St Aloysius College (Autonomous)

Mangaluru

Re-accredited by NAAC "A" Grade

Course structure and syllabus of

B.Sc.

BIOTECHNOLOGY

CHOICE BASED CREDIT SYSTEM

(2020 – 21 ONWARDS)

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(ಸ್ವಾಯತ್ತ)

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ST ALOYSIUS COLLEGE
(Autonomous)
P.B.No.720
MANGALURU- 575 003, INDIA
Phone:+91-0824 2449700,2449701
Fax: 0824-2449705
Email: principal_sac@yahoo.com
principal@staloysius.edu.in
Website: www.staloysius.edu.in

Re-accredited by NAAC with 'A' Grade - CGPA 3.62
Recognised by UGC as "College with Potential for Excellence"
College with 'STAR STATUS' conferred by DBT, Government of India
3rd Rank in "Swacch Campus" Scheme, by MHRD, Govt. of India

Date: -06-2020

NOTIFICATION

Sub: Syllabus of **B.Sc. Biotechnology**under Choice Based Credit System.

Ref: 1. Decision of the Academic Council meeting held on 09-006-2020 vide Agenda No: 9(2020-21)
2. Office Notification dated ……

Pursuant to the above, the Syllabus of **B.Sc. Biotechnology**under Choice Based Credit System which was approved by the Academic Council at its meeting held on 09-006-2020is hereby notified for implementation with effect from the academic year **2020-21**.

PRINCIPAL **REGISTRAR**

To:

1. The Chairman/Dean/HOD.
2. The Registrar Office
3. Library

PROGRAMME OUTCOMES (PO):

Students having an academic background of science at 10+2 level can pursue B.Sc programme in various branches. After the completion of the B.Sc degree there are various options available for the science students, they can pursue master degree in Science i.e. M.Sc, work in research related fields and can even look for professional job oriented courses. After completion of the course students can be absorbed into various core industries, self employability. Often, in some reputed universities or colleges the students are recruited directly by big MNC's after the completion of the course. The student is also eligible for the job of a Medical Representative. The student after graduating will be eligible for various government exams conducted by UGC, CSIR, UPSC etc.

PROGRAMME SPECIFIC OUTCOMES (PSO):

After successful completion of B.Sc. Biotechnology Course:

- Graduates in biotechnology will be eligible for pursuing higher education, M.Sc. programmes in the different field of life science.
- Graduates will exhibit contemporary knowledge in Biotechnology and students will be eligible for doing jobs in pharmaceutical and biotechnological Industry.
- Graduates will be able to understand the potentials, and impact of biotechnological innovations on environment and their implementation for finding sustainable solution to issues pertaining to environment, health sector, agriculture, etc.
- Graduates will be able to design, conduct experiments, analyze and interpret data for investigating problems in BT and allied fields.
- Graduates will be able to work individually as well as in team to survive in multidisciplinary environment.
- Students are able to learn the modern molecular biological techniques viz, chromatography, SDS-PAGE, Agarose Gel Electrophoresis, fermentation, downstream processing and PCR which are very much required for the large-scale production of biotechnology derived products.

Scheme of Credit Based Semester System for the I to VISemesters for B.Sc. in Biotechnology

I Semester							
Paper	**Instruction hours / week**		**Duration of Exam in Hours**	**Marks**		**Total Marks**	**Credits**
	Theory	**Pract.**		**Exam**	**I.A**		
G 511.1 (Theory) – Biophysics and Biostatistics	**4**	**-**	**3**	**80**	**20**	**100**	**2**
G 511.1P (Practical) – Biophysics and Biostatistics	**-**	**3**	**3**	**40**	**10**	**50**	**1**
Elective G511.1E Food Processing Technology	2	-	2	40	10	50	1
II Semester							
Paper	**Instruction hours / week**		**Duration of Exam in Hours**	**Marks**		**Total Marks**	**Credits**
	Theory	**Pract.**		**Exam**	**I. A.**		
G 511.2 (Theory) – Biochemistry	**4**	**-**	**3**	**70**	**30**	**100**	**2**
G 511.2P (Practical) – Biochemistry	**-**	**3**	**3**	**40**	**10**	**50**	**1**
Elective G 511.2E Biotechnology & Its Applications	**2**	**-**	**2**	**40**	**10**	**50**	**1**

III Semester							
Paper	**Instruction hours / week**		**Duration of Exam in Hours**	**Marks**		**Total Marks**	**Credits**
	Theory	**Pract.**		**Exam.**	**I.A.**		
G 511.3 (Theory) – Microbiology and Immunology	**4**	**-**	**3**	**70**	**30**	**100**	**2**
G 511.3P (Practical) – Microbiology and Immunology	**-**	**3**	**3**	**40**	**10**	**50**	**1**
Elective G511.3E Plant Tissue Culture & Mushroom Culture Techniques	**2**	**-**	**2**	**40**	**10**	**50**	**1**
IV Semester							
Paper	**Instruction hours / week**		**Duration of Exam in Hours**	**Marks**		**Total Marks**	**Credits**
	Theory	**Pract.**		**Exam**	**I.A**		
G 511.4 (Theory) – Molecular Biology and Recombinant Technology	**4**	**-**	**3**	**70**	**30**	**100**	**2**
G 511.4P (Practical) – Molecular Biology and Recombinant Technology	**-**	**3**	**3**	**40**	**10**	**50**	**1**
ElectiveG511.4E Immune System & Disease Management	**2**	**-**	**2**	**40**	**10**	**50**	**1**

V Semester							
Paper	Instruction hours		Duration Exam.Hr	Marks		Total Marks	Credits
	Theory	Pract.		Exam	I.A.		
G 511.5a (Theory) – Plant Biotechnology	3	-	3	80	20	100	2
G 511.5b (Theory) – Animal Biotechnology	3	-	3	80	20	100	2
G 511.5P (Practical) – Plant biotechnology and Animal Biotechnology	-	4	4	80	20		2

VI Semester

Paper	Instruction hours		Duration Exam.Hr	Marks		Total Marks	Credits
	Theory	Pract.		Exam	I. A.		
G 511.6a (Theory) Environmental Biotechnology	3	-	3	80	20	100	2
G 511.6b (Theory) –Bioprocess Technology	3	-	3	80	20	100	2
G511.6pa (Practical) Environment Biotech& Bioprocess technology	-	4	4	40	10	50	1
Project Work				40	10	50	1
OR							
Independent Practical Skill Development (IPSD)*	-	4	4	40	10	50	1

*is only to those students who don't have biotechnology project

Semester I

G 511.1–Biophysics and Biostatistics

Part A-BIOPHYSICS

Total Hours: 48

COURSE OUTCOMES:

After successful completion of the course, the students will be able to:

- Understand the principle, working, maintain and calibrations of bio analytical tools and techniques for industrial and research purpose.
- This course covers both fundamental and applications of the instruments that are routinely used for the characterization of biomolecules
- Biophysical techniques for the Isolation, Identification and Quantification of Biomolecules.
- Able to learn underlying principle of techniques such as electrophoresis, microscopy, spectroscopy, centrifugation and chromatography.
- Enrich the students how to utilize various tools of biostatics in interpretation of biological data.
- Students will be able to characterize data and understand different sampling methods.
- The course covers other core areas of biostatistics including Standard Deviation, probability and correlation
- By the end of the course, the students are able to appreciate the importance of statistics in research and prepares them for a career in research

Unit 1		**12hrs**
	1.1 Introduction: Introduction to biophysics: Historical overview, importance in Biology	2hrs
	1.2: **pH and Buffers**-Henderson and Hasselbach equation, role of pK, pH meters, preparation of buffers, impact of pH on bimolecular reactions	2hrs
	1.3 Instrumentation in Biology Microscopes: Basic principles of microscopy, Construction and working principles of bright field, dark field, phase-contrast, fluorescent and electron microscopy (SEM and TEM). Use of microscopes in biology.	4hrs
	1.4 Photometry: Beer Lambert law and its validation and limitations.Instruments used in biology using BL principle- recent advances. Colorimetry, various types of spectrophotometers- UV and Visible spectrophotometry. IR, Fluorimetry ,ESR, NMR and Raman Spectroscopy.(In brief).	4hrs
Unit II		**12hrs**
	2.1:Centrifugation: Principles, Svedberg Law, various types of centrifuges, Continuous Centrifuges, density gradient separation, ultracentrifugation with applications.	3hrs
	2.2:Chromatography: Principles and Types- Paper, TLC and Column chromatography, $R_f$value, its importance, Gas chromatography, HPLC and GC-MS in brief and applications.	5hrs
	2.3:Electrophoresis: Principle ,Gel electrophoresis in separation of biomolecules (Agarose, Polyacrylamide)for nucleic acids .Native and Denatured gel for protein separation.2-D electrophoresis, Flow cytometry.	4hrs

