry and to the principles that integrate biochemistry with other chemical and biological disciplines. They acquire knowledge in the quantitative and qualitative estimation of biomolecules.

Course Contents:

UNIT-I: Chemical foundations of Biology – pH, pK, acids, bases, buffers, weak bonds and covalent bonds. Classification, structure, properties and biological significance of carbohydrates. Monosaccharides, Disaccharides, and Polysaccharides. Biological role of peptidoglycans, glycosaminoglycans and Lectins. Lipids - classification, structure and properties of fatty acids, triglycerides, phospholipids, sphingolipids and cholesterol.

UNIT-II: Amino acids - Classification, structure and physico-chemical properties. Chemical synthesis of peptides – solid phase peptide synthesis. Proteins - classification, purification and criteria of homogeneity. Structural organization, sequence determination and characterization of proteins. Confirmation of proteins – Ramachandran plots. Denaturation of proteins. Hetero cyclic compounds – Heme and Chlorophylls.

UNIT-III: Structure and properties of purines, pyrimidines, nucleosides, and nucleotides. Covalent structure of DNA and different forms of DNA - A, B and Z. DNA super coiling. Types of RNA and covalent structure of t-RNA. Classification, structure and physiological roles of Vitamins.

UNIT-IV: Hormones- classification and mechanism of action of steroid and protein hormones. Signal transduction cascade by cyclic AMP, Phosphoinositate and calcium (Ca+), G-proteins, growth factors and membrane receptor tyrosine kinases. Phytohormones and their physiological roles.

Course Learning Outcomes:
After studying this paper, Postgraduate students will be able to:

CLO1: Understand biochemistry at the atomic level, draw molecules and reaction mechanisms perfectly and detail about amino acid structures, types of amino acids, classifications, structure of proteins and types of proteins

CLO2: Recognize the structural levels of organization of proteins,3D structure of proteins, its functions, denaturation (hemoglobin, myoglobin etc.) and be able to describe/recognize lipid and porphyrin structures, lipoproteins and functions of porphyrins (heme, chlorophyll etc.).

CLO3: Learn how amino acids and proteins are metabolized, emphasizing the role of few intermediates of their metabolism, monitoring the deficiency and abundance disorders of amino acid metabolisms and the role of enzymes in the regulation of the pathways

CLO4: Understand the structure and function of genetic material.

Text Books:

- A.L., Lehninger, PRINCIPLES OF BIOCHEMISTRY (1982), Worth Publishers, Inc. New York, ISBN: 9780716743392, 0716743396
- L. Stryer , BIOCHEMISTRY (1995) W.H. Freeman Press, San Francisco, USA, ISBN: 9781319248086, 131924808X.

Reference Books:

- Voet, D. and Voet, J.G., Biochemistry, (2004). 3rd Edition, John Wiley & Sons, Inc.USA,
- U. Sathyanarayana, Biochemistry by Books and Allied (P) Ltd. Kolkata, ISBN 0-87893- 214-3, (2014), ISBN: 9788187134800, 8187134801

Online links for study & reference materials:
https://www.khanacademy.org/test-prep/mcat/biomolecules
https://nptel.ac.in/courses/104/105/104105076/

MOLECULAR BIOLOGY (STPB-202)

L	T	P
4	0	2

Course Name: Molecular Biology
Course Code: STPB-202
Course Credit Hour: 4 hrs
Total Contact hour: 60 hrs

Course Objective:

To acquaint the students with basic and advanced knowledge of molecular biology. Course objectives is focus discuss the better understanding of molecular Biological processes like DNA replication, transcription and repair systems, different genes regulation and replication.

Course Description:

This course presents the genetics at molecular level Goals: On successful completion of the subject the student should have understood the molecular aspects of Molecular biology

Course Contents:

Unit I: Organization of genetic material - Packing of DNA in to chromatin - protein components of chromatin, histones, nucleosome organization. Solenoids loops, domains & scaffolds. Gene amplification, polytene chromosomes. DNA replication – apparatus, enzymes involved and mechanism. Replication at telomeres. DNA damage and repair mechanism. Nuclear genome.C - value paradox. Mitochondrial & plastid genomes and genes. Fine structure of the eukaryotic gene. Split genes. Different kinds of genes: overlapping, assembled, polyprotein & nested genes.

Unit II: Transcription in prokaryotes and eukaryotes. Mechanism of transcription, enzymes and transcription factors, zinc finger, leucine zipper mechanism. Maturation and processing of mRNA, splicing, 5' end capping & 3' end tailing. RNA editing and transport. RNAi and small RNAs.

Unit III: Translation in prokaryotes and eukaryotes: Genetic code - properties of the genetic code, deciphering of the genetic code. Ribosome as a translation factory. t - RNA as an adaptor, its mode of function. Post translational modifications. Leader sequences & protein targeting.

Unit IV: Regulation of gene expression in prokaryotes - The operon concept, lac &tryp operons. Transcriptional control. Post translational control. Regulation in eukaryotes - Control by promoter, enhancer and silencers. Cis-trans elements. Environmental & developmental regulation. DNA methylation & gene expression. Chromatin structure & gene expression.

Course Learning Outcomes (CLOs):

CLO1. Understand the basic concept molecular biology especially organization of genetic material.
CLO2. Describe the basic knowledge of transcription in prokaryotes and eukaryotes.
CLO3. Describe the basic knowledge of translation in prokaryotes and eukaryotes.
CLO5. Discuss the basic concept of regulation of gene expression in prokaryotes and eukaryotes.

