JAI HIND COLLEGE
BASANTSING INSTITUTE OF SCIENCE
&
J.T.LALVANI COLLEGE OF COMMERCE
(AUTONOMOUS)

"A" Road, Churchgate, Mumbai - 400 020, India.

Affiliated to
University of Mumbai

Program: B.Sc.

Proposed Course: Life Sciences

Semester-VI

Credit Based Semester and Grading System (CBGS) with effect from the academic year 2020-21

T.Y.B.Sc. Life SciencesSyllabus

Academic year 2020-21

Semester – VI			
Course Code	**Course Title**	**Credits**	**Lectures /Week**
SLSC601	Genetics & Immunology II	04	04
SLSC602	Developmental Biology & Neurobiology II	04	04
SLSC603	Fermentation technology & Genetic engineering: A Biotechnological Approach II	04	04
SLSC604	Environmental Biotechnology II	04	04
SLSC6PR1	Life Sciences Paper 1 & 2 Practicals	04	08
SLSC6PR2	Life Sciences Paper 3 &4 Practicals	04	08

Semester VI – Theory

Course Code: SLSC601	Course Title: Genetics and Immunology – II	04 Credits
Learning Objectives:	On completion of the course, the student must be able to: 1. Understand the concept of recombination and gene mapping in Eukaryotes 2. Understand various types of mutations and mutagenesis methods 3. Understand various tools used in molecular genetics 4. Understand the concept of recombinant DNA technology 5. Understand the relationship between malfunctions of the immune system and disorders such as autoimmunity, hypersensitivity, graft/host rejection and immunodeficiency. 6. Understand the adverse effects of immune response hypersensitivity, auto immunity 7. Understand the Principles of tumour immunology,mechanisms of transplant rejection; andimmunodeficiency disorders. 8. Apply key immunologic concepts and methods to diagnose immune disorders.	
Course Description:	This course is formulated to provide knowledge of Genetics and Immunology. The genome is the blueprint of an organism and it is important to understand the mechanisms of inheritance, mutations and gene manipulation. The Immune system protects the body from possibly harmful substances by recognizing and responding to antigens with great precision.Most human diseases result from some loss of this precision. Sometimes the immune system is overwhelmed by an infection or a tumor. On other occasions the immune system aberrantly or over-exuberantly responds to innocuous environmental molecules or microbes – or to self-structures – and this results in a loss of immune regulation that results in disease. Understanding immunology has allowed the prevention of infections by the use of vaccines, has helped the medical world develop the ability to transfuse blood making modern surgery possible, has allowed transplantation to become a reality, and has led to rational treatments for allergies and autoimmune diseases**.**	
	THEORY	**60 lectures**
Sub-Unit	**Unit – I: Mechanisms of Inheritance and variation in Eukaryotes**	**15 lectures**
1.	**Genetic recombination in Fungi:** Life Cycle, recombination in *Neurospora* and mapping by Tetrad	**05**

	Analysis	
2.	**Genetic recombination in *Drosophila:*** Life Cycle; Recombination – Mapping the genome by two and three factor crosses, co-efficient of co-incidence and interference.	**05**
3.	**Genetic recombination in Humans:** (a) Somatic cell Genetics: Use of cell hybrids and hybridomas for gene mapping (b) The Human Genome Project and beyond: aims, major features and applications	**05**
Sub-Unit	**Unit – II:**	**15 lectures**
1.	**Mutational Variation:** i. Types of Mutations and Mutagenic agents ii. Natural biological mutagenic agents – Prokaryotic Transposable elements and their significance, Eukaryotic Transposable elements, iii. Induced mutations - Site-Directed mutagenesis using Oligomers, Cassette mutagenicity; PCR-based methods of mutagenesis iv. Mutagenicity testing – Ames test, SCE Test and Mouse Specific Locus Test.	**08**
2.	**Tools and Techniques in Molecular Genetics:** (a) DNA Sequencing – Maxam and Gilbert‟s method and Sanger and Coulson's method (b) DNA Fingerprinting (c) PCR:Polymerase chain reaction i) Method ii) Limitations and applications iii) Types of Primers – Universal, Nested, Poison primers iv) Types – Q-PCR, RT-PCR	**07**
Sub-Unit	**Unit – III: Hypersensitivity, Vaccines and Immunodeficiency:**	**15 lectures**
1.	**Hypersensitivity:** Gell and Coombs classification- Type I: Ig E mediated Ag-Ab reactions viz. RIST and RAST Type II: Antibody mediated : Transfusion reaction , Hemolytic disease of newborn, drug induced Hemolytic anemia Type III: Immune complex mediated Type IV: Delayed type Hypersensitivity- DTH response, contact dermatitis	**07**
2.	**Vaccines:** Passive immunization- i. Preformed antibodies and problems ii. Use of Chimera / humanized antibodies iii. Active immunization- Designing Vaccines for Active immunization i. Whole organisms (attenuated vs. inactivated ex. Polio)	**04**

