KERALA UNIVERSITY OF FISHERIES AND OCEAN STUDIES

Panangad, Kochi- 682506, Kerala

M. Sc. Biotechnology

Syllabus

2020

Regulations, Eligibility, Scheme and Syllabus For M. Sc. Biotechnology

(Effective from 2020 Admission onwards)

All the general rules and regulations laid down by the Kerala University of Fisheries and Ocean Studies PG Curriculum shall be applicable.

I. ELIGIBILITY CRITERIA

Those students who possess B.Sc./B.Tech Degree in Biological/Chemical including Biotechnology/Microbiology, Biochemistry/ Chemistry/Lifesciences/ Zoology/ Botany/ Veterinary/ Fishery Science / Pharmacy are eligible for admission to this Programme.

II. PROCESS OF ADMISSION

Candidates for admission will be selected on the basis of entrance examination conducted by Kerala University of Fisheries & Ocean Studies

III. PROGRAMME AND SCHEME OF EXAMINATIONS

1. M.Sc. Biotechnology programme shall have 5 core courses and 3 core practical courses in 1st semester, 4 core courses and 3 core practical courses and 2 elective courses in 2nd semester; 4 core course, 4 core practical courses and 2 elective courses in 3rd semester. In 4th semester viva-voce, evaluation of project work/ dissertation/viva voce and journal credit seminar will be conducted at the end of 4th semester.
2. There shall be external university examination of 3 hour duration for each theory courses at the end of each semester, to be conducted after the completion of 80 working days.
3. Each theory shall have 3 credits and practical course 2 credits.
4. Practical examination will be in the mode of continuous evaluation. There will be 2 internal practical examinations during each semester for each course. Each practical exam will be evaluated for 90 marks and 10 marks for the records.
5. There will be a pass minimum of 40% for theory and practical examination. Students who fail to get pass minimum of 40% in theory or in practical examination will be given another chance to reappear for 1 additional test in theory of practical examination. The marks of which will be taken into account for averaging in the case of theory or totalling in the case of practical.
6. For external, supplementary examination will be conducted as per the university regulations.

IV. EVALUATION

7. Project / dissertation evaluation/ viva-voce shall be conducted at the end of the programme only.
8. Project / dissertation, journal seminar and viva voce shall carry 22 credits in total.
9. Combined field studies and study tours may be carried out at any time during the entire period of the programme.
10. Each theory question paper may contain 10 short answer types, of weightage 1, 4 short essays out of 6 questions of weightage 5. Two long essays out of 4 questions of weightage 10.

V. EVALUATION AND GRADING

The evaluation scheme for each course shall contain two parts (a) Internal evaluation and (b) external evaluation. 50 marks shall be given to internal evaluation and the remaining 50 to external evaluation.

Internal evaluation: The internal evaluation shall be based on predetermined transparent system involving periodic written tests, assignments, seminars, classroom participation and attendance. Theory courses will be based on written tests while lab skill/records/viva/ attendance will be considered in the case of practical courses. The weightage assigned to various components for internal evaluation is a follows.

VI. TABULATION OF RESULTS

1. Marks obtained in each course will be entered separately.
2. For a pass the student should score a minimum of 40% in each course and 50% in aggregate (theory and practical) 4
3. Note: A paper wise minimum of 40% in each course and a 50% aggregate in each semester as stipulated for a student to pass the examination. If a candidate has scored 50% aggregate but failed to get the paper minimum of 40% in any papers, such candidate shall reappear for the concerned paper only to get the paper minimum (40%).

. COMPONENTS OF INTERNAL EVALUATION

	Component	Weightage
A	Assignment	10
B	Seminar	5
C	Attendance	5
D	Class room participation	5
E	Test paper	25

To ensure transparency of the evaluation process, the internal assessment grade awarded to the students in each course in a semester shall be published on the notice board at least one week before the commencement of external examination. There shall not be any chance for improvement for internal grade.

The course teacher shall maintain the academic record of each student registered for the course, which shall be forwarded to the University, through the Director of the School.

External evaluation: The external Examination in theory courses is to be conducted by the University with question papers set by external experts. The evaluation of the answer scripts shall be done by examiners based on a well-defined scheme of valuation. The external evaluation shall be done immediately after the examination preferably in a Centralized Valuation Camp.

VII. GRIEVANCE CELL

Students grievances pertaining to the award of internal marks shall be brought to the notice of the teacher concerned. In the case of failure to settle the grievances, the matter shall be placed in a three member departmental committee consisting of School Director, HOD and the concerned teacher. School Director/HOD will be the chairman of the committee and the decision of the committee shall be final.

VIII. EVALUATION OF PROJECT REPORT/ DISSERTATION

Dissertation will be valued by two examiners who conduct the viva voce/dissertation evaluation (external) at the end of 4th semester. Valuation schedule is as given below.

Distribution of 15 weightage allotted for dissertation will be as follows

Methodology	4 weightage
Content	4 weightage
Presentation	2 weightage
Answering question	2 weightage
Originality or overall outlook	3 weightage
Total	15 weightage

IX. JOURNAL SEMINAR/CREDIT SEMINAR

All students need to present an internal journal seminar based on the project work done by them. Students should have to present using power point presentations and must be able to present the research work and answer the questions posed by the internal examiner.

Journal seminar	5 weightage
Total	**5 weightage**

M.Sc. Biotechnology-Course Structure, Scheme & Syllabus

(Credit Semester System-2020 Admission onwards)

I Semester

Course	Course code	Course Title	Lecture	Tutorial	Practical	Credit	Exam duration (hrs)	Internal (%)	External (%)
			Hours						
Core	BIT2101	Biochemistry	3			3	3	50	50
Core	BIT2102	Microbiology	3	1		3	3	50	50
Core	BIT2103	Cell Biology & Genetics	3	1		3	3	50	50
Core	BIT2104	Bioinformatics	3			3	3	50	50
Core	BIT 2105	Biophysics and Biostatistics.	3			3	3	50	50
Practical Courses	BIT2106	Practical in Biochemistry & Cell Biology and Genetics			5	2	3	100	—
	BIT2107	Practical inMicrobiology			5	2	3	100	—
	BIT2108	Statistical Analysis			2	1	3	100	—
		Total Credits for I Semester = 20							

II Semester

Course	Course code	Course Title	Lecture	Tutorial	Practical	Credit	Exam	Internal duration(%) (hrs)	External (%)
Core	BIT2201	Molecular Biology	3		3	3	50	50	
Core	BIT2202	Immunology	3			3	3	50	50
Core	BIT2203	Genomics and Proteomics	3		3	3	50	50	
Core	BIT2204	Plant Biotechnology	3			3	3	50	50
One Elective Course	BIT2205	Nanotechnology	2			2	3	50	50
	BIT2206	Environmental Biotechnology							
Practical Courses	BIT2207	Practical in Molecular Biology			4	2	3	100	—
	BIT2208	Practical inImmunology			4	2	3	100	—
	BIT2209	Practical in Plant Biotechnology			4	2	3	100	—
Open Elective Courses	BIT 2210	General Oceanography	3			3	3	50	50
	BIT 2211	Environment and Biodiversity							
	BIT 2212	Maine Drugs							
	BIT 2213	Marine chemistry							
	BIT 2214	Climate change and Polar Sciences							
		Total credits for II Semester = 23							