Text Books:

- Jeff Hardin, Gregory Bertoni, Lewis J. Kleinsmith, Wayne M. Becker. Becker's World of the Cell, 8th edition, Benajmin Cummings, 9780321689634, 0321689631, (2012).
- EDP De Robertis and EMF De Robertis. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, 9780781734936, 0781734932, (2006)

Reference Books:

- Gerald Karp, Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc, 9780470483374, 0470483377 (2010)
- G.M. Cooper, and R.E. Hausman. The Cell: A Molecular Approach. 5th Edition. ASM Press 780878931064, 0878931066 (2009)

Online links for study and reference materials:
http://www.open2study.com/cellbiology
https://nptel.ac.in/courses/102103012/

IMMUNOTECHNOLOGY (STPB-203)

L	T	P
4	0	2

Course Name: Immunotechnology
Course Code: STPB-203
Course Credit Hour: 4 hrs
Total Contact hour: 42 hrs

Course Objective:

This course is mainly focused on the host immune system which includes concept of immunology, Type of immune system, Classes of immune cells, Antigen-Antibody interaction immune cell tolerance, vaccine technology, and other immunotechnology related topics. Basic of immunology and molecular biological techniques are usually two major courses form the essential prerequisites for Immunotechnology.

Course Description:
This course is mainly focused on the host immune system which includes basic concept of immunology, Type of immune system, Classes of immune cells, Antigen-Antibody interaction immune cell tolerance, vaccine technology and other relevant topics. It also discuss the basic concept of Vaccine technology including DNA vaccines, immunodiagnosis of Infectious diseases.

Course Contents:

Unit I: Introduction to immunology: History and scope of immunology; types of immunity; anatomy of lymphoid organs- primary and secondary lymphoid organs; immunoglobulin structure and function; memory cells, lymphocyte differentiation.

Unit II: Biology of complement systems: Structure and function of MHC class I and II molecules; antigen recognition and presentation; humoral and Cell mediated immune responses; hypersensitivity reaction; immune suppression and immune tolerance; auto immune disorders.

Unit III: Antigen & Antibodies: Antigen- isolation, purification and characterization of various antigens and haptens; antibodies- production, purification and quantification of immunoglobulins; antigen - antibody reaction; hybridoma and monoclonal antibody production; immuno-diagnosis and applications; human monoclonal antibodies; complement fixation.

Unit IV: Immunotechnology: Purification of mononuclear cells from peripheral blood; isolation and characterization of T cells subsets; Antigen processing and presentation; fluorescent activated cell sorter (FACs); mitogen and antigen induced lympho-proliferation assay; mixed lymphocyte reaction (MLR); Assay of macrophage activation; Macrophage & Dendritic cells culture.

Unit V: Vaccine Technology: Introduction to Vaccine technology including DNA vaccines - identification of T and B epitopes for vaccine development. immunodiagnosis of Infectious diseases.

Course Learning Outcomes (CLOs):

CLO1. Understand the basic concept immune system, types of immunity and immunoglobulin structure and function.
CLO2. Discuss Structure and function of MHC class I and II molecules, antigen recognition and presentation.
CLO3. Describe the Basic characteristics of an antigen and Structure, Types, Functions and Properties of antibodies.
CLO4. Explain the isolation and characterization of different immune cells, Antigen processing and presentation.
CLO5. Discuss the basic concept of Vaccine technology including DNA vaccines, immunodiagnosis of Infectious diseases.

Text Books:

- Immunology, V Edition - Richard A.Goldsby, Thomas. J. Kindt, A. Osborne, JanisKuby, 2003. W.H. Freeman and company.
- Arnold, HeinemanAbbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
- Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition WileyBlackwellScientific Publication, Oxford.

Reference Books:

- Basic and Clinical Immunology, 2010, D.P. Stities and J.D. Stobo.
- Kuby's Immunology. 6th edition W.H. Freeman andCompany, New York.
- Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.
- Immunology, Richard A. Goldsby, Thomas J. Kindt. Barbara, A. Osborne, Janis Kuby 5th Edition, 2003. W. H. Freeman & Company.

Online links for study & reference materials:
https://nptel.ac.in/courses/102103038/
https://nptel.ac.in/courses/102103041/18

BIOSTATISTICS, COMPUTER APPLICATIONS AND BIOINFORMATICS (STPB-204)

L	T	P
4	0	2

Course Name: Biostatistics, Computer Applications and Bioinformatics **Course Code:** STPB-204
Course Credit Hour: 4 hrs **Total Contact hour:** 60 hrs

Course Objective:

The objective of this course is to impart fundamental knowledge of computers, and biostatistics which is used in population genetics and evolutionary studies and understand how the biological data generated through various biological branches can be assimilated and studied using computer application.

Course Description:

This course provides students with in depth knowledge Bioinformatics, its application and various tools and their usage. It also provides information regarding the various algorithms used in the bioinformatics tools that enable easier processing of biological data and also enables to identify interaction across various or subbranches of bioinformatics like genomics, proteomics, drug designing, chemical interactions between molecules etc.

Course Contents:

UNIT-I Introduction to Bioinformatics – Genomics and Proteomics. Bioinformatics – Online tools and offline tools. Biological databases. Types of data bases – Gen bank, Swiss port, EMBL, NCBL, and PDB. Database searching using BLAST and FASTA.

UNIT-II Sequence and Phylogeny analysis - Sequence Alignments, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

UNIT-III Dynamic programming- Gene and Genome annotation – Tools used. Physical map of genomes. Molecular phylogeny - Concept methods of tree construction.

UNIT-IV: Bioinformatics tools in proteomics: Introduction, strategies and methods. Bioinformatics tools in proteomics. Application of proteomics. Protein-protein interactions. Basic introduction of Proteomics technologies: 2D-electrophoresis, MALDI-TOF mass spectrometry. Biological Protein Databases: PDB, SWISSPROT, TREMBL. Protein secondary structure prediction. Protein 3D structure prediction.