Unit III		**12hrs**
	3.1: Radiations and its Applications in Biology: Introduction, various types, Positive and Negative Effects of radiations on biological systems applications in Biology. Radioactivity, Isotopes , radioactive decay (half life) units of radiations, measurement of radiations. (Ionization chamber, Geiger- Muller counter, scintillation counter and Gamma counters), Uses of isotopes in biology.	4hrs
	3.2 Autoradiography: specimen preparation and uses of autoradiography	2hrs
	3.3 Biophysical Basis of Transport across Membrane Cell membrane- structure, properties and function. Physical process occurring in biological systems: diffusion, osmosis, membrane transport system- passive, active and facilitated. Principle: membrane potential, electrochemical potential, Donnan equilibrium.	6hrs
	Biostatistics	**12hrs**
Unit IV	**4.1 Basic concepts of biostatistics**: Definition of Biostatistics. Concepts of population, sample, census and sample surveys, Classification and tabulation of data, frequency and cumulative frequency table	4hrs
	4.2 Statistical methods-data representation and computation: Diagrams and graphs- bar diagram, pie- diagram, histogram, frequency polygon, frequency curve important averages- arithmetic mean, median and mode. Important measures of variation- range, mean deviation, variance and standard deviation. (problems included). Coefficient of variation. Correlation	6hrs
	4.3: Probability: Definitions of probability. Additive and multiplicative theorems of probability.	2hrs

G 511.1 P–Biophysics and Biostatistics(practicals based on G 511.1) (Each Practical session is of 3 hours duration)	
1	Instrumentation in biophysics-, pH meter, Microscopy, colorimeter, centrifuge, electrophoretic units, TLC, HPLC.
2	Calculation of Normality, Molarity, Stock Solutions
3	Preparation and use of buffers and determination of pKa of a buffer solution.
4	Validation of Lambert Beer's law (absorption maxima of a solution) by using Colorimeter and spectrophotometer.
5	Separation of blood components by centrifugation.
6	Study of Cyclosis in elodea and osmotic potential in plant cells
7	Separation of Plant pigments by Paper chromatography- ascending or descending or circular, and determination of Rf values
8	Column chromatographyof amino acids
9	Gel electrophoresis any sample(Demonstration)
10	SDS-PAGE (Demonstration)
11	Problems in biostatistics – Sampling, mean, median, mode , histogram, frequency polygon, standard deviation ,correlation
12	Plot of Graph using Microsoft Excel
13	Practical test – internal assessment

REFERENCES	
1	Banerji P.K., 2005 Introduction to biostatistics, Scand and co ltd
2	Casey E.J. 1962. Biophysics; concepts and mechanisms. First edition New York: Reinhold Pub.
3	Co Rastogi. V.B .,2007, Fundamentals of biostatistics, New Delhi.
4	Gurumani .N. 2005 Introduction to biostatistics, Ed 2, MJP publishers Chennai.
5	Jackson M. B. Molecular and cellular Biophysics.2006 Cambridge University Press.
6	Sokal, Robert R. and F. James Rohlf (1969, 1981, 1994 (any edition).Biometry: The Principles and Practice of Statistics in Biological Research,) W H Freeman & Co.; ISBN: 0716724111
7	Subramanian M.A.2005 Biophysics principles and techniques. MJP publishers
8	Cotteril R., 2002. Biophysics: An Introduction (Paperback) Wiley Publishers, New Ed.
9	Upadhyay, A., Upadhyay, K., and Nath, N., 2007, Biophysical chemistry, Third Edition,Himalaya publishing House, Mumbai.
10	Wilson. K and Walker. J., 2010. Principles and techniques of Biochemistry and Molecular Biology, Seventh edition. Cambridge University Press,New York, USA

ELECTIVE -1: SUPPORTIVE ELECTIVE

G511.1E- FOOD PROCESSING TECHNOLOGY

CREDITS: 1 **TOTAL HOURS: 30**

COURSE OUTCOMES:

After successful completion of the course the students will be able to:

- Describe the source and variability of raw food material and their impact on food processing operations.
- Explain the spoilage and deterioration mechanisms in foods and methods to control deterioration and spoilage
- Explain the methods of food processing and packaging

UNIT I **1.1 Introduction** **10hr**

Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general.Microbial spoilage of various foods. Proximate analysis(Ash, moisture etc)

1.2 Methods of food preservation:-Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, chemical methods of food preservation: salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene

1.3 Separation processes:-Principles and methods of: distillation, extraction, washing, filtration, sedimentation,sieving and centrifugation

UNIT II **2.1 Food Processing-** Definition**,** classification of processing, types **15hr**

2.2 Methods of Processing

Freezing- Freezing methods -direct and indirect, still air sharp freezer, blast freezer, fluidizedfreezer, plate freezer, spiral freezer and cryogenic freezing**.**

Dehydration:-Normal drying curve , effect of food properties on dehydration , change in food

during drying ,drying methods and equipment.Air convection dryer, spray dryer, drum dryer, vacuumdryer ,freeze drying.

Food Irradiation and Microwave Heating:- Ionizing radiation and sources, unit of radiations, direct and indirect radiation effects,safety and wholesomeness of irradiated food. Microwave heating and application**.**

Thermal processing

Introduction, classification of Thermal Processes, Principles of thermal processing,Thermal Death Time, Lethality concept (Give examples of food processed by thermal process).

2.3 Packaging of foods

Packaging: Properties of packaging material, factors determining the packagingrequirements of various foods and brief description of packaging of frozen products,dried products, fats and oils and thermally processed foods. Smart Packaging.

REFERENCES

1 Desrosier NW and Desrosier JN, 1998. The Technology of Food Preservation,CBSPublication, New Delhi

2 Paine FA and Paine HY, 1992. Handbook of Food Packaging, Thomson Press India Pvt Ltd, NewDelhi

3 Potter NH, 1998. Food Science, CBS Publication, New Delhi.

4 Ramaswamy H and Marcott M, 2006. Food Processing Principles and Applications CRC Press

5 Rao PG, 2010.Fundamentals of Food Engineering, PHI Learning Pvt Ltd, New Delhi

6 Toledo Romeo T, 1999.Fundamentals of Food Process Engineering, Aspen Publishers.

Semester II

G 511.2– BIOCHEMISTRY

Total Hours : 48

COURSE OUTCOMES:

After successful completion of the course the students will be able to:

- Comprehend the structure and function of different biomolecules including of proteins, lipids, nucleic acids, and carbohydrates.
- Upon successful completion of this course, the student will learn, the major classes ofenzyme and their functions in the cell
- Basic concepts of enzymes their mechanism of action
- The course also provides information pertaining to role of co-enzyme cofactor inenzymecatalyzed reaction, properties of enzymes and regulation of biochemical pathways.
- Students are able to understand enzyme kinetics, thermodynamics and other related areas
- Acquire knowledge base of metabolic pathways such as Glycolysis, Kreb's Cycle, ETCetc. occurring inside living cells.