II Semester

Course	Course code	Course Title	Lecture	Tutorial	Practical	Credit	Exam duration(hrs)	Internal (%)	External (%)
Core	BIT2301	Animal Biotechnology	3		3	3	50	50	
Core	BIT2302	Genetic Engineering &							
		rDNA Technology	3			3	3	50	50
Core	BIT2303	Bioprocess Technology	3			3	3	50	50
Core	BIT2304	Aquaculture Biotechnology	3		3	3	50	50	
Practical Courses	BIT2305	Practical in Animal Biotechnology			4	2	3	100	-
	BIT2306	Practical in Genetic Engineering & rDNA Technology			4	2	3	100	-
	BIT2307	Practical inBioprocess Technology			4	2	3	100	-
	BIT2308	Practical in & Aquaculture Biotechnology			4	2	3	100	—
One Elective Course	BIT 2309	Research Methodology and Scientific Writing	2			2	3	50	50
	BIT 2310	Biopharmaceutical							
	BIT 2311	Biodiversity							
Open Elective Courses	BIT2312	Coastal Oceanography	3			3	3	50	50
	BIT 2313	Instrumentation techniques							
	BIT 2314	Marine Geology							
	BIT 2315	Marine Chemistry							
	Total Credits for III Semester = 25								

IV Semester

Core	BIT2401	Dissertation	——	8	20	——	——	100
Core	BIT2402	Recent Advances in Biotechnology- Journal seminar	——	2	2	——	100	
Total credit for IV semester = 22								

Total Credits for M.Sc. Biotechnology Course (20+23+25+ 22) = 90 Credits

SEMESTER I

Core Paper

BIT-2101-Biochemistry (3 credits)

Unit-I

Biomolecules: micromolecules, macromolecules, water, buffer systems and importance. Carbohydrates-structure, classification- monosaccharaides (trioses, tetroses, pentoses, hexoses, aldoses, ketoses), disaccharides and polysaccharides (homo and hetero polysaccharides); biological functions of carbohydrates. Lipids- classification-simple lipids, (neutral fats and waxes), conjugated lipids (phospholipids, sphingolipids, glycolipids, lecithins, cephalins, cerebrosides, gangliosides), derived lipids (fatty acids, essential fatty acids, Omega 3 fatty acids, steroids, prostaglandins), biological functions of lipids. Carbohydrate metabolism – glycogenesis, glycogenolysis, hexose monophosphate shunt, metabolic pathway of glucose- glycolysis, Kreb's cycle, electron transport cycles, chemiosmosis, hormonal control of carbohydrate metabolism.

Unit-II

Proteins - classification of proteins, amino acids- basic structure, structure of protein- primary, secondary, tertiary and quaternary structures, haemoglobin as atypical protein, biological functions of proteins. Proteins as Enzymes – classification and nomenclature, general properties of enzymes; mechanism of enzyme action, enzyme kinetics (basics); enzyme specificity, isoenzyme, co-enzyme, co-factors, lysozyme, zymogen. Enzyme activation and Inhibition and different types of inhibitors.

Unit-III

Lipid metabolism – hydrolysis of lipid, beta oxidation, mention alpha and omega oxidation of fatty acids, hormonal control of lipid metabolism. Protein metabolism – deamination, transamination, formation of urea, hormonal control of protein metabolism. Nucleic acid metabolism- biosynthesis, catabolism and regulation of purine and pyrimidine metabolism.

Unit-IV

Enzyme kinetics -Enzyme catalysis- General principles of catalysis : quantitation of enzyme activity and efficiency; enzyme characterization/kinetics, Michaelis-Menten equation, Km, Vmax efficiency of enzymes, enzyme inhibition- types and their kinetics, relevance of enzyme in metabolic regulation, activation, inhibition and co-valent modification, single substrate enzyme, metaloenzyme and allosteric enzyme.

Reference Books:

Donald Voet,

1. Judith G. Voet(2010) Biochemistry, 4th Edition,Wiley.
   David L. Nelson
2. , Michael M. Cox (2013) Lehninger Principles of Biochemistry, 6th Edition, Macmillan.
3. Jeremy M. Berg, John L.Tymoczko and LubertStryer(2012) Biochemistry,7th Edition.W.H.Freeman and Co New York.
4. Robert Murray, David Bender, Kathleen M. Botham, Peter J. Kennelly, Victor Rodwell, P. Anthony Weil (2012) Harpers Illustrated Biochemistry, 29th Edition.McGraw-Hill Medical.

Core Paper

BIT-2102- Microbiology (3 Credits)

Unit I

Introduction to Microbiology: Discovery of microorganisms: spontaneous generation, Koch's postulates, pure culture methods, microscope: light microscope, dark field, phase contrast, fluorescence microscope, confocal microscope, electron microscope: transmission and scanning electron microscope.

Unit II

Bacterial cell structure: pili, flagella- structure and fuction, plasma membrane cell walls, peptidoglycan layer, biosynthesis of peptidoglycan layer, cell inclusions, PHB,carboxysomes, gas vesicles, magnetosomes, nucleoid, endospore and sporulations. Archeal cell structure, flagella and motility, cell envelope, plasma membrane, cell walls cytoplasm, ribosome nucleoid. Viruses- structure, multiplication, lytic and lysogenic cycle. Examples of microbial, plant, and animal viruses. Microbial taxonomy. Classification of microorganisms, criteria for classification, polyphasic identification molecular and biochemical characterization.

Unit III

Microbial growth, factors influencing growth, solutes, PH, temperature, uptake of nutrients; Passive diffusion, facilitated diffusion, group translocation. different phases of growth, growth curve, measurement of growth, synchronous growth, autotrophic and heterotrophic growth. Media: selective and different types of media, preservation of cultures. Viable count. microbial respiration- Embden-Myerhof pathway, Enter-Doudroff pathway, Pentose phosphate pathway, tricarboxylic acid cycle, ETC , Oxidative phosphorylation, anaerobic respiration, control of microorganism- sterilization, heat, radiation, chemical agents: phenolic, alcohol, halogens, heavy metals. Antimicrobial activity, susceptibility test, disk diffusion test. Antimicrobial drugs and its action: penicillins, cephalosporins, tetracylins, cholramphenicols, sulphonamides, quinolones, antiviral drugs and antifungal drugs. Drug resistance in Bacteria.

Unit IV

Microbial Genetics: Bacterial transformation, conjugation, transduction. Mutations, types of mutations,

mutagens, isolation of mutants, Ames test, transposable elements, Plasmids. Bacterial diseases: Diptheria, tuberculosis, Chickenpox, small pox, HIV, SARS, NIPPA, CORONA (SARS-2)

Unit V

Environmental Microbiology: Microbiological analysis of water, waste water treatment,- primary and secondary treatment, measuring water quality, total organic carbon, chemical oxygen demand, biochemical oxygen demand, Rhizosphere, mycorrhiza, symbiosis,(Nitrogen fixation)Bioremediation , microbial fuel cell, prebiotics and probiotics, microbial quorum sensing.

Reference Books

1. Willey, J.M.Sherwood, L., Woolverton, C.J, Prescott, L.M (2011). Precott,s Microbiology, New york: Mc Graw Hill
2. Michael Pelczar (2001) Microbiology. Mc Graw Hill
3. Jeffrey C. Pommerville,Jeffrey Pommerville (2010) Alcamo,s Fundamentals of Microbiology. Jones and Bartlett Learning.
4. David Wessner, Chritine Dupont, Trevor Charles (2013) Microbiology. Wiley.