	ii. Purified macromolecules (Polysaccharide, toxoid and recombinant antigen vaccines) iii. Peptide Vaccines iv. DNA Vaccines	
3.	**Immunodeficiency:** i. B-celled- X-linked agammaglobulinimea ii. T-celled- Di George iii. Combined-SCID iv. Phagocytic- CGD v. AIDS	**04**
Sub-Unit	**Unit – IV: Transplantation, Tumour Immunology, Tolerance and Autoimmunity:**	**15 lectures**
1.	**Transplantation:** i. Types of grafts ii. Tissue typing (serological and MLR) iii. Mechanism of graft rejection iv. Clinical manifestation of graft rejection iv. Graft vs. host disease w.r.t. bone marrow or cornea	**01**
2.	**Tolerance:** i. Mechanism of T cell and B cell tolerance ii. Immunology of pregnancy iii. Role of T- regulatory cells	**03**
3.	**Autoimmunity:** i. Mechanisms for induction (Aetiology) ii. Types of Auto immune diseases-organ specific and systemic. Example, Myasthenia gravis, Graves disease, SLE and Multiple sclerosis	**04**
4.	**Tumour Immunology:** i.Role of the immune system, Cell mediated and humoral responses ii. NK cells and macrophages iii. Tumor specific antigens iv. Immunological surveillance v. Immunological escape and potential for therapy	**07**
References	1. Snustad and Simmons. (2006). Principles of Genetics, 4th edn. John Wiley and sons. 2. Peter Russel (2006). I-Genetics; A Molecular approach, 2nd edn. Pearson. 3. Griffiths et al. (2005). Introduction to Genetic Analysis, 8th edn. Freeman and co. 4. Benjamin Lewin. (2008). Genes IX. Jones and Bartlett publishers. 5. S. B. Primrose and R. M. Twyman. (2007). Principles of Gene Manipulation and Genomics, 7th edn. Blackwell publication. 6. W. S. Klug and M. R. Cummings. (2003). Concepts of Genetics, 7th edn. Pearson.	

7. W. S. Klug, M. R. Cummings, C. A. Spencer. (2006). Concepts of Genetics, 8th edn. Pearson.
8. Tom Strachan and Andrew Read. (2004). Human Molecular Genetics, 3rd edn. Garland Science pub.
9. R.A.Goldsky, T. J. Kindt, B. A. Osborne, J. Kuby. (2003) Immunology 5th edn. W.H. Freeman.
10. C. A. Janeway, P. Travers, M. Walport, M. Shlomchik. (2005). Immunology: The immune system in health and disease, 6th edn. Garland Science Pub.
11. A. K. Abbas, A. H. Litchman. (2000). Cellular and Molecular Immunology, 5th edn. Elsevier publication.
12. Roitt. (2006). Essential Immunology, 11th edn. Blackwell publication.
13. D. Mole, J. Bronstoff, D. Roth, I. Roitt, Mosbey. (2006) Immunology, 7th International edn. Elsevier publication.
14. C. V. Rao. (2002). An Introduction to Immunology. Narossa Publishers.