Unit 1		**12hrs**
	1.1.Inter and Intermolecular interactions: Types of interactions: Covalent (Polar and Non-polar) and non covalent.(ionic, Hydrogen bonds, Vander Waals Interactions).	2hrs
	1.2 Carbohydrates: Classification, Biological importance. Monosaccharide nomenclature, different classes with examples, structure and functions. Oligosaccharides-Glycosidic bond, reducing and non-reducing sugars with examples. Structure and functions of Polysaccharides (cellulose, starch, chitin, pectinand peptidoglycans).	6hrs
	1.3 Lipids: Classification and their biological role. Fatty acids:nomenclature and Classification, Important Physical properties and chemical reactions, (Esterification, Rancidity, Hydrogenation of fatty acids), Acylglycerols: Saponification reaction ,Phospholipids, TAGs and sterols and their functions.	4hrs
Unit II		**12hrs**
	2.1Nucleic acids: Composition ,Classes-DNA & RNA, Structure and functions of nucleic acids.	2hrs
	2.2 Proteins: Structure and classification of amino acids, characteristics of Peptide bond. Classification of protein based on structure with example. Protein architectural levels- Primary structure and Secondary structures,Tertiary structure of protein with Myoglobin as example. Quaternary structure with	5hrs

	Eg:Haemoglobin.	
	2.3 Hormones: General characteristics and types – Peptide hormone (Eg: insulin and somatotropin) steroid hormones (Eg: adrenal cortical hormones)	3hrs
	2.4.Vitamins: Water soluble and fat-soluble vitamins and structures.	2hr
Unit III	**ENZYMOLOGY**	**12hrs**
	3.1 Enzymes: Enzymesas biological catalysts, Compared with inorganic catalyst, Characteristic features of enzymes, classification of enzymes-General Reactions with examples. Enzyme active site- Induced fit and Lock and Key model. Enzyme Specificity (Absolute specificity, broad specificity, intermediate specificity, stereo specificity),Multienzyme, Holoenzyme, Apoenzymes, Coenzymes and Co-Factors. Units of Enzyme -IU and katal, Enzyme assay with an example for direct & indirect assay method. Single and Bisubstrate enzyme catalyzed reaction with example	5hrs
	3.2 Enzyme kinetics: Activation energy, Factors affecting the rate of enzymatic reactions: Substrate concentration, pH, temperature. Michelis-Menten equation (derivation not required), Hyperbolic curve, K_m and V_{max} determination with LB plot and its significance.	3hrs
	3.3Enzyme inhibition: Reversible and Irreversible inhibition. Reversible inhibition. -competitive, non competitive ,uncompetitive Schematic representation of inhibitor interaction with enzyme.LB plot to differentiate the different types of reversible inhibitor effect. Irreversible inhibition with serine protease inhibitor as an example.	4hrs
Unit IV	**Thermodynamics and Metabolism**	**12hrs**
	4.1 Thermodynamics: Thermodynamics in living system. Laws of thermodynamics: first and second law of thermodynamics, Concept of enthalpy, entropy, free energy, standard free energy, ΔG, ΔG°& ΔG°'. Endergonic and exergonic reactions. High energy compounds- structure ATP. Its importance as biological energy currency.	4hrs
	4.2 Metabolism: Introduction; Catabolism and anabolism, Primary and Secondary Metabolism. Glycolysis, Krebs's cycle, Electron Transport Chain (ETC), Beta oxidation of fatty acids, Gluconeogenesis ,Glycogenolysis.	8hrs

	Secondary Metabolism: Classes of various plant of secondary metabolites and their importance (structure not required).	

G 511.2 P– Biochemistry (Practicals based on G 511.2) (Each Practical session is of 3 hours duration)	
1	Qualitative analysis of Carbohydrates (monosaccharides , disaccharides and polysaccharides): glucose, fructose, ribose/xylose,maltose, sucrose, lactose, starch/glycogen.
2	Qualitative analysis of Amino acids and proteins :histidine, tyrosine, tryptophan, cysteine, arginine and albumin.
3	Qualitative analysis of secondary metabolites.
4	Estimation of Reducing sugar by Anthrone method.
5	Qualtitative analysis of oil and fats.
6	Quantitative analysis-Estimation of carbohydrates (DNS method)
7	Quantitative analysis- Estimation of glucose by Nelson Somoyagi method.
8	Quantitative analysis- Estimation of glucose by Folin – Wu method
9	Quantitative analysis- Estimation of proteins by Lowry's method
10	Quantitative analysis- Estimation of proteins by Biuret method.
11	Qualitative analysis - Assay of enzymes (salivary amylase, Urease).
12	Practical test – internal assessment

REFERENCES

1	Berg, JM, Tymoczo JL, Stryer L, 2006. Biochemistry, 6thed,: W.H. Freeman and Company, New York
2	Buchanan,B.B, 2006 Biochemistry & molecular biology of plants,ed:6,American Soc. of Plant Physiologists
3	Champe.,C.P, Harvey.,R.A and Denise.R,2008.Biochemistry.Edition: 4 –, Lippincott Williams & Wilkins.
4	Denniston,K, Topping ,J and Caret.,R, 2007.Student Study Guide/Solutions Manual to accompany General, Organic &Biochemistry ,McGraw Hill Publications.
5	Murray R. K, Granner D. K, Mayes P. A and Rodwell V. W, 2006. Harper's Illustrated biochemistry (Harper's biochemistry).
6	Nelson., D.L, Cox., M.M, 2008. Lehninger Principles of Biochemistry 5thed:Illustrated W. H. Freeman and Company,: New York
7	Nicholas C.P. and Lewis Stevens, 1982. Fundamentals of Enzymology. Oxford
8	Palmer, T, 2001. Enzymes: biochemistry, biotechnology and clinical chemistry. Horwood**Publishing**Limited.
9	Wilson K. and Walker J., 2000. Practical biochemistry – Principles and techniques, 5th Ed. The Press Syndicate of the University of Cambridge publishers, Edinburgh, Cambridge.
10	Voet.,D.andVoet.,J, 2003. Biochemistry, Biomolecules, Solutions Manual (Volume 1). (Paperback) Wiley Publication.
11	Zubay, G. 1988. Biochemistry, 2nd Ed. MacMillan Publlishing Company, New York.

ELECTIVE -2: EXPANDED ELECTIVE

G511.2E- Biotechnology & Its Applications

CREDITS: 1 **TOTAL HOURS: 30**

Course Outcome:

After successful completion of the course the students will be able to:

- Explain various methods of gene transfer in plants and animals
- Application of biotechnology in agriculture, production of transgenic animals, biofertilizers, biopesticidesetc
- To describe DNA fingerprinting technology, PCR techniques

UNIT I **10hr**

1.1Introduction: Brief history of biotechnology, traditional approaches involved, scope of modern biotechnology.

1.2 Gene cloning: Steps in Gene Cloning, Gene Transfer in Plants- Physical and Chemical methods of gene transfer, Agrobacterium mediated gene transfer. Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer

UNIT II **15hr**

2.1 Biotechnology in agriculture: Biopesticide, biofertilizers, transgenic plants, production of hybrids (Give examples)

2.2 Biotechnology in animal husbandry: Transgenic animals (Give examples)

2.3 Biotechnology in Biomedical Research: DNA fingerprinting, RT-PCR, gene therapy, Production of therapeutics using rDNA technology.

REFERENCES

1 Brown T.A., 2006Gene cloning an introduction – 3rd edition Stanley Thornes publishers ltd

2 Watson JD, 2007 Recombinant DNA technology: genes and genomes 3rd edition. W.H. Freeman and company

3 Lousi-Marie Houdebine, 2003, Animal transgenesis and cloning. John Wiley and Son's.

4 Butler M. 2nd edition 2004.Animal Cell Culture and Technologyby. BIOS Scientific Publishers

Semester III

G511.3. MICROBIOLOGY AND IMMUNOLOGY

Part – A MICROBIOLOGY

Total Hours:48

COURSE OUTCOMES:

After successful completion of the course the students will be able to:

- To Classify and explain the structure and general characteristics of Microorganisms.
- To prepare various Bacteriological, Algal, and Fungal Media.
- To get insight in Primary and Secondary organs of Immune system.
- To describe Antigen-antibody interactions as well as techniques like ELISA, RIA, Immunofluorescence
- To explain cell mediated immunity, Monoclonal antibody production and Hypersensitivity.
- The course will provide sound knowledge of how immune system deals with various pathogens, different processes and cell types involved in prevention of disease along with the concept and significance of vaccines.