Core Paper

BIT-2103- Cell Biology and Genetics (3 Credits)

Unit-I

Discovery of cells, cell theory and its modern version. Prokaryotic and eukaryotic cells, nature and comparison. Structural organization and functions: Plasma membrane- structure/composition – lipid bilayer, protein associations within the fluid-mosaic arrangement, functions of plasma membrane, trans-membrane transport – pumps, carriers, channels, glycocalyx - membrane carbohydrates and their significance in cellular recognition. Mitochondria- structure, functions, oxidative phosphorylation and electro transport chain. Endoplasmic reticulum - morphology, types, functions and formation. Golgi bodies - morphology, types, functions (role in secretion) and formation. Lysosomes- morphology, major groups of enzymes, classification, polymorphism and functions. Microbodies - morphology, major enzymes, peroxisomes and glyoxisomes functions. Ribosomes - different types, subunits, functions. Proteasomes - structure, ubiquitin - tagged protein degradation. Centrioles and basal bodies- structure and functions. Cytoskeleton structure / function - microtubules, actin and intermediate filaments, MAPs, actin-binding proteins. Types of cell junctions, cell adhesion proteins, extracellular matrix in animals and plant cell wall.

Unit-II

Nucleus – structure and function, nuclear envelope, pore-complexes, nuclear lamina, nucleolus - structure, nucleolar cycle, ribosome biogenesis, nucleoporins and macromolecular transport. Chromatin organization - euchromatin and heterochromatin, nucleosome organization (solenoid / zig-zag) condensation and coiling (condensins / cohesions / remodelling complexes). Chromosome structure - typical metaphase chromosome; endomitosis and polytene chromosomes; lamp brush chromosome. Cell cycle and its regulation: G0 / G1, S, G2, and M phases, cdk /cyclin complexes, checkpoints; Mitosis and Meiosis: description of all stages, synaptonemal complex. Apoptosis – intrinsic and extrinsic pathways. Cancer and metastasis.

Unit-III

Cell signalling and signal transduction, structure and electrical properties of neurons, electrical impulses and their transmission, resting potential, action potential, propagation of action potential, voltage gated and ligand gated channels, synaptic transmission, membrane analyses and patch clamp techniques, chemical signals and receptors, second messengers: cAMP, Ca^{2+} ions, Ras pathway, glycogen breakdown by epinephrine. Molecular mechanisms of membrane transport, nuclear transport, transport across mitochondria and chloroplasts, intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/ cell exterior.

Unit-IV

History of Genetics; Pre-Mendelian genetic concepts, Inheritance of acquired characters, Germplasm theory. Mendel and his experiments, genetic terminology-gene, allele, genotype, phenotype, genome; wild type and mutant type, test cross, back cross and reciprocal cross. Interaction of genes: allelic, incomplete dominance, lethal and co-dominance, non- allelic, complementary gene action; Co-epistasis, dominant (feather coat) and recessive (coat colour), polygenic action (skin colour), pleiotropism, multiple alleles, ABO blood group system, Rh group and its inheritance. Linkage, crossing over and recombination: Linked genes, linkage groups, chromosome theory of linkage, factors affecting linkage, crossing over and recombination, mechanism, kinds and factors affecting crossing over and its significance. Chromosome mapping. Sex Linkage: characteristics of sex linked inheritance, sex linked inheritance of man (colour blindness and haemophilia), incompletely sex linked genes, holandric genes, sex limited genes and sex influenced genes, protogynous, protoandrous. Cytoplasmic inheritance: Mitochondrial DNA, kappa particles in paramecium, maternal effects in Drosophila.

Unit-V

Population genetics- Hardy-Weinberg Equilibrium, selection, genetic drift, Genetic variation, Allele frequencies and its changes, mutation , gene flow, random mating, migration, inbreeding, outbreeding, assortive mating, hybrid vigor. Human Genetics: Karyotyping and chromosome banding techniques, FISH, normal chromosome compliment, pedigree analysis, chromosomal anomalies in man, autosomal (eg. Down syndrome, Edwards syndrome), allosomal (eg. Klinefelters syndrome, Turner's syndrome)

Reference Books:

1. Lodish*et al.* (2012) Molecular Cell Biology, 7th Edition. W H Freeman & Co.
2. Gerald Karp (2013) Cell Biology, 7th Edition. Wiley.
   Geoffrey M. Cooper, Robert E.
3. Hausman(2013) The Cell: A Molecular Approach, 6th Edition. Sinauer Associates, Inc.
4. Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander D Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter(2013) Essential Cell Biology, 4th Edition. Garland Science.
   D. Peter
5. Snustadand Michael J. Simmons (2011) Principles of Genetics, 6th edition. John Wiley and Sons.
6. Peter J. Russell (2009) *i*Genetics: A Molecular Approach, 3rd Edition. Benjamin Cummings.
   Monroe W. Strickberger
7. (2008) Genetics, 3rd Edition. Prentice-Hall.

Core Paper

BIT-2104- Bioinformatics (3 Credits)

Unit-I

Need and use of bioinformatics; computer fundamentals – networking, hardware and internet. Biological information access, storage and retrieval; database management system. Data structures: array, stack, queue and linked List. Sorting and searching techniques: bubble sort, merge sort and insertion sort binary search. Introduction to algorithm design and analysis, sorting and searching algorithms, divide and conquer, dynamic programming: introduction and applications.

Unit-II

Database concepts and organization: data, metadata, data dictionary, ontologies, B-trees, hah indices, relational databases; infrastructure: data warehouse, OLAP technology. Primary databases - Nucleotide sequence database - NCBI, EMBL, EBI, DDBJ; Protein sequence databases - Swissprot, Protein Information Resource (PIR); Structural database - Protein Data Bank (PDB). Secondary databases - KEGG, Prosite, SCOP, CATH; Marine microbial genome databases; Marine biodiversity databases- GBIF, CoML, IO-CoML; Data retrieval tools - Entrez, SRS, Pubmed, Medline, OMIM.

Unit-III

Sequence alignment; Needleman and Wunsch; Smith and Waterman algorithms for pairwise alignments; dynamic programming; gap penalties; use of pairwise alignments for analysis of nucleic acid and protein sequences and interpretation of results; tools for similarity search and sequence alignment - FASTA, BLAST, E-value; scoring matrices -BLOSUM, PAM matrices.

Unit-IV

Multiple sequence alignment and applications, methods available - interactive alignment, progressive alignment – ClustalW, T - Coffee; Profile methods - Gribskov profile, PSI-BLAST, phylogenetic analysis; dendrogram and cladogram; various methods used in generating evolutionary tree; tree evaluation; Hidden Markov Models (HMMs); gene prediction methods; genome analysis and mapping - DNA fragment assembly, genetic linkage analysis. Comparative genomics: concepts of synteny, orthology, paralogy; tools and methods.

Reference Books:

1. David W. Mount (2001) Bioinformatics – Sequence and Genome analysis, Cold Spring Harbor Laboratory Press.
2. Stephen A. Krawetz& David D. Womble(2003) Introduction to Bioinformatics A Theoretical and Practical Approach. Humana Press.
3. Jiawei Han, MichelineKamber. Data Mining: Concepts and Techniques. The Morgan Kaufmann Series in Data Management Systems.
4. Bioinformatics: A Practical Guide to the Analysis of Genes & Proteins, 2005, John Wiley &Sons, Inc
5. David Hand, HeikkiMannila, Padhraic Smyth. Principles of Data Mining. Prentice Hall India.

Core paper

BIT 2105 Biophysics and Biostatistics.

Biophysics.

Unit-I

Laws of thermodynamics, the concept of enthalpy, entropy and free energy, thermodynamic equilibrium, redox potential, high energy molecules, examples of redox potential in biological system.