UNIT-IV: Basics of Biostatistics: Brief description and tabulation of data and its graphical representation. Measures of central tendency and dispersion - mean, median, mode, range, standard deviation, variance. Simple linear regression and correlation. Types of errors and level of significance. Tests of significance – F & t tests, chi-square tests, ANOVA.

Course Learning Outcomes (CLOs):
After successful completion of the course the students:

CLO1. Outlines the basic background of Bioinformatics, terminology, history and introduction to various databases

CLO2. Describe in detail the various mechanisms involved sequence similarity, algorithm matrices MSA and Phylogenetic analysis

CLO3. Introduces various programming and software tools involved in genome annotation, mol. Phylogeny.

CLO4. Discuss the basic background of proteomic and various tools and their application in understanding the proteome and its analysis

CLO5. Describes the mathematical tools involved in evaluation of the various dataset generated and their evaluation via statistics.

Text Books:

- D. Mount, Bioinformatics – Sequence and Genome Analysis, 2nd Ed. Cold Spring Harbor Laboratory Press, 9780879697129, 0879697121
- William Mendenhall, Robert J. Beaver, Barbara M. Beaver, Introduction to Probability & Statistics, 14th Edition, Cengage Learning,1133103758, 9781133103752,

Reference Books:

- Arthur M.Lesk, Introduction to Bioinformatics, 4th Ed. Oxford press, 9780199651566, 0199651566

Online links for study and reference materials:
https://nptel.ac.in/courses/102/106/102106065/
www.ncbi.nlm.gov

"SEMINAR" (STPM-205)
RECENT DEVELOPMENT IN MICROBIOLOGY

L	T	P
2	0	0

Course Name: Modern Research in Microbiology
Course Code: STPM-205
Course Credit Hour: 2 hrs
Total Contact hour: 30 hrs

Course Objective:

Develop an ability to understand and present a seminar on the latest scientific and technological developments in the field of microbiology which enhances writing as well as oral communication skills.

Course Contents:

Every student, who has been enrolled in M.Sc.. (Microbiology) course, shall have to deliver a Seminar on a Recent Topic related to Recent and Applied Developments in Microbiology. Seminar will be of 45-minute duration during which the presentation will be followed by questions session by the audience comprising of faculty and students. Every student shall be required to submit the topic of his/her seminar in consultation with the Head of the Department/Faculty members well in advance so that the same may be displayed on the notice board. The speaker has to write an Abstract to be distributed during Seminar in addition to two copies of write-up giving relevant details of the background of the subject, methods used and references/List of sources from where the material for presentation has been collected.

Course Learning Outcomes (CLOs):

After completion of the course, students will understand about the Modern Research in Microbiology and develop presentation skill during the discussion and presentation. Additionally, Student will develop a drafting and writing skill.

M.Sc. Microbiology 2nd Year
SEMESTER-III

ENZYMOLOGY & BIOPROCESS TECHNOLOGY (STPB-301)

L	T	P
4	0	2

Course Name: Basics of Immunology
Course Code: STPB-301
Course Credit Hour: 4 hrs
Total Contact hour: 60 hrs

Course Objective:

This course focus on the basis of Enzymology, bioprocess technology and their techniques. It basically covers the Bioprocess parameters, spoilage of food stuffs and food processing.

Course Description:

This is a specialized branch of life sciences that deals with the biochemical nature and activity of enzymes and is a subject that has relevance to students from a wide range of disciplines. In addition, it will serve as an individual reference for students pursuing their post graduate degree programmes in life sciences and it could be recommended to anyone wishing to get an idea of the present day scope and applications of enzymology. The present course opens the door to all of the abundant careers in and out of the area of biological sciences including health/medical/ Environmental Sciences.

Course Contents:

Unit I: Isolation, preservation and maintenance of industrial microorganisms, kinetics of microbial growth and death, product decomposition, effect of environmental conditions. Bioreactors; Media for industrial fermentation, types of fermentation processes; Analysis of batch, Fed-batch and continuous bioreactions, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photobioreactors etc.).

Unit II: Measurement and control of bioprocess parameters, basic principles of feedback control, proportional, integral and derivative control; Downstream Processing: introduction, removal of microbial cells and solid matter, foam preparation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, membrane process, drying and crystallization.

Unit III: Enzyme and cell immobilization and their industrial applications; Use of microbes in mineral beneficiation and oil recovery; Industrial production of chemicals: Alcohol (ethanol), acids (citric, acetic and gluconic), solvents (glycerol, acetone, butanol), antibiotics (penicillin,

streptomycin, tetracycline), amino acids (lysine, glutamic acid). Effluent treatment: DOC and COD treatment and disposal of effluents.

Unit IV: Introduction to Food Technology- elementary idea of canning and packing, sterilization and Pasteurization, technology of typical Food/Food products (bread, cheese, idli), food preservation, fermented foods and probiotics.

Course Learning Outcomes (CLOs):

CLO1. Understand the basic concept preserving and maintenance of industrial microorganisms.
CLO2. Discuss the bioprocess parameters and their feedback control.
CLO3. Describe the basic characteristics of enzyme and cell immobilization and their industrial applications.
CLO4. Explain the Major Food Preserving techniques and their implimentations.

Text Books:

- Stanbury, A.H., A. Whittaker and Hall S.J. 1995. Principles of fermentation technology 2nd edition, Pergamon Press.
- Lehninger, Nelson, D. L. and Cox, M. M 2000. Principle of Biochemistry, Worth Publishers.

Reference Books:

- Stanburry P.P. and Whitaker, A. 1984. Principles of Fermentation Technology. Pergamon Press, OxfordUK.
- R2. Steinkraus, K.H. 1983. Handbook of Indigenous Fermented Foods. Marcel Dekker, New York.