Unit 1		**12hrs**
	1.1: Introduction: Definition, scope of microbiology. History of Microbiology: Discovery era, transition period, golden age Contributions of Antony van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming,	3hrs
	1.2: Classification of Microorganisms: Outline Classification of major groups of microorganisms. Prokaryotic and Eukaryotic-Bacteria, Fungi, Algae and viruses. Species and strains with examples.16S rRNA based Classification	1hr
	1.3: Basic Techniques in Microbiology **Sterilization Techniques:** Principle and methods of sterilization. Physical methods - Use of dry heat, moist heat, filtration autoclave, hot-air oven, laminar air flow, filter sterilization. Radiation methods - UV rays, electron beam radiation, gamma rays and ultrasonic methods. Chemical methods - Use of Alcohols, aldehydes, dyes, halogens, hypochlorites, phenols, Phenol coefficient, metallic salts, detergents, gaseous agents.	3hrs
	1.4: Culturing of Microorganisms: **Culture Media:** Characteristics of a culture medium, Types ,preparation and uses of media: Simple medium, complex media and selective media	5hr

	Isolation, Culturing and Preservation Techniques: Culture of Bacteria and Fungi: Sources, methods of Isolation and identification techniques –Serial Dilution, plating: Pour, streak-plate, spread-plate Technique, pure culture. Maintenance and methods of Preservation of microbial culture- serial subculture: Use of slants, at very low temperature, overlaying culture with mineral oil, lyophilization, freeze drying using liquid nitrogen . **Identification:** Study of colony characteristics. **Staining of Microorganisms:** Principle of staining and types of stains - Simple stain, differential stains- Gram staining and Acid- fast staining, Negative staining, structural stains - Endospore and capsule staining	
Unit II		**12hrs**
	2.1: Study of Microorganisms: **Prokaryotes:**GeneralFeatures with examples **Morphology and ultra structure of Bacteria:** Size, Shape and arrangement, Ultra structure of a bacterial cell- Capsule, fimbriae, flagella, cell wall, cytoplasmic membrane, cytoplasm, ribosomes, storage granules nucleoid and extrachromosomal elements., Features of archaebacteria, cyanobacteria, mycoplasmas with examples	3hrs
	2.2: Nutrition and reproduction in bacteria: **Nutrition: Nutritional Classifications:** Autotrophs -Photolithotrophs and Chemolithotrophs, and heterotrophs with examples. Bacterial Growth Curve.Factors affecting bacterial growth. Measurement of Cell growth: Viable count: Standard plate count, Total count: Turbidity method, haemocytometer method. **Chemotherapeutic Agents:** Antibiotics, classification and their mechanism of action in brief. **Reproduction** -Vegetative and asexual methods (Budding ,fission).	5hrs
	2.3 Economic importance of bacteria	1hrs
	2.4: Study of Viruses and Eukaryotes: **Viruses**:General characteristics and classification of viruses -Plant, animal and bacterial types with examples. Importance of viruses- (Mention of interferons, vectors, viral diseases in plant animal and humans)	3hrs

Unit III	**Part B– IMMUNOLOGY**	**12hrs**
	3.1.Introduction: Brief history to immunology, innate and adaptive immunity – skin, physiological, phagocytic and inflammation, lymphocytes, cell mediated and humoral immunity. Hematopoiesis, cells and organs of the immune system.	4hrs
	3.2.Antigens and antibody: Antigens – structure and types. Factors influencing immunogenicity, epitopes, haptens. Antibody – fine structure, classes with structure and functions, antigenic determinants on immunoglobulins. MHC complex – types, structure, and functions	3hrs
	3.3 Antigen-antibody interactions : Principle, Antigenrecognition by B-cells andT cells**.** Types: Precipitation reactions, agglutination reactions, radioimmunoassay, ELISA, western blotting, immunofluorescence	3hrs
	3.4 . Hypersensitive reactions : **Type I, type II, type III and type IV. - General features, and immune response. Examples-systemic anaphylaxis, hemolytic disease of newborns, localized arthus.**	2hrs
Unit IV		**12hrs**
	4.1 Immune response to infectious diseases : Brief account on infection and mechanism of immune responses - Virus - influenza virus, bacteria - *Mycobacterium tuberculosis* and protozoan-malaria infection and fungal infection–candidiasis	3hrs
	4.2.Autoimmunity: Organ specific autoimmune diseases –Hashimoto's Thyroiditis, IDDM (insulin dependant diabetes mellitus), Grave's disease, systemic autoimmune disease – systemic lupus erythematosus, multiple sclerosis.	3hrs
	4.3. Vaccines: Active and passive immunization, types of vaccines – whole organism vaccine, purified macromolecules, recombinant –vector, DNA vaccines and multivalent subunit vaccines.	2hrs
	4.4. Immunodeficiency and immune system: Brief account on HIV, mechanism of infection, immune responses (AIDS as an example).	2hrs
	4.5. Cancer and **Immune responses:** Introduction to oncogene and cancer induction, tumor antigens, immune response, cancer immunotherapy.	2hr

G 511.3P –Microbiology and Immunology (based on G 511.3) (Each Practical session is of 3 hours duration)	
1	Laboratory rules and good laboratory practices (GLP)an introduction to tools, equipments and other requirements in Microbiology laboratory. Equipments: - Autoclave, Oven, Incubator, Laminar air flow Hood, water bath, microscope, autoclave, incubator, hot air oven, centrifuge, pH meter, Quebec colony counter)
2	Preparation of culture media: Solid / Liquid. Autoclaving and sterilization of glassware and culture medium Sterilization and Sterilization techniques.
3	Isolation and culturing serial dilution and plating techniques (Bacteria and Fungi).
4	Hanging Drop method to observe motility of bacteria.
5	Biochemical tests for bacteria :Indole, Methyl red, VogesProskauer, Citrate test, Oxidase test, Catalase tests.
6	Study of Cyanobacteria :*Nostoc,* Scytonema, study of Protozoa: Amoeba, Malarial parasite: *Entamoeba* ,Euglena Study of fungi *Rhizopus,SaccharomycesPenicillium, , Aspergillus*from permanent slides/cultures).
7	Antibiotic sensitivity of bacteria - Antibiotic sensitivity test – disc diffusion method
8	Determination of blood groups and Rh typing.
9	Differential counting by Giemsa/Leishman
10	Immunodiffusion reactions –Double immuno diffusion, radial immuno diffusion
11	**Practical test**

REFERENCES

1	Aneja K.R., Jain P, Aneja R,2008. A Textbook of Basic and Applied Microbiology, New Age International,New Delhi.
2	Brock T.D. and Madigan, M.T. 1988. Biology of Microorganisms. Prentice Hall, New Jersey
3	Goldsby R. A., Thomas J. K, Osborne B A., 2007. Kuby Immunology, W. H. Freeman and Company, New York.
4	Krieg N.R. and J.G. Holt. 1986. Ed. Bergeys Manual of Systematic Bacteriology.
5	Pelczer M.J, R.D. Reid, Chan, E.C.S., 1997. Microbiology, Dynamics and Diversity. Haricot Brace College Publishers, New York.
6	Prescott, L. M., Harley, J. P. and Klein, D. A. 2005. Microbiology. 6th ed, McGraw Hill, Boston.
7	R.C. Dubey and D.K. Maheshwari. Practical Microbiology. 2004. S.Chand& Co. Ltd, New Deihi (1st Edition).
8	Roitt, L., Brostoff, J. and Male, 1990. Immunology, D. Grower Medical Publishing, London.
9	Tortura, J.G, Funk, B, R., Case C L.2010. Microbiology - An Introduction.9th edition. Communing Publishing Company Inc.

Semester III

OPEN ELECTIVE - SKILL ENHANCEMENT COURSE

G511.3E-PLANT TISSUE CULTURE & MUSHROOM CULTURE TECHNIQUES

CREDITS:1 **TOTAL HOURS: 30**

Course Outcome:

After successful completion of the course the students will be able to:

- Understand the concepts of plant tissue culture, preparation of media
- It will explain the production of haploid plants, Hybrids, Virus free plants
- Explain the methods of germplasm conservation
- Mushroom culture and its nutritional values

UNIT I **15hr**

Plant Tissue Culture

History of plant tissue culture, Laboratory requirements and general techniques involved in micropropagation techniques, Media-types, preparation, composition of media and growth regulators.