Unit-II

Protein structure, globular and fibrous protein; protein stability; protein folding. Structural implication of peptide bond, Ramachandran plot, protein families, alpha domains, beta domains. Physics of nucleic acids: Forces stabilizing structures; double helical structures; properties; helix – coil transitions. DNA polymorphism, GC content, re-association kinetics and Cot, Rot curves, DNA-Protein interaction- Interactions of transcription factors(Helix turn helix, Leucine Zipper, Cys-His, Zinc fingers,). Histone-DNA interaction, RNA protein interactions.

Unit-III

Electromagnetic spectrum, Beer Lambert's Law. Photometry, UV/VIS Spectrophotometry, X-ray crystallography , Circular dichroism, Infrared and Raman spectroscopy, Atomic absorption spectroscopy, ESR and NMR spectroscopy. Chromatographic techniques (HPLC), Mass spectroscopy (LC-MS, GC-MS).Fluorescent spectroscopy.Applications of different Spectroscopic techniques in Biology.

Biostatistics

Module I

Bivariate data, Scatter diagram, measures of relationship, covariance and correlation, types of correlation, Simple linear correlation –Pearson's coefficient of correlation, Spearman's Rank Correlation Coefficient. Regression - types of regression, Fitting of simple linear regression equations using the least square method, properties of correlation and regression coefficients, coefficient of determination, applications of correlation and regression in Biology.

Module II:

Basic concepts of probability, classical, empirical and subjective theories of probability. Random variables and probability distributions – Binomial, poisson and normal distributions (definitions, properties and uses only. Point and interval estimation, confidence interval for the mean of a normal population. Tests concerning means (one sample and two sample cases).Chi-square test for goodness of fit and independence.

Reference Books:

1. Roland Glaser (2012) Biophysics: An Introduction, 2ndEdition.Springer.
2. William Bialek (2012) Biophysics:Searching for Principles.Princeton University Press.
3. T.M Nordlund(2011) Quantitative Understanding of Biosystems: An Introduction to

Biophysics.CRC Press.
4. V. Raicu and A. Popescu (2008) Integrated Molecular and Cellular Biophysics. Springer.
5. Agarwal B.L. (2000) Basics Statistics, New Age International (p) Ltd.
6 Rengasamy R. (2013) A Text book of Agricultural New Age International (p) Ltd.
8. Zar, J.H. (1995) Bio statistical Analysis, Pearson Edn.
9. Croxton, F.E., Cowden, D.J. Klenis, S. Applied General Statistics, Prentice Hall.
10. Gupta, S.C. and Kapoor, V.K. (1978) Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
11. Nabendu Pal and Sahadeb Sarkar (2013) . Statistics - Concepts and Applications. PHI Learning Private Limited , New Delh
12. Elhance, D. N. and Elhance, V. (1988). Fundamentals of Statistics, KitabMahal.

Core Practical Paper

BIT-2106- Practical in Biochemistry (2 Credits)

1. Units and Measurements
2. Preparation of buffers, pH measurement.
3. Quantitative estimation of Carbohydrates (Anthrone method/enzymatic methods)
4. Quantitative estimation of Protein (Lowry's / Bradford's methods)
5. Quantitative estimation of amino acids (ninhydrin method)
6. Quantitative estimation of Lipids (Floch method)
7. Estimation of DNA and RNA (Diphenyl amine method/Orcinol method)
8. Cholesterol estimation
9. Salivary amylase activity
10. Thin layer chromatography (Lipids)
11. Paper chromatography (Aminoacids)
12. Native PAGE and SDS- PAGE
13. Agarose Electrophoresis (DNA/RNA)
14. Purification and characterization of any suitable enzyme.
    a) Preparation of cell-free lysate
    b). Ammonium sulphate precipitation
    c) Ion exchange chromatography
    d) Dialysis of purified protein (enzyme) solution
    e) Assessing purity of samples from each step of purification by SDS-PAGE Gel Electrophoresis,
    f) Enzyme kinetics: Km, Vmax,

Practical in Cell Biology & Genetics (2 credits)

1. Cell-Structure (microscopy)
2. Buccal smear study and staining methods for Barr bodies

3. Vital Staining of Mitochondria
4. Salivary gland Chromosome (Drosophila/Chironomous larva)
5. Preparation of onion root tip for the stages of mitosis
6. Preparation of stages of meiosis (Grass Hopper)
7. Mono hybrid Cross
8. Di hybrid Cross
9. Pedigree analysis of Mendelian traits
10. Karyotyping

Problems in genetics- Linkage / Crossing over, Selection index

BIT 2107- Practical in Microbiology (2 credits)

1. Sterilization techniques
2. Preparation of Media (Solid, Liquid)
3. Culturing of microorganisms (Streak plate method, pour plate method, spread plate method, slant preparation)
4. Staining techniques (Simple, Differential-Grams, Specialized - spore and capsular)
5. Biochemical tests for identification of microorganisms (IMViC, Carbohydrate fermentation test)
6. Antimicrobial susceptibility test of microorganism, (Kirby-Baur method)
7. Growth curve of microorganisms (Turbidimetry method)
8. Preservation of bacterial cultures.
9. Bacterial transformation
10. Bacterial conjugation.

BIT 2108 Practical in Biostatistics (2 credits)

1. Data analysis using SPSS and MS-Excel in the following topics :
2. Graphical representation of data, computation of various measures of central tendency and dispersion.Computation of correlation coefficient, fitting of simple linear regression.
3. Construction of confidence intervals concerning mean.
4. Parametric tests of Hypothesis concerning mean.
5. Chi-square tests for goodness of fit and independence.

Semester II

Core Paper

BIT-2201- Molecular Biology (3 credits)

Unit-I

Introduction to Molecular biology, DNA as genetic material, mechanism of DNA replication, prokaryotic DNA replication, initiation of DNA replication, proof reading and editing, DNA repair systems – direct and indirect repair – photoreactivation, alkyl transferases, base and nucleotide excision repair, recombination repair, mismatch repair, SOS repair; termination of DNA replication; gene mutation, point mutation, insertion, deletion, suppressor mutation, chemical and physical mutagens. Homologous, non-homologous, site-specific recombination, DNA transposition.

Unit-II

Transcription and Transcriptional control: Structure of bacterial RNA polymerase, Transcription events, and sigma factor cycle, Eukaryotic RNA polymerases, Promoter elements, TATA box, Hogness Box, CAAT box, Enhancers and Silencers, upstream and downstream activating sequences, initiation and termination of transcription in prokaryotes and eukaryotes, mRNA, rRNA and tRNA processing in prokaryotes and eukaryotes. Transcriptional and post-transcriptional gene-silencing.

Unit-III

Prokaryotic and eukaryotic translation, genetic code and wobble hypothesis, the translation machinery, mechanisms of initiation, elongation and termination, regulation of translation. Post-translational modifications.

Unit-IV

Control of gene expression in prokaryotes and eukaryotes. Operon model- lac and trp operon. Autogenous regulation, feedback inhibition, Lytic cascades and lysogenic repression. Molecular biology of cancer - causes and genetics of cancer, onco genes (ras, myc) and tumor suppressor genes (p53 and pRB).Molecular biology of stress; Stress proteins-heat and cold shock protein, molecular chaperones, salt and starvation stress tolerances.

Reference Books:

1. Lodish*et al.* (2012) Molecular Cell Biology, 7th Edition. W H Freeman & Co.

Geoffrey M. Cooper, Robert E. Hausman
2. (2013) The Cell: A Molecular Approach, Sixth Edition. Sinauer Associates, Inc.
3. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick (2013) Molecular Biology of the Gene, 7th Edition. Cold Spring Harbor Laboratory Press.
4. Jocelyn E. Krebs, Stephen T. Kilpatrick, Elliott S. Goldstein (2013) Lewin's Genes XI.Jones and Bartlett Publishers, Inc.