Online links for study & reference materials:
www.bioprocessingsummit.com
https://biopharmaceutics.pharmaceuticalconferences.com

INDUSTRIAL AND FOOD MICROBIOLOGY (STPM-302)

L	T	P
4	0	2

Course Name: Industrial and Food Microbiology
Course Code: STPM-302
Course Credit Hour: 4 hrs
Total Contact hour: 60 hrs

Course Objective:

This course aims to provide instruction in the general principles of food microbiology. lt is assumed that students will have received adequate introduction to microbiology per se. The course covers the biology and epidemiology of foodborne microorganisms of public health significance, including bacteria, yeasts, fungi, protozoa and viruses, and food spoilage microorganisms; the microbiology of food preservation and food commodities; fermented and microbial foods; principles and methods for the microbiological examination of foods; micro biological quality control, and quality scheme.

Course Description:

This course deals with the beneficial and harmful association of microorganisms with the food and prospective application of the microorganisms in the food industry. Teaches the methods of controlling the type and number of microorganisms in the food as per requirement. Teaches about the role of food regulatory bodies and measures of food safety and quality control.

Course Contents:

Unit I: Introduction to industrial microbiology: Sources of industrially important microbes, strain development, types of fermentation and fermenters, process optimization, and recent developments in fermentation technology. **Downstream processing of microbial products:** Filtration, centrifugation, cell disruption, liquid-liquid extraction, chromatography, membrane processes, drying (lyophilization and spray drying), and crystallization

Unit II: Fermentation economics: Basic objective for successful economically viable fermentation process, cost break down for well-established fermentation processes, market potential of the products, cost aspects of various stages in the processes development including effluent treatment.

Unit III: Production aspects: Microbial strains, substrates, strain improvement, flow diagrams, product optimization, and applications of industrial alcohol (ethanol and butanol), amino acids (lysine, phenylalanine, tryptophan), antibiotics (cephalosporins, tetracyclines, polyenes), enzymes

and immobilized enzymes, SCP, microbial polyesters, biosurfactants, and recombinant products (insulin, somatostatin, thaumatin).

Unit IV: Microbiology of foods: Vegetables, fruits, milk, fermented and non-fermented milk products, fresh meats, poultry and non-dairy fermented foods.

Unit V: Microbial spoilage of foods Food preservation: Chemical, physical and biological methods. Fermentation processes: Production of milk and milk products, plant based products, fish products, meat products and food beverages. Food-borne diseases

Course Learning Outcomes (CLOs):

Upon successful completion of this course the student will be able to:

CLO1. Get equipped with a theoretical and practical understanding of industrial microbiology Appreciate how microbiology is applied in manufacture of industrial products.

CLO2. Know how to source for microorganisms of industrial importance from the environment.

CLO3. Know about design of bioreactors, factors affecting growth and production, heat transfer, oxygen transfer**.**

CLO4. Understand the rationale in medium formulation & design for microbial fermentation, sterilization of medium and air**.**

CLO5. Appreciate the different types of fermentation processes.

Text Books:

- Casida, Industrial Microbiology, (1999) by. LE, New age International (P) Limited, Publishers. ISBN: 9788122438024, 8122438024
- A.H. Patel, Industrial Microbiology (2000) by. Macmillan Publishers India, ISBN: 9780333908426

Reference Books:

- A.H.Patel, Industrial microbiology by, Macillan India Ltd.
- P. Stanbury & Allan Whitekar, Principles of Fermentation Technology by, Pergamon. ISBN: 9781483292915, 1483292916

Online links for study & reference materials:

https://www.khanacademy.org/

https://nptel.ac.in/courses

GENETIC ENGINEERING (STPM-303)

L	T	P
4	0	2

Course Name: Genetic Engineering
Course Code: STPM-303
Course Credit Hour: 4 hrs
Total Contact hour: 60 hrs

Course Objective:

Following are the key course objectives:

- To make the students familiar about the translation machinery and concept of r-DNA technology and their application in advanced research
- To make the student to understood the concept of gene manipulation and gene transfer technologies
- To make aware the students about manipulation of genes, Transfer techniques, Expression systems and methods of selection

Course Description:

Course basically helps in getting basic concept about genetics principles and also to be aware of the tools for genetic engineering such as PCR, Restricting mapping and other relevant topics.

Course Contents:

Unit I: Genetic Engineering and Recombinant DNA technology: Introduction to the scope of genetic engineering. Overview of the principles and progress in genetic engineering. Basic steps involved in recombinant DNA technology: Isolation of DNA from various sources, fragmentation methods, ligation strategies, introduction of the chimeric DNA into various host cells and selection and screening of recombinant clones. Basic enzymes used in RDT.

Unit II: Cloning and expression vectors: Introduction to Plasmids; Lambda based vectors and derivatives (Insertion vectors, replacement vectors, cosmids, phasmids, phagemids, in-vitro packaging, selection schemes); high-cloning capacity vectors: single stranded DNA vectors (M13); YACs, BACs.

Unit III: Polymerase Chain Reaction: Basic principles and its modifications, designing of primers, Different schemes of PCR, application of PCR, Brief introduction to RT- PCR and Real-Time PCR.

Unit IV: Gene Sequencing methods: Introduction to Nucleic acid sequencing methodologies, Sequencing techniques: Maxam & Gilbert degradation method, Sanger's Dideoxy method, Organo-chemical gene synthesis mechanism, cDNA using reverse transcriptase.

Unit V: cDNA Libraries and molecular techniques: Construction and Screening of genomic and cDNA libraries, Different blotting techniques: Southern, Northern, Western blotting, DNA Fingerprinting, RFLP, VNTR, STR and its applications.