Concept of cellular totipotency, callusing, cytodifferentiation. Types of culture-seed culture, embryo culture, root culture, callus culture, organ culture, endosperm culture, Meristem and shoot tip culture.
Protoplast isolation, Protoplast culturing techniques, Fusion of protoplast, testing of viability of isolated protoplast. Haploid productions and germplasm storage.

UNIT II **15hr**

Mushroom Culture

Biology of Mushrooms: Varieties**,** Button, Straw& Oyster- General morphology, distinguishing characteristics, spore germination and life cycle. Nutrient Profile of Mushroom, Health benefits of Mushroom.

Cultivation techniques**-** Edible mushroom, Mushroom Poisoning, preparation of culture media**,** collection of raw materials, Preparation of mushroom fungal culture, preparation of mother spawn, Preparation of bed spawn, Mushroom bed preparation, Mushroom Production Technology, Post harvest Technology and Value addition, Economics for mushroom

production

REFERENCES

1 Bhojwani S.S. and Razdan M.K., 2004. Plant tissue culture, Panima Publishing Corporation, Delhi.

2 Chawla H.S., 2004. Plant Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd.

3 Giri C C and Giri A, 2007. Plant Biotechnology practical manual, I K International publishing house Pvt Ltd.

4 Mushroom Production and Processing Technology, PathakYadavGour, 2010 Published by Agrobios (India).

5 A hand book of edible mushroom, S.Kannaiyan& K.Ramasamy,1980. Today & Tomorrows printers & publishers, New Delhi

6 Handbook on Mushrooms, Nita Bahl, oxford & IBH Publishing Co.

Semester IV

G 511.4– Molecular Biology and Recombinant DNA Technology

Part – A MOLECULAR BIOLOGY

Total Hours:48

COURSE OUTCOMES:

After successful completion of the course the students will be able to:

- To describe Fine structure of prokaryotic and eukaryotic genes
- To understand the mechanism of replication, transcription, translation in prokaryotes and eukaryotes.
- This course provides technical know-how on versatile techniques in recombinant DNA technology.
- To isolate the DNA from bacteria, plant and animal cells
- To explain the construction of DNA & c DNA library and their applications.
- To explain the application of gene cloning in agriculture and medicine
- The course will provide techniques involved in production of transgenic plants and animals and their pros and cons.
- Approaches in handling the perceived risks of GMOs released into the environment possible adverse impacts of GMO's on biodiversity.
- Intellectual Property Rights.

Unit 1		**12hrs**
	1.1. Nucleic acids: Central dogma, Experiments on DNA (Griffith's, Avery *et al* and Hershey and Chase experiment) and RNA as genetic material -TMV – Frankel Conrat experiment. Organelle DNA:cp DNA and mt DNA. Transposons	3hrs
	1.2: Structure of genes: Fine structure of prokaryotic and eukaryotic genes, Concepts of recon, muton and cistron with examples.	2hr
	1.3: Genetic code: Genetic code: features with examples and exceptions	1hr
	1.4: DNA Replication and repair mechanism : Mechanism of replication in prokaryotes and eukaryotes (steps and enzymes), semiconservative methods with experimental evidence.DNA Repair mechanisms with examples.	6hrs
Unit II		**12hrs**
	2.1 DNA recombination mechanism : Mechanism in prokaryotes - Homologous, Holliday model. Mechanisms in eukaryotes. Mechanism of Gene transfer in bacteria - conjugation, transformation, transduction and transfection	3hrs

	2.2 Transcription in prokaryotes and eukaryotes: Mechanism of Transcription in prokaryotes, mechanism of transcription in eukaryotes and Post transcriptional modification in Eukaryotes-.mRNA processing	4hrs
	2.3 Translation in prokaryotes and eukaryotes: Mechanism of Translation in prokaryotes and Mechanism of Translation and types of Post translational modification in eukaryotes.	2hrs
	2.4 Regulation of gene expression: Prokaryotic gene regulation-operons (e.g. lac) Eukaryotic gene regulation at genome, transcriptional and post transcriptional levels.	3hrs
Unit III	**Part – B rDNA TECHNOLOGY**	**12hrs**
	3.1 Introduction: Aims, objective and scope of gene cloning and recombinant DNA technology.	1hr
	3.2 Isolation and purification of DNA: Introduction, isolation of DNA from Bacterial, plant and animal cells and simple purification methods (cell lysis, centrifugation, column chromatography, anion-exchange resin), Quantification of DNA.	4hrs
	3.3 Gene cloning: Introduction, Tools - restriction enzymes. DNA modifying enzymes (Nucleases, Ligases, Alkaline Phosphatases,Topoisomerases, Polymerases). Techniques involved in introduction of foreign DNA into plant and animal cells –physical (Microinjection,Shot gun Method, Electroporation), chemical (calcium Chloride, Liposome)and biological methods (Agrobacterium Mediated). DNA vectors e.g. plasmids (pBR322,pUC18), bacteriophages (λ phages), phagemids-M13 phage, cosmids .	7hrs
		12hrs
Unit IV	**4.1 Screening and selection of recombinants:** Introduction, tools, techniques, Screening and selection of recombinants by selection media (X-gal and IPTG, Ampicilin and Tetracycline Resistance), probes, PCR and blotting techniques (Southern, Western and Northern Blotting).	3hrs
	4.2 DNA libraries: **Introduction to genomic and cDNA libraries-construction of cDNA libraries and its applications.**	2hrs
	4.3 Applications of gene cloning: In agriculture – introduction, transgenic plants - Bt cotton. In medicine - brief account on recombinant vaccines, Interferons. Genetically engineered products – tPA, Insulin, Factor VIII, Human growth hormone.	4hrs
	4.4Biosafety and IPR: **Biosafety:Hazards and biosafety measures for recombinant DNA technology and GMOs.**	2hrs

	IPR: Introduction, World Organisations involved in IPR (GATT, TRIPs,WIPO,WTO).General account on patenting (Forms of Protection-Patent/Confidentiality, agreement, copyright, Trade marks, Trade secrets, Geographical indications, designs)	

G 511.4P– Molecular Biology and Recombinant Technology (based on G 511.4)

(Each Practical session is of 3 hours duration)

1	Isolation of RNA from bacterial/animal/plant origin
2	Isolation of DNA from bacterial/animal/plant origin.
3	Tests for DNA / RNA/ proteins isolated from tissue
4	Spectrophotometric estimation of DNA and RNA/Purity Analysis
5	Quantitative estimation of DNA by Diphenylamine method.
6	Quantitative estimation of RNA by Orcinol method
7	Estimation of total DNA / RNA/ protein from animal cells and plant cells
8	Nucleic acid separation by Agarose gel electrophoresis
9	Restriction digestion
10	DNA ligation
11	PCR and Blotting Techniques-Demonstration.
12	Practical test – internal assessment

REFERENCES

1	Alberts, B, Bray, D, Lewis, J, Raff, M, Roberts, K, Watson, J.D (eds) 2008. Molecular Biology of the cell 4th edn. Garland Publishing, Inc, New York.
2	Brown T.A., 2006Gene cloning an introduction – 3rd edition Stanley Thornes publishers ltd.
3	Cooper G.M, 2007. The Cell – A Molecular Approach. 2nd ed. Sunderland (MA): Sinauer Associates, Inc.;
4	De Robertis, E.D.P. and De Robertis, E.M.F. 1995. Cell and Molecular Biology. 8thedn, B. I. Waverly Pvt. Ltd, New Delhi
5	Griffiths, Anthony J. F.; Gelbart, William M.; Miller, Jeffrey H.; Lewontin, Richard C. 1999. Modern Genetic Analysis**,** New York: W. Freeman & Co,
6	Karp G., 2009. Cell and Molecular Biology - Concepts and Experiments 6th Edition: John Wiley & Sons
7	Krebs, J., Goldstein,E., Lewin,B and Kilpatrick,S.2009.Lewin's essential genes, Jones and Barlett publishers.
8	Lodish, H., Berk,A ., Zipursky,L., Masudaira,P& Baltimore, D.2008. Molecular cell Biology, 4thedn, WH. Freeman and company, New York
9	Watson JD, 1992. Recombinant DNA technology – Scientific American books
10	Watson JD,2007 Recombinant DNA technology:genes and genomes 3rd edition. W.H. Freeman and company.