Core Paper

BIT-2202- Immunology (3 Credits)

Unit-I

Introduction, history, development and scope. Immunity, classification of immunity. Innate (non-specific), acquired (specific) and passive immunity. Clonal nature of immune response. Immune system, organs and tissues of the immune system. Primary (central) - thymus, bone marrow, bursa of Fabricius; secondary (peripheral) - spleen, lymph nodes, mucosa associated lymphoid tissue (MALT). Organization and structure of lymphoid organs.

Unit-II

Lymphocytes – T cells and B cells – formation, development and maturation; plasma cells and null cells – natural killer cells, killer cells, lymphokine - activated killer cells; phagocytes / macrophages; antigen presenting cells – macrophages, B-lymphocytes, dendrite cells, langerhans cells; follicular dendrite cells, neutrophils, eosinophils, basophils, mast cells.

Unit-III

Antigens (immunogens) (Ag): definition, complete antigens, haptens, antigenic determinants or epitopes; antibodies (Immunoglobulins)- definition, general structure of Ig, Ig determinants, physico-chemical properties of Ig, classes of Ig- G, M, A, D, E; mention abnormal Igs; antigen – antibody reactions- mechanism, precipitation reactions, agglutination reactions, complement fixation, neutralization, opsonisation. Complement system: definition, general features, major histocompatibility complex (MHC). Immune response-definition, types of immune responses-humoral immune response (antigen mediated immunity - AMI) and cellular immune response (cell mediated immunity - CMI), immunological memory, immunological tolerance and immune suppression. Polyclonal and monoclonal antibodies. Hybridoma techniques- T cell cloning and their applications. ELISA, RIA, Western blotting, Fluorescent techniques, Fluorescent activated cell sorting (FACS).

Unit-IV

Hyper sensitivity / allergy: definitions, classification- types I, II and III;Immuno deficiency diseases (ID)- definition, primary IDs, disorders of immune mechanism (humoral, cellular and combined IDs), disorders of complements, disorders of phagocytosis, secondary IDs, Acquired Immune Deficiency Syndrome (AIDS); auto immunity-definition, mechanism, auto immune diseases; transplantation immunity-definition, classification of transplants, graft versus host reactions; graft rejection, mechanism of graft rejection, factors affecting graft survival; Immunisation and vaccination-definitions, vaccines; types of immunization- active immunization- killed and live attenuated vaccines, microbial extracts, vaccine conjugates, toxoids, recombined vaccines, DNA/RNA vaccines, subunit

vaccines; passive immunization- pooled normal human Igs, specific Igs (hyper antisera); combined immunization.

Reference Books:

1. Judy Owen, Jenni Punt, Sharon Stranford (2013) Kuby Immunology, 7th Edition. W. H. Freeman.
2. David Male, Jonathan Brostoff, David Roth, Ivan Roitt (2012) Immunology, 8th Edition. Saunders.
3. William E. Paul (2012) Fundamental Immunology,7th Edition. LWW.
4. Kenneth M. Murphy (2011) Janeway'sImmunobiology, 8th Edition.GarlandScience.

Core Paper

BIT-2203- Genomics and Proteomics (3 Credits)

Unit-I

Structure and organization of genomes; genome mapping and sequencing methods; assembly of DNA sequences- methods; genomic libraries of marine organisms; marine organisms - comparative genomics including phylogenomics, structural genomics, functional genomics - differential gene expression, digital gene expression, DNA microarray, cDNA and intragenic array, protein array; transcriptomics. Assigning gene function;

Unit-II

Gene silencing techniques; introduction to siRNA technology; micro RNA; Construction of siRNA vectors; gene knockouts; gene therapy - somatic and germ-line therapy, suicide gene therapy; gene replacement; gene targeting; transgenics; genomics of model organisms; marine metagenomics; marine genomics – advances and applications; advances in genomics- introduction to epigenomics, medical genomics and personal genomics.

Unit –III

Genomic Sequencing Projects- Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web. Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in genome sequence

Unit IV

Introduction to Proteomics, strategies and challenges in proteomics; proteomics technologies- Protein structure; sample preparation, protein purification and separation methods;2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, yeast 2-hybrid system, proteome databases. Transcriptome analysis for identification and functional annotation of gene.

Reference Books:

1. Arthur M. Lesk (2012) Introduction to Genomics, 2nd Edition. Oxford University Press.

2. Richard Twyman (2013) Principles of Proteomics, 2nd Edition. Garland Science.
3. Malcolm Campbell and Laurie J. Heyer (2006) Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings.
4. Haleem J. Issaq and Timothy D. Veenstra (2013) Proteomic and Metabolomic Approaches to Biomarker Discovery. Elsevier.

Core Paper

BIT-2204- Plant Biotechnology (3 Credits)

Unit I

Introduction to plant cell and tissue culture, tissue culture as a technique to produce novel plant and hybrids. Plasticity, and totipotency, the culture environment, tissue culture media (composition and preparation) plant growth regulators, various culture types: Callus, cell suspension cultures, Protoplasts isolation, culture and fusion, root cultures, Shoot tip and meristem culture, Embryo culture, Microspore culture, anther, pollen and ovary culture for production of haploid plants. Culture preservation methods.

Unit II

Plant transformation technology: The basis of tumour formation, hairy root, features of T1 and R1 plasmids, mechanism of DNA transfer, role of virulence gene, use of T1 and R1 as vectors, binary vectors. Basic features of vectors for plant transformations: promoters and terminators, 35S promoter, inducible promoters, selectable markers, reporter genes, origin of replication, co-integrative and binary vectors. Methods of nuclear transformation; multiple gene transfers, direct gene transfer, particle bombardment, electroporation, polyethylene glycol (PEG) mediated transformation. Agrobacterium mediated gene transfer.

Unit III

Application of plant transformation: improvement of crop yield and quality; the genetic manipulation of fruit ripening, ripening related genes, manipulation of fruit softening, significance of olden rice. Long shelf life of fruits and flowers, use of ACC synthase, poly-galactrunase, ACC oxidase. Carbohydrate composition and storage, ADP glucose pyrophosphatase. Herbicide resistance, glyphosate resistance, insect resistance,- Bt –genes, Protease inhibitors, alpha amylase inhibitor, diseases resistance, Chitinase, glucanase, RIP antifungal proteins, PR proteins.

UnitIV

Metabolic engineering/ molecular farming: Plant secondary metabolite, control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway, alkaloid and industrial enzymes, antibodies and edible vaccine/biopharmaceuticals.

Unit V

Molecular marker assisted breeding / selection: RAPD markers, AFLP, linkage analysis, RFLP, STS, microsatellites, SCAR (sequence characterized amplified region), SSCP (single strand conformational polymorphism, MAS (molecular assisted selection)

Reference Books.

1. Plant Biotechnology J. Hammond P McGarvey and V. Yusibov, eds. Springer Verlag.
2. Plant propagation part I and II. E.F. George, exegetics, England
3. Plant Tissue culture, S.S. Bhojwani and M.K. Razdan, Elsevier, Amerstdam
4. Plant Cell culture- A practical approach, Dixon et al, IRL press, Oxford.
5. Gene transfer to plants, I Porykus and G Spangerberg, springer-verlag, Berlin.
6. Plant Biotechnology. The genetic manipulation of plants. Salater, A, Scott, N And Fowler M. Oxford University press.
7. Introduction to plant Biotechnology. Chawla H.S. Oxford and IBH publishing Co. pvt. Ltd.