Course Code: SLSC602	Course Title: Developmental Biology and Neurobiology – II	04 Credits
Learning Objectives:	On completion of the course, the student must be able to: 1. Describe the cellular and molecular basis of development and genes involved during the earlydevelopment. 2. Describe the applications of developmental biology in different fields related to treating various conditions anddiseases. 3. Explain the basics of stem cellresearch. 4. Have a clear understanding about the human sense organs, its transduction mechanisms andpathways. 5. Understand the mechanisms of Prostaglandin inhibition for painmanagement. 6. Discuss the structure of reflex arc and mechanism of musclecontraction. 7. Explore neurobiological basis of certain behaviours anddiseases.	
CourseDescription:	This course is based on Developmental biology and Neurobiology which form the fundamental aspects of Life Sciences. Development is a process by which a single cell (the zygote) gives rise to an entire multicellular organism. During the early developmental stages, the cells are totipotent and as they mature they become committed to one particular type. Various genes play a role during the early development which helps decide the location of organs, anterior-posterior and dorso-ventral axis. Developmental biology gives a clear idea about the genes which plays a role during the early development. It further helps us to study the congenital abnormalities and it can be used to study and treat various conditions/diseases in humans. Neurobiology, on the other hand, is the means by which we communicate with the world. It gives us a clear idea about how senses work and the pathways and mechanisms which underlie it. This field also helps one to understand Pathophysiology of various neurobiological conditions and diseases.	
	THEORY	**60 lectures**
Sub-Unit	**Unit – I: Cellular aspects of development:**	**15 lectures**
	a) Totipotency, Pluripotency, Determination and Differentiation b) Stem cell biology - basic concepts, stem cell niche, Induced Pluripotency, Transdifferentiation c) Differentiation as a change in gene expression d) Cell cell communication in development e) Genes in early development (with Drosophila as example)Maternal genes, Segmentation genes, Realiasator genes, Homeotic–Drosophila. f) Cell cycle and itscontrol. g) Apoptosis	

Sub-Unit	Unit – II: Applications of developmental biology:	15 lectures
	i. Assisted humanreproduction ii. Pre and Post nataldiagnosis iii. Congenitalabnormalities iv. Aging and Senescence: cellular and molecular changes v. Metamorphosis vi. Regeneration vii.Teratogenesis: Alcohol and Retinoicacid	
Sub-Unit	**Unit – III: Sensory and motor system:**	**15 lectures**
	i. Human Sense organs: receptors, receptor mechanisms and pathways (Introduction) ii. Visual system: Vision - structure of the eye, retina, photoreceptors (rods and cones) and colour vision, phototransduction, binocular vision, visual pathway (flow chart only– LGN to visual cortex), light & dark adaptation. iii. Auditory System: Structure of the ear, cochlea and organ of corti receptors 1, Mechanism of transduction, Auditory pathway: (MGN to audiocortex) iv. Vestibular System: Structure of the vestibular labyrinth, maculaeand cristae. Mechanism oftransduction. v. Chemosensory system: Olfactory and Gustatory receptors – structure vi. Skin as sense organ: somatic receptors - Types of mechano-receptors, pain reception & Pain management (example analgesic effect by prostaglandin inhibition -aspirin) Reflexes: Monosynaptic reflex arc (knee jerk reflex)and polysynaptic reflex arc (tendonreflex)	
Subunit	**Unit IV: Neurobiological basis of behaviour and Diseases:**	**15 lectures**
	i. Qualitative and temporal categories of memory, molecular mechanisms of short and long term memory, e.g.: behaviour test in Aplysia. ii. Addiction – narcotic drugs and their effects on CNS (eg:Opiates) v. Schizophrenia- Positive and negativesymptom vi. Prions and Mad cow disease vii. Duchene‟s muscularDystrophy viii. Alzheimer‟sdisease Huntington‟sDisease	
References	1. Wolpert L., Tickle C., and Arias AA. (2015) Principles of Development, Oxford University Press. 2. Gilbert SF., Barresi M.J.F. (2016) Developmental Biology, Sinauer Associates, Oxford University Press. 3. R.M.Twyman. (2000) BIOS Instant Notes in Developmental Biology, Taylor & Francis. 4. Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore D,	