IV SEMESTER

OPEN ELECTIVE – INTERDISCIPLINARY

G511.4E- IMMUNE SYSTEM AND DISEASE MANAGEMENT

CREDITS:1 **TOTAL HOURS: 30**

COURSE OUTCOME

After successful completion of the course the students will be able to:

- Understand the principles governing vaccination and the mechanisms of protection against disease
- Understand how immuno deficiencies related to disease
- Understand and explain the basis of allergy and allergic diseases.

UNIT I **10hr**

Introduction

Brief history to immunology, innate and adaptive immunity – skin, physiological, phagocytic and inflammation, lymphocytes, Cells and Organs of Immune system, Antigen and antibody structure & functions

UNIT II **20hr**

Microbial Diseases

The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control

Bacterial diseases: Respiratory Diseases: *Haemophilusinfluenzae, Mycobacterium tuberculosis*

Gastrointestinal Diseases: *Salmonella typhi*, *Vibriocholerae*

Viral diseases: Polio, Hepatitis, Rabies, Dengue, Influenza with brief description of swine flu, Ebola, Nipah virus, Corona virus

Protozoan diseases: Malaria, Kala-azar

Fungal diseases: Cutaneous mycoses: Tineapedis (Athlete's foot); Systemic mycoses: Histoplasmosis; Opportunistic mycoses: Candidiasis

Sexually transmitted diseases (STD): Types, route of infection, clinical symptoms and prevention.

Vaccines & Cancers

Active and passive immunization, types of vaccines. Cancer-types of cancer, causes of cancer.

REFERENCES

1 Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication

2 Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.

3 Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms.14th edition. Pearson International Edition

4 Goldsby R. A., Thomas J. K, Osborne B A., 2007. Kuby Immunology, W. H. Freeman and Company, New York.

Semester V

G 511.5a– Plant Biotechnology

Total Hours:42

COURSE OUTCOMES:

After successful completion of the course the students will be able to:

- This course will provide the students knowledge about different techniques of plant biotechnology utilized for conservation and mass propagation of rare and endangered plant species.
- The course will enlighten student about principles of plant tissue culture including *in vitro* culture of different plant parts.
- The course will provide detail pertaining to tools and processes involved in generation of transgenic plants.
- It will explain the production of haploid plants, Hybrids, Virus free plants and selection of variants
- It will teach Germplasm conservation and various methods involved

Unit 1		**14hrs**
	1.1 Introduction: **Brief history of plant tissue culture:**Principle, Laboratory requirements and general techniques involved inmicropropagation techniques(Equipments Media-types,explants, sterilization techniques). Role of micro, macronutrients, pH and gelling agents and growth regulators.	5hrs
	1.2.Cell differentiation: Introduction,Concept of cellular totipotency, callusing, cytodifferentiation - xylogenesis, organogenesis general account, factors affecting the growth and differentiation, applications and limitations. Meristem and endosperm culture :Methodology and applications (in brief)	5hrs
	1.3. Somatic embryogenesis: Introduction, mechanism of embryogenesis. Somatic embryo versus zygotic embryos, synchronizing embryo development, large scale production of somatic embryos. Factors involved and applications of somatic embryogenesis. **Synthetic seed production, storage and its applications**	4hrs
Unit II		**14hrs**
	2.1 Protoplast isolation & Culture Principles, isolation of protoplasts, factors affecting the viability, testing of viability of isolated protoplast and applications.	3hrs

	2.2. Somatic hybridization: Methods of protoplast fusion, selection of hybrid cells. Cybrids, Protoplast culture and regeneration.	3hrs
	2.3. Single cell culture and production of secondary metabolites: Single cell culture, types of suspension culture ,growth kinetics, growth measurements, Bergman's plating technique for single cell culture, and applications. Introduction to secondary metabolite, bioreactors in plant cell culture, and applications in secondary metabolite production	5hrs
	2.4. Haploid culture: Anther and pollen culture, Direct and indirect androgenesis, factors affecting androgenesis, ontogeny of androgenic haploids, plant regeneration from pollen embryos. Gynogenesis and applications	3hrs
Unit III		**14hrs**
	3.1. Variant selection: Introduction, somaclonal variation, variants with few examples, selection of variants, origin and mechanism behind the generation of variants and application of variants.	4hrs
	3.2 Transformation technology: **Introduction, *Agrobacterium* mediated gene transfer. Selection, identification and recovery of transformed cells. Applications of gene transfer in plants (e.g: Golden Rice, edible vaccines).**	4hrs
	3.3.Production of virus free plants: Virus elimination methods – heat treatment, callus culture and meristem tip culture, factors affecting virus eradication by meristem tip culture.	3hrs
	3.4. Germplasm conservation: Introduction, methods and types of cryoprotectants and applications.	3hrs

REFERENCES

1	Bhojwani S.S. and Razdan M.K., 2004 Plant tissue culture, Panima Publishing Corporation, Delhi.
2	Chawla H.S., 2004 Plant Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd.
3	**Chawla,H.S.,2003, Plant biotechnology: a practical approach. Oxford and IBH.**
4	Giri C C and Giri A, 2007. Plant Biotechnology practical manual, I K International publishing house Pvt Ltd.
5	Khanna V.K., 2003: Plant tissue culture practicals, Kalyani, 2nd edition, U.P.
6	Kumar K, 2004. An introduction to plant tissue culture, New Central Book Agency (P) Ltd.
7	Peter K V, Keshavachandran R 2008.Plant Biotechnology: Methods in Tissue culture and gene transfer. Universities press, Hyderabad.

8	Ramawath K.G. , 2004.Plant Biotechnology,. Chand publication, Delhi.
9	Slater,A., Scott, N and Fowler ,M,2008. Plant Biotechnology The genetic manipulation of plants.SecondEdition ,Oxford university press,NY.

Semester V
G 511.5b– Animal Biotechnology

Total Hours:42

COURSE OUTCOMES:

After successful completion of the course the students will be able to:

- To understand principles of animal culture, media preparation
- To explain Invitro fertilization and embryo transfer technology.
- The course will describe as to how animal cell culture is carried out for research and diagnostic purposes.
- The techniques involved in cloning
- The course will describe gene therapy and its applications
- How transgenic animals are generated, what are the pros and cons along with ethical issues associated with transgenesis.

Unit 1		**14hrs**
	1.1 Introduction: History of the development of cell culture. Equipments and materials for animal cell culture.	2hrs
	1.2Culturemedia Different constituents of culture media and balanced salt solutions. Natural and artificial media, their applications. Importance of growth factors and their applications.	4hrs
	1.3Cell Differentiation and Cell culture: Cell differentiation- concepts and mechanism, Mammalian cell culture *in vitro*. Primary explant culture, and primary cell culture, disaggregation of tissue, cell countand cell viability(Trypan Blue method) cell separation techniques; maintenance of cell culture, Cryopreservation, banding techniques.	4hrs
	1.4 Growth kinetics Growth of cells in culture, measurement of cell proliferation- PDL, PDT, multiplication rate, MTT assay and ^{3}[H]: thymidine incorporation, Cell synchronization.	4hrs
Unit II		**14hrs**
	2.1 Cell lines and Secondary Culture: Cell lines: definition, cell strains, secondary cultures, characteristics, examples of commonly used cell lines and routine maintenance., Characterization of cell lines, Monolayer culture, suspension culture -Non-adherent substrates for small scale culture, mass culture of cells in fluid suspension, micro-encapsulation.	4hrs
	2.2 Organ culture and cell fusion Introduction, methods in organ culture (plasma clot, raft method, grid method, agar gel method, cyclic exposure to medium and gas phase), advantages and limitations. Introduction to cell fusion, methods used in cell fusion, properties and selection of hybrids and applications of hybrid cells.	4hrs
	2.3 Genetic engineering techniques: Methods used in transfer of foreign gene to host cell, production of monoclonal antibodies by hybridoma technology.	2hrs
	2.4 Gene expression in Transformants: Expression vector, immunostaining, reporter genes-GFP, antibiotic resistance markers (thymidine kinase, Dihydrofolatereductase, CAD	4hrs