Elective Paper

BIT-2205- Nanotechnology (2 Credits)

Unit I

Introduction: Introduction to Nanobiotechnology; Concepts, historical perspective; Different formats of nanomaterials and applications with example for specific cases; Cellular Nanostructures; Nanopores; Biomolecular motors; Bio-inspired Nanostructures, Synthesis and characterization of different nanomaterials.

Unit II

Biofilms and Nanoparticles: Introduction to Biofilms; Thin films; Colloidal nanostructures; Self Assembly, Nanovesicles; Nanospheres; Nanocapsules and their characterisation. Nanoparticles and applications Nanoparticles for drug delivery, concepts, optimization of nanoparticle properties for suitability of administration through various routes of delivery, advantages, strategies for cellular internalization and long circulation, strategies for enhanced permeation through various anatomical barriers.

Unit III

Applications of Nanomaterials: Nanoparticles for diagnostics and imaging (theranostics); concepts of smart stimuli responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development. : Nanomaterials for catalysis, development and characterization of nanobiocatalysts, application of nanoscaffolds in synthesis, applications of nanobiocatalysis in the production of drugs and drug intermediates.

Unit IV

Nanotoxicity: Introduction to Safety of nanomaterials, Basics of nanotoxicity, Models and assays for Nanotoxicity assessment; Fate of nanomaterials in different stratas of environment; Ecotoxicity models and assays; Life Cycle Assessment, containment of nanotoxicity.

Reference Books:

1. GeroDecher, Joseph B. Schlenoff, (2003); Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials, Wiley-VCH Verlag GmbH & Co. KGaA
2. David S. Goodsell, (2004); Bionanotechnology: Lessons from Nature; Wiley-Liss

3. Neelina H. Malsch (2005), Biomedical Nanotechnology, CRC Press
4. Greg T. Hermanson, (2013); Bioconjugate Techniques, (3rd Edition); Elsevier
5. Recent review papers in the area of Nanomedicine.

Elective Paper

BIT-2206- Environmental Biotechnology (2 Credits)

Unit-I

Status and Scope of Biotechnology in environmental protection. Non-conventional energy sources. Environment protection Acts, environmental laws, environmental policies, environmental ethics. UN declaration. Environmental protection and conservation. Environmental Impact Assessment, Eco planning, Sustainable development and Green technologies.

Unit-II

Physicochemical and bacteriological analysis of soil and water-microbial ecology, Problems associated with soil: alkali soils, sodic soils, and solid waste, Insecticide, fungicide, pesticide cycle in soil, use of genetically modified (insect, pest and pathogen resistant) plants. Ecotoxicology of soil pollutants, Solid Waste Management.

Unit-III

Effluent water constituents, analysis and selection of flow rates and loadings, process selection, Physical unit operations / Chemical unit operations, fundamentals of biological treatment, Role of biotechnology in water purification systems. Biological treatment –types and kinetics. Biological Processes for Industrial and domestic effluent treatment, Aerobic Biological Treatment-Trickling filter, UASB, Anaerobic Biological Treatment-Lagoons, Activated sludge process.

Unit-IV

Bioremediation-Biotechnology for clean environment, bio-indicators and biosensors for detection of pollution. Biomaterials as substitutes for non-degradable materials (Bio plastics). Metal microbe interactions: heavy metal pollution and impact on environment, Microbial systems for heavy metal removal, biosorption, molecular mechanisms of heavy metal tolerance, Phytoremediation. Xenobiotic, oil spills, biological detoxification of Polycyclic Aromatic Hydrocarbons (PAH). Role of biopesticides, biofertilizers, vermiculture.

Reference Books:

Gareth G. Evans
1. and Judy Furlong (2010) Environmental Biotechnology: Theory and Application, 2nd Edition. Wiley-Blackwell.
2. Bruce E. Rittmann, Perry L. McCarty (2001) Environmental Biotechnology: Principles and Applications. McGraw-Hill.

John C. Crittenden, R. Rhodes Trussell, David W. Hand, Kerry J. Howe,George Tchobanoglous
3. (2012) MWH's Water Treatment: Principles and Design, 3rd Edition. Wiley.
4. Marian Petre (Ed.) (2013) Environmental Biotechnology - New Approaches and Prospective Applications. InTech.

BIT-2207- - Practical in Molecular Biology (2 Credits)

1. Isolation of total DNA from Bacteria
2. Isolation of total RNA using TRIzol
3. Isolation of Plasmid DNA
4. Restriction digestion of Lambda Phage DNA
5. DNA ligation of PCR products
6. Basics of PCR amplification using 16s RNA Primers,
7. Introduction to RT-PCR
8. Analysis of DNA using Agarose gel electrophoresis

BIT 2208 Practical in Immunology (2 credits)

1. Determination of blood group
2. Blood film preparation ND IDENTIFICATION OF CELLS.
3. Lymphocyte separation from peripheral blood
4. Antigen preparation and immunization
5. Immunnodiagnostics (Widal or VDRL using kit.)
6. Single and Double immunodiffusion
7. Immunoelectrophoresis
8. Western blotting
9. ELISA
10. Affinity chromatography
11. Flurochrome-Ab conjugation
12. Preparation of single cell suspension from spleen
13. Cryokpreservation and thawing of cells/cell lines.

BIT 2209 – Practical in Plant Biotechnology (2 credits)

1. Preparation of media
2. Surface sterilization,
3. Organ culture
4. Callus propagation, organogenesis, transfer of plants to soil
5. Agrobacterium culture, selection of transformants, Reporter gene (GUS) asssya.
6. Analysis of RFLP and RAPD maps.

Semester III

Core Paper

BIT-2301- Animal Biotechnology (3 Credits)

UNIT I

Structure and organization of animal cell. Primary and established cell line culture: isolation of the tissues, mouse, chicken embryo, human biopsy material, primary explant, enzymatic disaggregation-trypsinisation, collagenase method, mechanical disaggregation, separation of viable and nonviable cells, enrichment of viable cells. Cell lines: immortalization of cell lines, selection of cell line, routine maintenance, replacement of medium, subculture, criteria for subculture, use of antibiotics.

UNIT II

Introduction to the balanced salt solutions and simple growth medium. Brief account on the chemical, physical and metabolic functions of different constituents of culture medium. Roe of carbon dioxide, serum and supplements. Serum and protein- free defined media and their applications.

UNIT III

Measurement of viability and cytotoxicity: specific culture methods, cytotoxicity, viability. Comparison of micro titration with cloning, assay by survival and proliferative capacity. Relationship between cell number and cytotoxicity index, anticancer drug screening. Basic techniques of mammalian cell culture in vitro: disaggregation of tissue and primary culture, maintenance of cell culture: cell separation of Density Gradient, immune panning, magnetic sorting, Fluorescence- activated cell sorting.

UNIT IV

Scaling of animal cell culture: General methods and culture parameters- Growth knenetics, medium and nutrients, pH and oxygen. Monolayer culture; cell attachment, scaling up, roller bottle. Suspension culture; small-scale suspension culture, stirred bioreactors, continuous flow culture, mixing and aeration, airlift fermenter, rotating chambers, perfused suspension culture.

UNIT V

Immobilized cultures: entrapment cultures, micro carriers. Perfused monolayer culture: membrane perfusion, hollow-fibre perfusion. Stem cell cultures, embryonic stem cells and their applications, cell culture based vaccine. Organ and histotypic cultures: Types of organ culture techniques: clotted plasma substrate, agar substrate, raft method, Grid method,waqtch glass techniques, single slide techniques, agar gel techniques. Organ culture of tissues e.g. neural cells, rat liver, histotypic culture, gel and sponge techniques.