	Darnell J. Molecular Cell Biology. (2000) Molecular Cell Biology, W.H. Freeman. 5. Purves P., Augustine G., Fitzpatrick D., Hall WC., LaMantia AS., White LE. (2011) Neuroscience, Sinauer Associates, Inc. 6. Tortora GJ., Derrickson B. (2013) Principles of Anatomy and Physiology, John Wiley & Sons Inc 7. Longstaff A. (2011) BIOS Instant Notes in Neuroscience, Taylor & Francis 8. Smith C.U.M. (2002) Elements Of Molecular Neurobiology, Wiley	

Course Code: SLSC603	Course Title:Fermentation technology & Genetic engineering: A Biotechnological approach II	04 Credits
Learning Objectives:	On completion of the course, the student must be able to: 1. Understand the enzyme technology, the various methods of immobilization of enzymes 2. Understand how the fermentation technology can be applied in medicine 3. Basic Knowledge of plant and animal tissue culture and production of secondary metabolites 4. Provide examples of current applications of biotechnology and advances in the different areas like medical, microbial, agricultural, plant and animal tissue culture 5. Understand cloning in eukaryotes and applications of recombinant DNA technology and related ethical issues 6. Understand important recent tools used in genetic engineering 7. Understand basic Bioinformatics	
CourseDescription:	This course emphasizes the practical use of microbial organisms in the production of enzymes, the knowledge of fermentative processes used in the industrial production of vaccines, vitamins, secondary metabolites like penicillin and other biopharmaceuticals.This course also introduces the student to the theory of plant and animal tissue culture Students study media, sterilisation, explants, micro propagation, callus culture, organogenesis, somatic embryogenesis, Protoplast isolation and fusion in plant tissue culture. The course also introduces the practice and process of culturing animal cells and cell lines in a laboratory. Focuses on media preparation, cryopreservation and maintenance of cell lines. This course also focuses on applications in recombinant DNA technology and Bioinformatics.	
	THEORY	**60 lectures**
Subunit	**Unit I: Enzyme and Pharmaceuticals Production**	**15 lectures**
I	**EnzymeTechnology:** i. Enzyme production; example Amylase (bacterial & fungal) ii. Immobilized Biocatalyst (method of immobilization, applications – biosensors)	**07**
2.	**Application of fermentation technology in medicine:** Production of: i. Antibiotics (Penicillin) ii. Vitamins (Vit. B12) iii. Vaccines (Polio, HbsAg) iv. Monoclonal antibodies v. Biopharmaceuticals (Insulin / IFN)	**08**