	protein, Xanthine guanine phosphoribosyltransferase, Neomycin phosphoribosyltransferase), DNA microarray, fish antifreeze protein.	
Unit III		**14hrs**
	3.1:Cloning: Introduction, Dilution cloning and suspension cloning, methods of cloning, Applications and limitations of cloning. Reproductive cloning (nuclear transplantation- Cloning of Dolly) and therapeutic cloning(xenotransplantation)	4hrs
	3.2 Gene therapy and applications: Stem cell-Introduction, types. Stem cell cultures-methodology ,their applications and limitations. Somatic therapy and germline therapy with examples – SCID, CF. Tissue engineering and applications (e.g. artificial skin, ovarian).	4hrs
	3.3Biopharming: Concept, mammary glands of farm animals as bioreactors for production of regulatory proteins [α- anti trypsin (AAT), human tissue plasminogen activator], Silkworms as bioreactors for production of heterologous proteins. Transgenic animals and applications (e.g. transgenic cattle, sheep and fish). Tissue plasminogen activator, hormones-insulin, Growth hormones, and hepatitis B vaccine.	6hrs

REFERENCES

1	Butler M. 2nd edition 2004.Animal Cell Culture and Technologyby. BIOS Scientific Publishers.
2	Davis J. M , 2 edition 2002. Basic Cell Culture: A Practical Approach (Practical Approach Series)by Oxford University press, oxford.
3	FreshneyI.R. , Wiley-Liss 2000. Culture of Animal Cells: A Manual of Basic Technique 4th Edition
4	Jenkins N., 1999.Animal Cell Biotechnology: Methods And Protocols ed., Humana Press, US
5	Joseph Panno,2005.Animal Cloning-The Science of Nuclear Transfer(The New Biology),Facts on File.
6	Lousi-Marie Houdebine,2003,Animaltransgenesis and cloning. John Wiley and Son's
7	Masters J., 2000. Animal Cell Culture: A Practical Approach, 3rd ed. ed., Oxford University Press.
8	Portner R.,2007.Animal Cell Biotechnology: Methods and Protocols, 2nd ed., Humana press

	G 511.5Pa– Plant and Animal Biotechnology **(Based on theory G 511.5a and G511.5b)) (12 × 4 hr)**
1	Laboratory organization for plant and animal tissue culture, Physical aspects of sterilization and instrumentation
2	Contamination in plant and animal tissue culture
3	Culture media preparation for plant and animal tissue culture.
4	Seed germination on plain agar media ,Callus induction, rooting, hardening
5	Protoplast isolation and culture, Anther culture and Embryo culture .
6	Preparation of synthetic seeds.
7	Primary explant culture using liver cells / kidney / spleen cells
8	Disaggregation of liver tissue by Warm Trypsin and Cell counting for the trypsinized liver cells by Hemocytometer.
9	Estimation of cell viability for the trypsinized liver cells by dye exclusion method
10	Heamatopoietic culture from bone marrow
11	Practical test

Semester VI

G 511.6a -ENVIRONMENTAL BIOTECHNOLOGY

Total Hours:42

COURSE OUTCOMES:

After successful completion of the course the students will be able to:

- Learning outcome of Environment Biotechnology is to describe existing and emerging technologies that are important in the area of environment and the principles and techniques which underline the application of biosciences, address environmental issues including pollution,Environment Protection laws, biogeochemical cycle, mineral resource, renewable energy and water recycling.
- Course will have a specific focus on bioremediation and treatment of polluted effluent.
- The course will also provide conceptual knowledge on water analysis, solid and liquid waste management
- To explain the microbial degradation of pesticides, Bioremediation &Biofertilizers.
- Course will have a specific focus on biofuels and energy gardens.

Unit 1		**14hrs**
	1.1 Environmental pollution and laws Environmental protection. Environmental pollution (soil, water and air),Pollution control measures, Environmental protection laws- BIS (Bureau of Indian Standards), and permissible limits and indices for pollutants.	5hrs
	1.2Soil Microbiology: Interaction among microorganisms in Soil: Positive and Negative interactions: Neutralism, Commensalisms, Synergism (proto-cooperation), Mutualism (symbiotic), Competition, Amensalism, Parasitism and Predation.	5hrs
	1.3 Aerobiology: Microbial composition of air ,Sampling Techniques of trapping of indoor and air borne microbes in brief: agar plate, Gravity slide. Anderson, Burkard. Significance of air spora study-types of allergic disorders -air borne diseases in brief (Diphtheria, Tuberculosis, Pneumonia, Small pox, Measles, Mumps,Corona, SARS, MERS) and allergens (Hay fever, Rhinitis).	4hrs
Unit II		**14hrs**
	2.1 Aquatic microbiology: Aquatic microbiology –Microorganisms in fresh water, marine water, estuaries (mangroves). **Analysis of Water** –sampling, qualitative (Presumptive,Confirmed and completed coliform test) and quantitative -Membrane filter technique. Standards of water quality for drinking and industry; especially food and pharmaceutical. **Water borne Diseases:** Water borne pathogens and diseases- Bacterial (Cholera,Shigella)**, Viral and Protozoan types(Amoebiasis, Giardiasis).**	5hrs
	2.2 Solid and Liquid Waste management: Introduction: solid, semisolid and liquid wastes, BOD, COD. Waste treatment methods for solid and liquid wastes – primary treatment (Screening, sedimentation), Secondary Treatment (Trickling Filters, Activated sludge process, Oxidation	5hrs

	ponds, Rotating biological contactor, Fluidised bed reactor) Tertiary treatment, advanced treatment and solids processing - Composting (types and vermicompost), landfilling	
	2.3Bioremediation: Introduction,Types -Phytoremediation, microbial bioremediation . Methods of *In situ* and *ex situ* bioremediation. Biodegaradation of Hazardous wastes -e.g. textiles (dyes), paper(lignin), leather (chemicals), Petroleum products(hydrocarbons) Microbial degradation of xenobiotics -e.g. pesticides, detergents, Biosorption/Bioleaching: Enrichment of ores by microorganisms (copper, and Uranium).	4hrs
Unit III		**14hrs**
	3.1 Biofertilisers : Introduction to biofertilizers, Production of biofertilizers and utilization of organisms-for Biological Nitrogen fixation .Ex:*Rhizobia*, cyanobacteria, *Azotobacter, Azospirillum,* Phosphate solubilising organisms, mycorrhiza-ectomycorrhiza and endomycorrhiza, sea weeds for soil enrichment.	4hrs
	3.2 Biopesticides Introduction to biopesticides, properties, organisms- bacteria (*Bacillus thuringiensis, Bacillus papillae, Bacillus sphaericus),* Fungi (Trichoderma species) virus (*Baculovirus*), protozoans and plant products as biopesticides. Limitations of biopesticides.	4hrs
	3.3 Energy sources **Renewable and non-renewable resources (solar, wind and tidal energy), biomass energy (e.g. firewood, plant and animal wastes, animal oils coal and gas)** **Biofuels:** Methanogenic bacteria and biogas production, microbial hydrogen production, conversion of sugars to ethanol, gasohol Energy gardens (e.g. *Pongamia, Jatropha*).	6hrs

REFERENCES	
1	Alexander M. 2001. Biodegradation and Bioremediation, 2nd ed, Academic Press
2	Alexander,GandNikaido ,H.2006. Microbial Biotechnology:Funamentals of Applied Microbiology.WH Freeman and Company.
3	Arundel J., 1999.Sewage and industrial effluent treatment Blackwell science pub
4	Chatterji A.K., 2002.Introduction to Environmental Biotechnology. . Prentice-Hall of India Pvt. Ltd., New Delhi.
5	Ghosh T.K.,Chakraborthy,T.,Tripathi,G.2005.Biotechnology in environmental Management Vol1 and 2.A.P.H.Publication CORP,New Delhi.
6	Glazer A. N., Nikaida H., 1995. W. H. Freeman and Company. Microbial Biotechnology, Fundamentals of Applied Microbiology, New York.
7	Jogdand S.N,2004.Environmental Biotechnology.2nded.Himalaya Publishing House.
8	Karnely D., ChakrabarthyK.,Omen G.S. 1989. “Biotechnology and Biodegradation”,