Reference Books:

1. Culture of animal cells. R.Ian Freshney, Wiley- Liss
2. Animal cell culture- Practical approach. John R.W. Mastrs, Oxford.
3. Cell growth and Division. Apractical Approach. Ed. R. Basega. IRL. Press.
4. Animal Cell Culture Techniques. Eds. MartinClynes, Springer.

Core Paper

BIT-2302- Genetic Engineering and Recombinant DNA Technology (3 Credits)

Unit-I

Vectors; cloning vectors: plasmids-pBR322, pUC19 and bluescript vectors; bacteriophages - lambda vectors, insertion and replacement vectors; M13mp vectors; phagemids; cosmids; artificial chromosome vectors, BACs, PACs, YACs, HACs; animal virus derived vectors-SV-40, vaccinia, bacculo and retroviral vectors. Expression vectors; pMal; GST; pET based vectors; intein-based vectors. Baculovirus and Pichia vectors system. Plant based vectors- Ti and Ri as vectors; yeast vectors; shuttle vectors. Prokaryotic and Eukaryotic cloning hosts and expression hosts.

Unit-II

Nucleic acids probes - labelling of DNA and RNA – isotopic and non-isotopic methods (nick translation, random priming, end labeling). Hybridization techniques –southern, northern, western, colony hybridization and fluorescence in-situ hybridization; enzymology of DNA manipulation - restriction enzymes, DNA ligase, klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase.

Unit-III

Polymerase chain reaction, primer design; fidelity of thermo stable enzymes; chemical synthesis of oligonucleotides; PCR and its optimization; types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR; cloning of PCR products- T/A-vectors; proof reading enzymes; PCR in gene recombination; deletion; addition; overlap extension; and SOEing; site directed mutagenesis; PCR based mutagenesis; PCR in molecular diagnostics; viral and bacterial detection; mutation detection- SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), mismatch chemical cleavage (MCC), allele specific amplification (ASA), protein truncation test (PTT). cDNA and genomic libraries- construction and screening. Rapid amplification of cDNA ends (RACE). DNA Sequencing methods-chemical, enzymatic & automated.

Unit-IV

Gene cloning: cohesive and blunt end ligation, linkers, adapters, homopolymer tailing; transformation-bacteria - $CaCl_2$ mediated, electroporation, lipofection; Yeasts and fungi- lithium acetate, PEG mediated, frozen yeast protocol, protoplast transformation, gene gun. Plants - biolistic, electroporation, and viral transformation. Mammalian cells - microinjection, transfection methods. Expression cloning: Walking, Jumping/hopping libraries; southwestern and far-western cloning; recombinant protein technology: design and use of expression vectors. Expression of foreign gene in *E.coli*, baculovirus and pichia expression system. Recombinant protein purification-His-tag; GST-tag; MBP-tag; Principles in maximizing gene expression. Inclusion bodies and regeneration of active proteins. Methodologies to reduce formation of inclusion bodies. Differential gene expression

profiling by microarray, Gene knockouts in animals. Gene therapy: somatic and germ line gene therapy in vivo and ex-vivo, Design of SiRNA vectors and gene silencing. Direct gene transfer, molecular chimeras. Antisense technology/ gene transfer in animals and plants

Reference Books:

Michael R. Green, Joseph Sambrook

1. (2012) Molecular Cloning: A Laboratory Manual, Vol: I, II & III, 4th Edition. Cold Spring Harbor Laboratory Press.
2. Sandy B. Primrose, Richard Twyman (2006) Principles of Gene Manipulation and Genomics, 7th Edition. Oxford University Press.
3. T. A. Brown (2010) Gene cloning and DNA analysis - an introduction, 6th Edition. Wiley-Blackwell.
4. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick (2013) Molecular Biology of the Gene, 7th Edition. Cold Spring Harbor Laboratory Press.

Core Paper

BIT-2303- Bioprocess Technology (3 Credits)

Unit-I

Introduction to bioprocess technology, Chemical *vs* Biological processes. History of fermentation; Types of fermentation; Media for fermentation process; Understanding fermentation process, Process flow diagram. Industrial production of antibiotic, enzymes and vaccines.

Unit-II

Isolation, screening and strain improvement of industrially important microbes. Microbial Metabolism: microbial reactions and their types; stoichiometry calculations; yield coefficient; degree of reduction; transport of nutrients; Diffusion; facilitated diffusion; active transport; metabolic pathways- glycolysis, EMP and pentose pathway, TCA cycle, electron transport chain; anabolism; aerobic and anaerobic fermentation.

Unit-III

Microbial growth kinetics in batch and continuous fermentation; physico-chemical conditions affecting growth, pH, temperature, aeration and agitation; media for microbial growth; media optimization. Stoichiometry of growth; elemental balances and degree of reduction; specific growth rate, μ_{max}, biomass and productivity in a fermenter, dilution factor in a continuous system. Basic concepts of mass transfer, mass transfer resistance and heat transfer.

Unit-IV

Bioreactor technology: introduction to bioreactors; types of ideal reactors; design equation for ideal reactors; mode of operation of bioreactors- fed-batch and continuous reactors, fluidized bed reactors, immobilized reactors - immobilized enzyme reactors, methods of immobilization, solid state fermentation; bioreactors for plant and animal cell culture; bioreactor instrumentation and process control. Statistical modeling and large scale production systems.

Downstream process: introduction to downstream processing; strategies to recover and purify fermentation products; separation of insoluble products by filtration; centrifugation; coagulation and flocculation; cell disruption; precipitation; osmosis; dialysis; extraction; leaching; ATPS; adsorption; chromatography; drying; crystallization.

Reference Books:

1. Pauline M. Doran (2012) Bioprocess Engineering Principles, 2nd Edition. Academic Press.
2. James E. Bailey and David F. Ollis (2010) Biochemical Engineering Fundamentals, 2nd Edition. Tata McGraw - Hill Education.
3. Peter F. Stanbury, Allan Whitaker, Stephen J. Hall, (1999) Principles of Fermentation Technology, 2nd Edition. Butterworth-Heinemann.
4. WulfCrueger, AnnelieseCrueger, T.D. Brock (1991) Biotechnology: A Textbook of Industrial Microbiology, 2nd Edition.Sinauer Associates Inc.

Core Paper

BIT-2304- Aquaculture Biotechnology (3 Credits)

Unit-I

Fish Breeding: synthetic hormones for induced breeding. Gene bank and conservation: cryopreservation of gametes and embryos.Transgenics, methods of gene transfer in fishes, screening for transgenic, applications, regulation of GMOs, IPR.

Unit-II

Feed technology: micro encapsulated feeds, micro coated feeds, micro-particulate feeds and bio-encapsulated feeds, mycotoxins and their effects on feeds.

Unit-III

Health management: DNA and RNA vaccines, molecular diagnosis of viral diseases, PCR,dot-blot, ribotyping of pathogenic microbes, RNAi, genetically modified micro-organisms as probiotics, immunostimulants,bioremediation of soil and water.

Unit-IV

Post-harvest biotechnology: delaying of spoilage, detection of toxic substances and pathogenic microbes, biosensors for toxins. Application of nanotechnology in aquaculture. Ecotoxicology and pollution, Marine food processing.