Sub-Unit	Unit – II: Tissue Culture biotechnology	15 lectures
1.	**Application of fermentation technology Agriculture:** i. Secondary metabolites from plant tissue culture ii. Biopesticides – Bacteria (*B. thuringiensis*), Virus (Polyhedrosis virus),and fungal (*Trichoderma*), Mass production technology of bio-pesticides(in vitro and in vivo)	**06**
2.	**Plant and Animal Tissue Culture:** i. Animal – Laboratory setup, Media, Basic techniques (Disaggregation of tissue and primary culture, maintenance of cell lines. Cryopreservation and Cell banking - transport of animal germplasm (i.e. semen, ovum and embryos). ii. Plant – Media, Basic techniques (callus culture, organogenesis, & somatic embryogenesis, Protoplast isolation and fusion)	**09**
Sub-Unit	**Unit – III: Genetic Engineering:**	**15 lectures**
1.	**Cloning in Eukaryotes** i. Cloning vectors in yeast ii. Cloning vectors in animal: SV40, Baculovirus iii. Cloning in plants: Ti plasmid based vectors (binary and Co-integrative vectors), Microinjection method	**07**
2.	**Applications of recombinant DNA Technology:** i. In animals: - Transgenic animals - Knock-in, Knockouts and Knock-down systems - Giant mouse (MMT promoter growth hormone fusion gene) - Xenopus oocyte as expression system ii. Transgenic plants: Bt cotton and weedicide resistant gene, Genetically modified food iii. Gene therapy (Parkinson disease or SCID)	**07**
3.	Ethical, legal and social implications of recombinant DNA technology and consumer awareness (labelling of GM foods)	**01**
Sub-Unit	**Unit – IV: Tools in genetic engineering & Bioinformatics**	**15 lectures**
1.	**Tools in genetic engineering:** i. Electrophoresis: Agarose gel electrophoresis (Principle, methodology and applications), PAGE, Two-Dimensional Gel Electrophioresis ii. Blotting techniques: Southern blotting, Nothern blotting, Western blotting iii. Autoradiography iv. Microarrays v. Cre-Lox system and CRISPR-CAS9 system	**07**
2.	**Bioinformatics:** i. Biological databases (Formats: FASTA and GenBank) ii. Sequence annotation iii. Drug designing and Docking (basic concept)	**08**

	iv. Sequence alignment: Pairwise alignment Eg. BLAST, Multiple alignment Eg. ClustalW v. Phylogenetic trees and concept of bootstrapping vi. Primer designing	
References	1. Michael L Shuler and Fikret Kargi. (2008). Bioprocess Engineering*:* Basic Concepts., Prentice-Hall of India Pvt Ltd. 2. Stanbury P.F.,Whitaker A. and Hall S.J. (2007). Principles of Fermentation Technology. Elsevier India Pvt Ltd. 3. Prescott And Dunn. (2004). Industrial Microbiology. Chapman & Hall. 4. Casida, L.E. (2003) Industrial Microbiology. New Age International (P) Ltd. 5. S.B. Primrose and Twyman. (2006). Principles of gene manipulation, 7th Ed. Blackwell. 6. R.W. Old and S.B. Primrose. (2004). Principles of gene manipulation, 6th edition, Blackwell. 7. Watson. (20010), Recombinant DNA, 3rd ed. ASM Press. 8. T.A. Brown. (2009). Gene cloning and DNA analysis, 2nd ed. Wiley-Blackwell. 9. B. Glick et al. (2010). Molecular Biotechnology- Principles and application of recombinant DNA, 4th ed. ASM Press. 10. D. Clark, N. Pazdernik. (2009) Biotechnology- Applying the genetics to revolution. Academic Press.	

Course Code: **SLSC604**	**Course Title: Environmental Biotechnology II**	**04 Credits**
Learning Objectives:	**Upon completion of the course, the student would be able to:** 1. Understand the basic sustainability concepts of Population changes, carrying- capacity and various factors for the same. 2. Articulate the interdisciplinary context of environmental issues. 3. Prepare for career success in natural resources and its conservation, public health, environmental monitoring, industrial environmental management. 4. Develop a sense of community responsibility by becoming aware of scientific issues in the larger social context. 5. Develop standards of professional behaviour that include rules of ethics and etiquette. 6. Understand the basic theoretical concepts and methodologies of both the physical and social sciences. Learn how to solve large-scale problems using a multitude of tools and approaches.	
Course Description:	The students will be introduced to fundamentals of environmental science, rural environment and urbanization, natural resources and energy conservation, environmental impact analysis and environmental audits, public participation, environmental safety and society.Environmental biotechnology is the scientific study of the environmental system and the status of its inherent or induced changes on organisms. It includes not only the study of physical and biological characters of the environment but also the social and cultural factors and the impact of man on environment.	
	THEORY	**60 lectures**
Sub-Unit	**Unit – I: Human population and pollution**	**15 lectures**
1	**Human population**: size and growth, population fluctuations, carrying capacity and population reduction, density dependent and independent factors	**04**
2	**Urbanization and Sustainability:** a) Urban crisis, suburban sprawl, land use planning, urban open spaces b) Air pollution and diseases of future (cancer & respiratory diseases). c) Urban growth Challenges: causes, effects and control measures of urban and industrial waste.	**04**