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Course Learning Outcomes (CLOs):

CLO1. The students will have knowledge of tools and strategies used in genetic engineering
CLO2. Understanding of applications of recombinant DNA technology and genetic engineering (from academic and industrial perspective)
CLO3. Apply the knowledge of genetic engineering in problem solving and in practice
CLO4. Students will understand the basics of gene cloning, role of enzymes and vectors for genetic engineering.
CLO5. Students will be aquainted with Gene transfer methods, Techniques and safety measures of genetic engineering, genome mapping and gene therapy.

Text Books:

- Principles of Gene Manipulation by S.B. Primrose, RM Twyman and RW Old (6thEdition)
- Recombinant DNA: A Short Course by JD Watson, J. Tooze and DT Kurtz.
- Principles of Gene Manipulation and Genomics SEVENTH EDITION S.B. Primrose and R.M. Twyman

Reference Books:

- Molecular Cloning: a Laboratory Manual, J Sambrook, E F Fritsch and T Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
- Principles of Gene manipulation (1994) Old R.N. and Primrose S.B.
- Recombinant DNA (1992) Watson J.D., Witreowski J., Gilman M. and Zooller M.

Online links for study & reference materials:
www.microbenotes.com
www.nptel.ac.in
www.byjus.com

PARASITOLOGY (STPM-304)

L	T	P
4	0	2

Course Name: Host-pathogen interaction
Course Code: STPM-304
Course Credit Hour: 4 hrs
Total Contact hour: 60 hrs

Course Objective:

This course will enable students to acquire knowledge on the fundamentals of Host-pathogen interaction. It enables them to understand emerging and advanced concept in host pathogen interaction and this course also focuses on the host parasite interaction which include etiology, pathogenicity, life cycle, lab diagnosis and treatment. This program will facilitate the students to acquire knowledge in fields various aspects and molecular tools used in clinical application in alleviation of human disease.

Course Description:

This course is mainly focused to understand emerging and advanced concept in molecular pathogenesis of disease and role of biotechnology in diagnosis, prevention and therapeutics. An understanding of the basic biology and life cycles of human parasites; human parasitic infections, including epidemiology, clinical features, laboratory diagnosis, treatment and prevention.

Course Contents:

Unit I: Introduction: Basic concept of Host-pathogen interaction, Basic concept of Parasites, Classification of Parasites, Host, Types of host, Relationship between host and parasites.

Unit II: Protozoan infection and host response: (introduction, A-etiology, pathogenicity, life cycle, lab diagnosis and treatment): Amoeboids (*Entamoeba histolytica*), Flagellates (*Giardia* spp), Sporozoans (*Plasmodium* spp), Leishmania, Trypanosoma

Unit III: Platyhelminthes infection and host response: (Introduction, A-etiology, pathogenicity, life cycle, lab diagnosis and treatment): Taenia, Echinococcus

Unit IV: Nemathelminthes infection and host response: (introduction, A-etiology, pathogenicity, life cycle, lab diagnosis and treatment): Ascaris, Ancylostoma, Necator, Enterobius, Wuchereria

Unit V: Lab Diagnosis: Different specimens of parasitology, Collection & transportation. Processing of parasitological specimens

Course Learning Outcomes (CLOs):

CLO1. Understand the basic concept Parasitology and its importance.
CLO2. Discuss etiology, pathogenicity, life cycle, lab diagnosis and treatment of protozoan parasite.
CLO3. Discuss etiology, pathogenicity, life cycle, lab diagnosis and treatment of Platyhelminthes.
CLO4. Discuss etiology, pathogenicity, life cycle, lab diagnosis and treatment of Nemathelminthes.
CLO5. Explain the method for collection and processing of parasitological specimens.

Text Books:

- Textbook of Microbiology' by CP Baveja, 2nd edition, 1998, Arya longman Pvt. Ltd
- Textbook of Medical Lab Technology' 2010, by Praful Godkar
- Text book of Medical Laboratory' by Satish Gupta, Edition - latest, 2006, J.P. Bros.

Reference Books:

- Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.
- Medical parasitology' by Chatarjee, 3th edition
- Medical Microbiology and Immunology' by Warren Levinson, eighth Edition, Lange Medical books/ McGraw-Hill Publication

Online links for study & reference materials:

https://www.cdc.gov/parasites/about.html
http://www.onlinebiologynotes.com/
http://www.biologydiscussion.com/parasites/classification-of-parasites-parasitology/62036

CBCS** GENOMICS AND PROTEOMICS (STPB-305A)

L	T	P
2	0	0

Course Name: Genomics and Proteomics
Course Code: STPB-305A
Course Credit Hour: 2 hrs
Total Contact hour: 30 hrs

Course Objective:

It is intended to impart basic postgraduate-level knowledge in the area of Genomics and Proteomics. It also aims to familiarize them with the developments in the experimental approaches used by researchers to understand the complexity and diversity of genomes. Recent advances in genomics have transformed the way in which biologists study cells and biological systems. Furthermore, this course also provides knowledge of the use of high throughput techniques to study the entire range of proteins present in any cell/tissue/organism under specific conditions, to obtain a global view of cellular processes at the protein level.

Course Description:
This course is mainly focused on the Genomics and Proteomics and discuss the basic concept of genomics, such as origin, evolution and application of genomics and proteomics. This course also focuses to elaborates the Genomic and Proteomics techniques; from basic to advance level. It covers basic understanding of Genomics, Annotation of whole genome sequence & functional genomics, Pharmacogenomics and Proteomics.