Reference Books:

1. Garth L. Fletcher, Matthew L. Rise (2012) Aquaculture Biotechnology.Wiley-Blackwell.
2. T. J.Pandian, C.A. Strüssmann, M.P. Marian (Eds.) (2005) Fish Genetics and Aquaculture Biotechnology.Science Publishers.
3. Dunham, R.A. Stylus (2010) A Review of "Aquaculture and Fisheries Biotechnology, Genetic Approaches",
4. 2nd Edition. Cabi Publishing.
5. Boris Gomelsky(2011) Fish Genetics: Theory and Practice.VDMVerlagDr. Müller.

BIT-2305 Practical in Animal Biotechnology.

1. Preparation of culture medium and membrane filtration.
2. Preparation of single cell suspension from spleen.
3. Cell counting and cell viability test
4. Cell culture maintenance and sub culturing.
5. Role of serum in cell culture.
6. Cryopreservation and thawing
7. Preparation of metaphase chromosome from cultured cells.
8. MTT assays for cell viability and growth
9. Demonstration of apoptosis of DNA laddering.
10. Cell fusion with PEG.

Practical in Aquaculture Biotechnology

11. Isolation of total DNA from fish muscle tissue
12. Isolation of total RNA from fish liver using TRIzol
13. Preparation of extenders for cryopreservation for Tilpaia
14. Preparation of Cryoprotectants -DMSO, Ethlyene Glycol and Tilapia Sperm cryopreservation
15. Introduction to methods for generating transgenic fish –Microinjection and Electroporation
16. PCR analysis of Fish genes using semi qRT PCR
17. PCR dot blot,

BIT-2306- Practical in Genetic Engineering and rDNA Technology

1. Restriction digestion and analysis of Plasmid/Phage DNA.
2. Preparation of competent E. coli cells
3. Transformation and Selection of recombinant E. coli
4. First Strand cDNA synthesis
5. PCR amplification of selected genes from cDNA using qRT PCR
6. PCR Purification and cloning into Plasmid
7. Selection of recombinants/ Transformants by colony PCR
8. Restriction Fragment Length Polymorphism
9. Random Amplified Polymorphic DNA
10. DNA Barcoding using mitochondrial genes.
11. Southern Hybridization and Blotting

BIT-2307. Practical in Bioprocess Technology

1. Fermenter Parts, Function and Operation
2. Fermentation - estimation of biomass
3. Immobilization of Yeast cells
4. Ethanol Production by immobilized Yeast
5. Antibiotic production by microorganisms
6. Immobilization of enzyme

7. Separation of microbial cells through centrifugation process
8. Wine production by yeast

Elective Paper

BIT 2308- Research Methodology and Scientific Writing (2 credits)

UNIT I

Introduction to research methodology, objectives of research, types of research, research approaches, significance of research, research and scientific method, criteria of good research, general problems encountered by researchers,.

UNIT II

Defining research problems, selecting research problems, steps/techniques involved in defining research problems, research design, important concepts in research design, dependent and independent variables, extraneous variables, research hypothesis, experimental and non-experimental hypothesis, important experimental design, completely randomized design, randomized block design , Latin square design.

UNIT III

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

UNIT IV

Presentation skills – formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness.

UNIT V

Technical writing skills - types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers-peer review process and problems, recent developments such as open access and nonblind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.

Reference Books

1. Valiela, I. (2001). Doing Science: Design, Analysis, and Communication of Scientific Research. Oxford: Oxford University Press.
2. On Being a Scientist: a Guide to Responsible Conduct in Research. (2009).

Washington, D.C.: National Academies Press.
3. Gopen, G. D., & Smith, J. A. The Science of Scientific Writing. American Scientist, 78 (Nov-Dec 1990), 550-558.
4. Mohan, K., & Singh, N. P. (2010). Speaking English Effectively. Delhi: Macmillan India.
5. Movie: Naturally Obsessed, The Making of a Scientist.

---**e Paper BIT-2306-Biopharmaceuticals**

Elective Paper

BIT 2309 -Biopharmaceuticals (2 Credits)

Unit-I

Introduction to Pharmaceuticals. History & Definition of Drugs. Sources of Drugs - Plant, Animals, Microbes and Minerals. Different dosage forms. Routes of drug administration

Unit-II

Pharmacodynamics and Pharmacokinetics. Physico-Chemical Principles and mechanism of drug action, drug receptors and Physiological receptors: structural and functional families. Drug absorption, factors that affect the absorption of drugs, Distribution of drugs, Biotransformation of drugs, Bioavailability of drugs, Lipinski's rule; ADMET.

Unit-III

Sources, Production& analysis of Biopharmaceuticals. Good manufacturing practices, manufacturing facilities. Production of Therapeutic Proteins, Hormones, Cytokines - Interferon's, Interleukins I & II, Tumor Necrosis Factor (TNF); Nucleic acids. Vaccine production

Unit-IV

Controlled and sustained drug Delivery Systems. Biomaterial for the sustained drug delivery-Nanoparticles (chitin/chitosan). Drug delivery methods for therapeutic proteins-Liposome mediated drug delivery. Discovery and development of new drugs from natural resources. Nanomedicines. Toxicological testing. Phases in Clinical trial. Regulatory bodies- FDA, CDSCO, DGCI -OECD Guidelines.

Reference:

1. Raymond G Hill and Humphery P Rang (2012) Drug Discovery and Development: Technology in Transition, 2nd Edition. Churchill Livingstone.
2. ChandrakantKokate (2011) Textbook of Pharmaceutical Biotechnology. Elsevier.
3. Rick NG (2008) Drugs: From Discovery to Approval, 2nd Edition. Wiley-Blackwell.
4. Daan J. A. Crommelin, Robert D. Sindelar, Bernd Meibohm (Eds.) (2007) Pharmaceutical Biotechnology: Fundamentals and Applications, 3rd Edition.CRC Press.

5. Gary Walsh (2003) Biopharmaceuticals: Biochemistry & Biotechnology, 2nd Edition. Wiley-Blackwell

Elective Paper

BIT-2310- Biodiversity (2 Credits)

Unit-I

Introduction-definition-geological history of biodiversity-(global level scenario) Mega biodiversity countries, biodiversity hot spots - global and Indian. Marine biodiversity. Threats to biodiversity.

Unit-II

Extinct and endangered species, causes of biodiversity losses, conservation methods – *insitu* and ---------*exsitu* conservation, wild life management, national parks, sanctuaries, sacred groves, gene pool. Types of biodiversity-genetic, species (α, β, γ). Impact of Alien species; GMOs on biodiversity. Impact of exotic species on endemic biota. Eco-restoration.

Unit-III

Sustainable utilization and conservation of biodiversity: biodiversity status, monitoring and documentation biodiversity management approaches, biopiracy, principles of conservation, cryopreservation, germplasm conservation and gene bank conservation strategies. GIS –remote sensing; Biodiversity indices and software packages used for accessing diversity indices.

Unit-IV

International treaties and global efforts for management of genetic resources relating to biodiversity. Convention on Biological Diversity (CBD) and Cartagena protocol. Biodiversity Legislation in India; Indian Biodiversity Act 2002, National Biodiversity Authority of India. Climate change and conservation of genetic resources.

Reference Books:

Edward O. Wilson

1. (2010)The Diversity of Life, 15th Edition. Belknap Press.
2. Simon Levin (2013) Encyclopedia of Biodiversity, 2ndEdition.Academic Press.
3. Jane B. Reece, Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Robert B. Jackson (2013) Campbell Biology, 10th Edition. Benjamin Cummings.
4. Biodiversity and Conservation, Journal. ISSN: 0960-3115