	Urban problems related to energy	
3	**Rural environment:** a) Availability of fresh water, use of fresh water, ground water, contamination of ground water, rural sewage management, b) Impact of cities on rural environment eg; Delhi & Yamuna. Impact of Environmental degradation on Women	**02**
4	**Pollution:** a) Causes, effects and control measures of Air pollution, water pollution, soil pollution, Noise pollution, Acid rain. b) Role of Individual in prevention of pollution.	**05**
Sub-Unit	**Unit – II: Renewable and Non- Renewable resources**	**15 lectures**
1	**Natural resources**: a) energy conservation and renewable energy. b) Reserves of non-renewable energy resources: i) Hidden costs of using natural resources - electricity, generation and storing electricity.	**03**
2	**Evaluating energy resources**: a) Oil, Nuclear power, Coal, Natural gas, biomass burning, gas turbines, biofuels.	**06**
3	**Alternative energy resources**: hydropower, Wind energy, Geothermal, Tidal/wave power, ocean thermal energy conversions, Solar energy, Energy efficient buildings.	**06**
Sub-Unit	**Unit – III: Environmental Management**	**15 lectures**
1	**Environmental Impact Analysis:** Concept, procedure and data collection and analysis. Case studies of any mega development projects. (e.g. Solid waste Management of a Municipal corporation, and an industrial plant)	**05**
2	**Environmental audit:** Concept and Phases, procedure and data collection and EMP.	**04**
3	**Public Participation**: a) Methodology and approach for public participation in Environmental & development decision making. b) Case study: i) Plachimada struggle ii) Narmada Bachao andolan iii) Chipko movement c) Regulatory requirements for public participation eg Jaitapur or ENRON issues. i) Advantages and disadvantages of Public participation.	**06**

Sub-Unit	Unit – IV: Safety, Health and Environment	15 lectures
1	**Society and environment:** a) Nuclear proliferation, environment and war : i) E.g. use of Agent orange in Vietnam war, cost, benefit and risks, ii) Risk management (EIA and Environment protection agency) perception of risk and gain, setting up standards, iii) International cooperation - Treaties, planning for future. Vision of the world 2040.	**04**
2	**Safety and Health:** Lessons after 25 years of Bhopal gas tragedy. Perspectives and concerns of citizens: Environment as the ultimate beneficiary / loser.	**03**
3	**Safety and Health Hazards:** a) Identification of potential safety and health hazards in industrial and development projects, reduction strategies, policies and legislation, international and national perspective, b) safety standards and management systems, ISO 18000 (Occupational Health and Safety Management Systems) c) Environmental hazards and human health. Biological, chemical hazards etc.	**08**