Course Contents:

Unit I: Origin and Evolution of genomics: Introduction to genomics, type of genome exist in nature, DNA Marker & microsatellite, DNA based phylogenetic trees, genomes and human evolution, Introduction to Shotgun Sequencing methods, evolution of mitochondrial and Chloroplast genome, Anticipated Benefits of Genome Research

Unit II: Annotation of whole genome sequence and functional genomics: Whole genome shotgun sequencing, *In silico* methods, insertion mutagenesis (T-DNA and transport insertion), gene expression and transcript profiling, EST contigs and unigene sets, use of DNA chips and microarrays.

Unit III: Pharmacogenomics: Introduction to Pharmacogenomics, Use in biomedicine involving diagnosis and treatment of diseases, genomics in medical practice, personalized medicine, DNA polymorphism and treatment of diseases, use of SNP in pharmacogenomics, future of pharmacogenomics.

Unit VI: Proteomics: Introduction, definition concepts and approaches of proteomics studies and activities. Introduction proteome analysis tool and technique: Western blotting technique, Separation technique- Polyacrylamide gel electrophoresis (PAGE), 2DPAGE, Mass-spectrophotometery.

Course Learning Outcomes (CLOs):

CLO1. Gain an understanding of the basic concepts of genomics and its scope.
CLO2. Outline the fundamental of DNA based phylogenetic trees.
CLO3. Discuss the Annotation of whole genome sequence and functional genomics.
CLO4. Describe the basic concepts of pharmacogenomics and its future prospective.
CLO5. Explain the fundamentals of proteomics and advance molecular biology techniques.

Text Books:

- Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Campbell AM & Heyer LJ, Benjamin Cummings 2007; CSH Press, NY.
- Introduction to Proteomics: Tools for the New Biology. Daniel C. Liebler, 2002 Humana Press Inc.
- Primrose SB and Twyman RM. Genomics: Applications in human biology. Blackwell Publishing, 2008 Oxford, U.K

Reference Books:

- Genome III – T.A. Brown Garland Science Publ. June 08, 2006
- Bioinformatics and Functional Genomics – Jonathan Pevsner - 2nd edition, Wiley-Blackwell, 2009.
- Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press

Online links for study & reference materials:

http://www.genomenewsnetwork.org/resources
http://www.pss.co.jp/english/sc_bio/contents4.html
http://www.premierbiosoft.com/tech_notes/microarray.html

CBCS** BIOINFORMATICS (STPB-305B)

L	T	P
2	0	0

Course Name: Bioinformatics
Course Code: STPB-305B
Course Credit Hour: 2 hrs
Total Contact hour: 30 hrs

Course Objective:

It is intended to impart basic postgraduate-level knowledge in the area of Bioinformatics. This course is beneficial for students to understand the principles of analyzing biological data, building models and testing hypotheses using computer science algorithms. This course is a survey of algorithms and tools in biological sequence analysis, genome-wide disease association, and precision medicine. Basic concept machine learning and its application in the analysis of biological data are also included in this course.

Course Description:

This course is mainly focused on the basic concept of bioinformatics and discuss the basic overview of various information repositories widely used in biological sciences; and tools for searching or querying those databases. This course will build the foundation of sequence alignment techniques and find evolutionary connections. It will help students to analyze genome data and mRNA expression data and gene annotations.

Course Contents:

Unit I: Introduction to computers and bioinformatics- Types of operating systems, concepts of networking and remote login, basic fundamentals of working with unix.

Unit II: Biological databases- Overview, modes of database search, mode of data storage (Flat file format, db-tables), flatfile formats of GenBank, EMBL, DDBJ, PDB.

Unit III: Sequence alignment –Concept of local and global sequence alignment, Pairwise sequence alignment, scoring an alignment, substitution matrices, multiple sequence alignment. **Phylogenetic analysis-** Basic concepts of phylogenetic analysis, rooted/uprooted trees, approaches for phylogenetic tree construction (UPGMA, Neighbour joining, Maximum parsimony, Maximum likelihood).

Unit IV: Generation and analysis of high throughput sequence data- Assembly pipeline for clustering of HTGS data, format of ".ace" file, quality assessment of genomic assemblies, International norms for sequence data quality, Clustering of EST sequences, concept of Unigene.

Unit V: Annotation procedures for high through-put sequence data- Identification of various genomic elements (protein coding genes, repeat elements, strategies for annotation of whole genome, functional annotation of EST clusters, gene ontology (GO) consortium.

Course Learning Outcomes (CLOs):

CLO1. Basic concept of computational analyses of biological sequences, genome-wide studies and relate the results to core principles of biology; use computational methods to help execute a biological research plan.
CLO2. Outline the fundamental of DNA based phylogenetic trees.
CLO3. Discuss the Annotation of whole genome sequence and functional genomics.
CLO4. Describe the basic concepts of pharmacogenomics and its future prospective.
CLO5. learn to align sequences using dot matrices, dynamic programming and heuristic approach; understand the notion of similarity, identity, and gaps in the context of sequence alignment and deduce evolutionary relationships among sequences.

Text Books:

- Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Baxevanis A.D. and Ouellette, Third Edition. John Wiley and Son Inc., 2005.
- Bioinformatics Sequence and Genome Analysis by Mount D.W., CSHL Press, 2004
- Jonathan Pevsner. Bioinformatics and Functional Genomics, 2nd Edition. ISBN: 978-0-470-08585-1.
- Greg Gibson and Spencer V. Muse. A Primer of Genome Science, Third Edition. ISBN: 978-0-87893-309-9.

Reference Books:

- Bioinformatics and Functional Genomics – Jonathan Pevsner - 2nd edition, Wiley-Blackwell, 2009.
- Introduction to Bioinformatics by Tramontano A., Chapman & Hall/CRC, 2007.
- Understanding Bioinformatics by Zvelebil, M. and Baum, Chapman & Hall/CRC, 2008.