Semester VI – Practical

Course Code SLSC6PR1	Course Title: Life Sciences Paper 1 & 2 Practicals	04 Credits
Paper – I	**Genetics and Immunology**	
	1. Giant Chromosome preparation (*Drosophila* / *Chironomuslarvae*) 2. Estimation of bacteriophage titre by plaqueassay 3. Effect of UV radiation on microorganisms (Light repair and Darkrepair) 4. Isolation of antibiotic resistant / auxotrophic mutants using Replicaplate 5. Polymerase Chain Reaction 6. Ouchterlony test forImmunodiffusion 7. Mancini test – Single RadialImmunodiffusion 8. Agarose slide gel electrophoresis ofSerum 9. Separation of Mononuclearcells 10. ELISA	
Paper – II	**Developmental Biology and Neurobiology**	
	1. Effect of boron / calcium on pollen tube germination in *Vinca rosa* or any other suitablesample 2. Role of GA in seedgermination 3. Plant Tissue Culture: Initiation of plant tissue culture fromgerminated chick pea/any other suitablesource 4. Live observations of Development of *C. Elegans/ Dictostelium/ Drosophila/ Zebra fish* 5. Imaginal discs of*Drosophila* 6. Regeneration in earthworm / any other suitable system / hydra(using permanent slide /photographs) 7. Differential staining of white and grey matter of vertebratebrain. 8. Temporary mounts of any three of thefollowing: a) Cornea ofprawn. b) Statocyst ofprawn. c) Columella ofbird. d) Striated / smooth musclefibre. e) Methylene blue staining of earthworm nerve cord or any othersuitable nerve cord or brain to observe organization of neuronal cell bodies in invertebrates f) Olfactory & gustatorysensillae g) Histological staining of neuronal tissue using Heamotoxilin-Eosin stainningorNessil‟sstaining. 9. Making clay model of vertebrate brain and cranialnerves 10. Stroop test 11. Olfactory /Gustatory Behavioral study: Snail / Earthworm / insectlarvae or any other suitablesystem.	

	12. Associativeconditioning 13. Knee-jerk and pupillaryreflex Testing for locating the Blind Spot in theretina	

Course Code SLSC6PR2	Course Title: Life Sciences Paper 3 & 4 Practicals	04 Credits
Paper – III	**FERMENTATION TECHNOLOGY & GENETIC ENGINEERING: A BIOTECHNOLOGICAL APPROACH**	
	1. Thin layer chromatography of lipids/plant alkaloids/any othersuitable extract 2. Bioassay of antibiotic for anti-bacterialactivity 3. Assay of fermentationproduct: (a) Alcohol (b) Sugar 4. Extraction of plasmid DNA 5. Agarose Gel Electrophoresis of extracted plasmid DNA 6. Bioinformatics: Sequence annotation, Translation, Sequencealignment **7. Open-endedprojects:** (a) Home Wine production / Home-Vinegar production from any convenient source & assay for fermentationproducts (b) Plant tissue culture: i) Callus production ii) Preparation ofprotoplasts and estimate viability by trypan bluestaining (c) Growth curve of *Ecoli* (d) Culturing & biomass estimation of mushroom/ *Spirulina /chlorella* by cell count/dry weight and estimation of percentage totalprotein.	
Paper – IV	**Environmental Biotechnology**	
	1. EC,conductivity 2. N/P/K/Sulphates/ Na/Ca. 3. Estimation of Co2+ and Ni2+ by colorimetry / spectrophotometry/ 4. Water analysis for physico-chemicalcharacteristics 5. Estimation of Heavy metal in various samples by titrimetryor spectrometry 6. Potability of the given drinking water sample byMPN. 7. Remote Sensing and GIS: Principles of Remote Sensing and its application of Environmental Science. Application of GIS in EnvironmentalManagement 8. Collection and Interpretation of weather	

	data/Climatology ofMumbai city (Satellite images and statistical analysis of weatherdata) 9. Study of effect of a metal toxicity on the heart beat of Daphniaand statistical analysis of the same T- Test / LC50 10. Field visit to river/lake and waste water treatmentplantIdentification of local plant species as: Ecological indicators, exotic species.	

Evaluation Scheme

[A] Evaluation scheme for Theory courses

I. Continuous Assessment (C.A.) - 40 Marks

(i) C.A.-I: Test – 20 Marks of 40 min. duration

(ii) C.A.-II: Presis writing, Documentary making, Presentations, Quizzes based on videos, Surveys etc.

II. Semester End Examination (SEE)- 60 Marks

[B] Evaluation scheme for Practical courses

I. Continuous Assessment (C.A.) For each Practical – 20 Marks

II. Semester End Examination (SEE) For each Practical – 30 Marks

Grand total of Practicals = 100+100=200

Note: The Department of Life Sciences offers "Horticulture and Gardening as the applied component. The Syllabus of the same is available with the Department of Botany.