Online links for study & reference materials:

http://www.genomenewsnetwork.org/resources
http://www.pss.co.jp/english/sc_bio/contents4.html
http://www.ncbi.nic.

CBCS** BIOINFORMATICS (STPB-305B)

L	T	P
2	0	0

Course Name: Bioinformatics
Course Code: STPB-305B
Course Credit Hour: 2 hrs
Total Contact hour: 30 hrs

Course Objective:

It is intended to impart basic postgraduate-level knowledge in the area of Bioinformatics. This course is beneficial for students to understand the principles of analyzing biological data, building models and testing hypotheses using computer science algorithms. This course is a survey of algorithms and tools in biological sequence analysis, genome-wide disease association, and precision medicine. Basic concept machine learning and its application in the analysis of biological data are also included in this course.

Course Description:

This course is mainly focused on the basic concept of bioinformatics and discuss the basic overview of various information repositories widely used in biological sciences; and tools for searching or querying those databases. This course will build the foundation of sequence alignment techniques and find evolutionary connections. It will help students to analyze genome data and mRNA expression data and gene annotations.

Course Contents:

Unit I: Introduction to computers and bioinformatics- Types of operating systems, concepts of networking and remote login, basic fundamentals of working with unix.

Unit II: Biological databases- Overview, modes of database search , mode of data storage (Flat file format, db-tables), flatfile formats of GenBank, EMBL, DDBJ, PDB.

Unit III: Sequence alignment –Concept of local and global sequence alignment, Pairwise sequence alignment, scoring an alignment, substitution matrices, multiple sequence alignment. **Phylogenetic analysis-** Basic concepts of phylogenetic analysis, rooted/uprooted trees, approaches for phylogenetic tree construction (UPGMA, Neighbour joining, Maximum parsimony, Maximum likelihood).

Unit VI: Generation and analysis of high throughput sequence data- Assembly pipeline for clustering of HTGS data, format of ".ace" file, quality assessment of genomic assemblies, International norms for sequence data quality, Clustering of EST sequences, concept of Unigene.

Unit V: Annotation procedures for high through-put sequence data- Identification of various genomic elements (protein coding genes, repeat elements, strategies for annotation of whole genome, functional annotation of EST clusters, gene ontology (GO) consortium.

Course Learning Outcomes (CLOs):

CLO1. Basic concept of computational analyses of biological sequences, genome-wide studies and relate the results to core principles of biology; use computational methods to help execute a biological research plan.
CLO2. Outline the fundamental of DNA based phylogenetic trees.
CLO3. Discuss the Annotation of whole genome sequence and functional genomics.
CLO4. Describe the basic concepts of pharmacogenomics and its future prospective.
CLO5. learn to align sequences using dot matrices, dynamic programming and heuristic approach; understand the notion of similarity, identity, and gaps in the context of sequence alignment and deduce evolutionary relationships among sequences.

Text Books:

- Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Baxevanis A.D. and Ouellette, Third Edition. John Wiley and Son Inc., 2005.
- Bioinformatics Sequence and Genome Analysis by Mount D.W., CSHL Press, 2004
- Jonathan Pevsner. Bioinformatics and Functional Genomics, 2nd Edition. ISBN: 978-0-470-08585-1.
- Greg Gibson and Spencer V. Muse. A Primer of Genome Science, Third Edition. ISBN: 978-0-87893-309-9.

Reference Books:

- Bioinformatics and Functional Genomics – Jonathan Pevsner - 2nd edition, Wiley-Blackwell, 2009.
- Introduction to Bioinformatics by Tramontano A., Chapman & Hall/CRC, 2007.
- Understanding Bioinformatics by Zvelebil, M. and Baum, Chapman & Hall/CRC, 2008.

Online links for study & reference materials:
http://www.genomenewsnetwork.org/resources
http://www.pss.co.jp/english/sc_bio/contents4.html
http://www.ncbi.nic

M.Sc. Microbiology 2nd Year
SEMESTER-IV

ENVIRONMENTAL MICROBIOLOGY (STPB-401)

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Course Name: Environmental Microbiology
Course Code: STPB-401
Course Credit Hour: 4 hrs
Total Contact hour: 60 hrs

Course Objective:

The course provides the students with a conceptual and experimental background in the broad discipline of environmental microbiology. The students will be introduced to the major groups of microorganisms and their diversity in structure and functions and microbial interactions. Emphasis has been laid on Microorganisms and their Habitats. The course also introduces the students to the scope of Biogeochemical Cycling, Waste Management and Microbial Bioremediation.

Course Description:

This course is mainly focused on the Environmental Microbiology which includes basic concept of patents, patent regime (in India and abroad) registration aspects and other details.

Course Contents:

Unit I: Microorganisms and their Habitats: Structure and function of ecosystems; Terrestrial Environment: Soil profile and soil microflora; Aquatic Environment: Microflora of fresh water and marine habitats; Atmosphere: Aeromicroflora and dispersal of microbes; Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body.Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic& osmotic pressures, salinity, & low nutrient levels.Microbial succession in decomposition of plant organic matter

Unit II: Microbial Interactions: Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism,predation, Microbe-Plant interaction: Symbiotic and non symbiotic interactions. Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria.

Unit III: Biogeochemical Cycling: Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin, Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction, Phosphorus cycle: Phosphate immobilization and solubilisation, Sulphur cycle: Microbes involved in sulphur cycle, Other elemental cycles: Iron and manganese

Unit IV: Waste Management: Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill), Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary, sewage treatment

Unit V: Microbial Bioremediation: Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants.

Course Learning Outcomes (CLOs):

CLO1. Discuss the basic concept of ecosystems, microorganisms and their Habitats: Terrestrial and Aquatic Environment.
CLO2. Understand microbe-microbe interactions, microbe-Plant interaction and Microbe-animal interaction
CLO3. Describe the Basic concept of Biogeochemical Cycling, such as Carbon cycle, Nitrogen cycle, Phosphorus cycle, Sulphur cycle and others.
CLO4. Discuss the Solid Waste management, Liquid waste management, primary, secondary and tertiary sewage treatment.
CLO5. Discuss the basic concept and importance of Microbial Bioremediation; Principles and degradation of common pesticides: organic and inorganic matter

Text Books:

- Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition.Benjamin/Cummings Science Publishing, USA
- Microbial Ecology: Fundamentals & Applications. 4th edition.Benjamin/Cummings Science Publishing, USA (2000)
- Textbook for Environmental Studies, University Grants Commission, New Delhi and Bharati Vidyapeeth Institute of Environmental Education and Research, Pune. 361 (2003)

Reference Books:

- Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, AcademicPress
- Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition.Pearson/ Benjamin Cummings

Online links for study & reference materials:
www.highveld.com/ environmental microbiology
https//onlinecourse.nptel.ac.in

CLINICAL RESEARCH AND ENTREPRENEURSHIP (STPB-402)

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Course Name: Clinical Research and Entrepreneurship
Course Code: STPB-402
Course Credit Hour: 4 hrs
Total Contact hour: 60 hrs

Course Objective:

To enrich the understanding of clinical data management procedure in clinical research which sponsor, CRO and Hospital use for clinical trials. To know the latest technology of clinical data management used in clinical trials.

Course Description:

This course provides students with insight into the issues, challenges and opportunities involved in the creation and management of a new venture over its full life cycle. Typically, entrepreneurs are consumed with their product or service and are not prepared to strategically nor tactically lead the venture.

Course Contents:

Unit I: Clinical Research: Basic conventional drug design approaches, Drug development process (Preclinical, clinical and toxicological studies). Past, Present and future Importance, Mile stones of regulations. FDA, US, Indian clinical research, global scenario of clinical research, Regulatory agency. Designing clinical trials- History, principles, scheme for conducting clinical trials, planning defining, objectives, variables, study populations, testable hypothesis.

Unit II: Ethical Issues in clinical research- Introduction, codes, declaration and guidelines, informed concent, special issues, Roles and responsibilities of IRBS, issues with ethics review

Unit III: Introduction of Entrepreneurship: definition, history and scope of Biotechnology Entrepreneurship. **Biotechnology Marketing & Companies:** Biotechnology in capital market; Initial Public Offering (IPO) in the capital market; examples of success and failure of biotechnology companies and the possible reasons. **Patenting, licensing and partnership in biotechnology industry:** Patents on biological inventions, licensing revenue, selection of right partner; negotiations of the terms of the terms of the deal.

Unit IV: Entrepreneurship Skills: Entrepreneurship Skills of bio-entrepreneur, bio-entrepreneurial training; research experience, creativity, communication skills and other attributes;

participation in conferences, training and educational courses; institutes offering entrepreneurship courses.

Course Learning Outcomes (CLOs):

After completion of the course the students will be able to:
CLO1. Learn how to build a business in healthcare based on their own research, demonstrate an understanding of the opportunities of health innovation and entrepreneurship for utilization of research.
CLO2. Apply scientific background and new knowledge of health innovation to address challenges and develop services and products within a clinical setting and a biopharma/medtech setting and use various business tools for ideation and feasibility studies; to develop, prototype and test solutions in response to user needs.
CLO3. Develop a business plan based upon a novel idea and communicate a business plan to people within the startup world and demonstrate an understanding of how Tech Transfer Offices and other innovation support actors can support the commercialization process.
CLO4. Discuss and argue for different types of intellectual property and intellectual assets, and understand different patent strategies and apply the basics in financing a startup company from private and governmental funding bodies.
CLO5. Discuss and argue for different types of intellectual property and intellectual assets, and establish patent strategies and assess their skills in health innovation and reflect on the exploitation of their own research combine being a scientist and a health innovator/entrepreneur.

Text Books:

- Richard K. Rondel, Sheila A. Varley, Colin F. Webb, Clinical Data Management, 2nd Edition ISBN No. 9780471983293, 0471983292
- Susanne Prokscha, Practical Guide to Clinical Data Management, Taylor & Francis, ISBN no. 9781439848296, 1439848297

Reference Books:

- Raymond G Hill, Drug Discovery and Development , 2nd Edition by, ISBN No. 9780443064203, 0443064202
- Hisrich, Robert D., Michael P. Peters, and Dean A. Shepherd. Entrepreneurship. McGraw-Hill Education, 2017, ISBN No. 9783319487014, 3319487019

Online links for study & reference materials:
https://www.khanacademy.org/
https://swayam.gov.in/
https://nptel.ac.in/

PROJECT (STPB-403)

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Course Name: Research Project in Microbiology
Course Code: STPB-403
Course Credit Hour: 8 hrs
Total Contact hour: 120 hrs

Course Objective:

Develop an ability to understand the basic requirement to conduct a research project. Student also develop skill of writing and presentation on the assigned research topics in the field of microbiology.

Course Contents:

Every student will be required to undertake a research project based on any of the areas of Microbiology. The research project should have applied significance. The project report will be submitted in the form of dissertation duly certified by the supervisor of the Department of Microbiology or at national institutes and Universities in India, by seeking the placement. The project will be presented for evaluation at the end of semester by external experiments.

Course Learning Outcomes (CLOs):

After completion of the course, students will understand about the Research in Microbiology and develop presentation skill during the conduction of research, discussion and presentation. Additionally, Student will develop a drafting and writing skill.