	Advances in Applied Biotechnology Series, Vol. 4, Gulf Publications Co., London,.
9	Metcalf & Eddy, 1979.Waste water engineering 3rdedMc, Graw- Hill international Eds.
10	Ronald M. Atlas and Richard Bartha, 1998.Microbial Ecology, fundamentals and applications, 4th ed, , Benjamin/Cummings Publishing Co., Inc., California
11	Taylor,J.2001. Microorganisms and biotechnology Nelson Thomas Ltd.
12	Wang,L, Tay, J, Ivanov, V and Hung,Y.2010, Environmental Biotechnology:VOL 10,Humana press
13	Young M.M. 2004.Comprehensive Biotechnology, Vol 1, 2, 3 & 4,; Pergamon Press

Semester VI

G 511. 6 b–Bioprocess Technology

Total Hours:42

COURSE OUTCOMES:

After successful completion of the course the students will be able to:

- The role of a bioprocess engineer in chemical, pharmaceutical and distillation industry.
- The integrated bioprocess, design reactors, maintain contamination free environment in bioprocesses.
- To develop concepts to scale-up bioprocesses for industry as well as research organizations.
- Develop skills associated with screening of Industrially Important Strains.
- Understand principles underlying design of Fermentor and Fermentation Process.

Unit 1		**14hrs**
	1.1 Bioprocessing: Introduction to bioprocess technology, Concept of primary and secondary	3hrs

	metabolites, Growth kinetics, upstream and downstream processing. Advantages of bioprocess over chemical process with suitable examples.	
	1.2: Fermentation technology: Concepts of aerobic and anaerobic fermentations. Bioprocessor- Basic design and various parts of the fermentor and their functions, Types of fermentations Stationary, Submerged and Solid state fermentation. Batch, fed batch, semi continuous, continuous fermentations. Sterilization of fermentation equipment .Design of media, Inoculum preparations, seed culture and scaling up.	5hrs
	1.3. Down stream processing techniques: Cell lysis techniques: Physical and Chemical Techniques, Product separation and recovery of products Harvesting, clarification (microfiltration, rotary drum filtration, centrifugation, sedimentation), concentration - precipitation techniques and ultrafiltration, crystallization, packing.	6hrs
Unit II	**Industrial Biotechnology**:	**14hrs**
	2.1:Brief introduction to Primary and secondary screening for organisms producing important metabolites. Strain selection and improvement	2hrs
	2.2: Industrial production of antibiotics (penicillins), vitamins, amino acids (lysine), citric acid, alcohol, alpha-amylase	6hrs
	2.3.Protein Immobilization Techniques of immobilization, applications (few examples), Abzymes, Biosensors.	3hrs
	2.4.Applicationof enzymes: In Therapeutics and diagnostics, HRP, streptokinase, SGOT and SGPT In industry- food and brewing industry, starch industry, textiles, and dairy industries.	3hrs
Unit III	**Applied biotechnology**	**14hrs**
	3.1:- Microbial flora of food: Meat, Poultry, Eggs, Fruits and Vegetables. Microbes as food:,Mushroom culture and their nutritional value. Microbial spoilage of food, factors affecting spoilage, types of spoilage and prevention of spoilage of fresh food, fresh milk, canned food and stored grains. Food toxins: Botulism and Aflatoxins.	6hrs

	3.2:Microbiological Preservation of food: Microscopic examination and culture, phosphatase test of Pasteurized milk. Preservation of food- High temperature (pasteurization, boiling, appertization), low Temperature (freezing), dehydration, osmotic pressure, salting, chemical preservations, radiation.	4hrs
	3.3: Fermented foods- acidophilic milk, Curd, Cheese, Idli and Pickles.	2hrs
	3.4 Improvements in food quality: Probiotics and Prebiotics.	2hrs
REFERENCES		
1	Chaplin M F and Bucke; 1990.Enzyme technology, , Cambridge Univ. press	
2	Crueger and Crueger A., 2000. Biotechnology A textbook of industrial microbiology second edition, Punima Publishing Corporation, New Delhi.	
3	Morgan,N.L., Higton, G.,andRockey,J.S .2001.Industrial Microbiology: An Introduction.Blackwell Science.	
4	Prescott & Dunn's Industrial Microbiology, 1sted, 1959, Gerald Reed; CBS Publishers & Distributors, New Delhi	
5	Prescott & Dunn's Industrial Microbiology, 4thed, 1983, Gerald Reed; CBS Publishers & Distributors, New Delhi	
6	Stanbury P.F., Whittaker A., and Hall S. J., 1997.Principles of Fermentation Technology,.Aditya Books (P) Ltd, New Delhi.	

G511.6Pa-Environmental Biotechnologyand Bioprocess technology practical's (based on theory G 511.6a and G511.6b)) (12 × 4hrs)	
1	Isolation of micro-organism from soil,air and water and enumeration.
2	Estimation of dissolved oxygen/ carbon dioxide
3	Estimation of BOD in the given water sample.
4	Estimation of COD in the given water sample.
5	Estimation of total solids- dissolved and suspended solids
6	Estimation of phosphates and sulphates in the given water sample
7	Isolation and selection of *Rhizobium* from root nodules and phosphate solubilising organisms from soil
8	Qualitative analysis of water: presumptive, confirmed and completed coliform test
9	Screening of soil samples for enzyme producers (amylase) and for antibiotic producing microorganisms
10	Fermentor parts and methods of fermentation: Solid state and Shaker fermentation.

11	Wine production and estimation of alcohol and acidity in wine.
12	Citric acid production and estimation of citric acid.
13	Methylene blue dye reduction test (MBRT) and phosphatase test for assessing the quality of milk.
14	Practical test

ADDITIONAL PRACTICAL INSTEAD OF PROJECT (INDEPENDENT PRACTICAL SKILL DEVELOPMENT(IPSD))	
1	Kinetics of salivary amylase, urease and acid phosphatase
2	Isolation of enzymes from microorganisms (bacteria and fungus)
3	Production of enzymes from plants
4	Enzyme purification (ammonium sulphate precipitation, dialysis
5	SDS PAGE and Native PAGE
6	Estimation of sodium, Potassium & calcium using flame photometer
7	Isolation of air borne pathogens using air samplers
8	Phytochemical and secondary metabolite extraction

	Question Paper Pattern Theory (Core papers) **(Same scheme to be followed for all Semesters)** **For End Semester exam** **Time :3 Hours** **Max.Marks:100**	
	Part –A	
1.	Answer any **Ten** of the following (Ten to be answered out of Twelve)	**(2x10=20)**
	Part-B	
2	Answer any **Six** of the following Six to be answered out of Eight (I-IV semester) or Nine (V and VI Semester)	**(5x6=30)**
	Part-C	
3	Answer any **Five** of the following Five to be answered out of eight (I-IV semester) or Nine (V and VI Semester)	**(10x5=50)**
	Question paper will have three parts-A,B,C **Part A-Twelve questions from all the units with equal weightage** **Part B- Eight/Nine questions from all the units with equal weightage**	

	Part C- Eight/Nine questions from all the units with equal weightage

	Question Paper Pattern for Electives **(Same scheme to be followed for I-IV Semesters)** **For End Semester exam** **Time :2 Hours** **Max.Marks:50**	
	Part –A	
1.	Answer any **Ten** of the following (**Ten to be answered out of twelve from all the units with equal weightage)**	**(2x10=200)**
	Part-B	
2	Answer any **Six** of the following **(Six to be answered out of eight from all the units with equal weightage)**	**(5x6=30)**

The scheme is applicable for all the semesters - from semester I to semester VI **Scheme for practical examination for Semester I to semester IV**		
Practical exam (external)		**Time: 3hrs**
a	Major experiment	12 marks
b	Minor experiment	8 marks
c	Spotters A, B, C and D	(2X4) = 8 marks
d	Viva	2 marks
	Class record	10 marks
	Total –	**40 marks**
	Practical internal assessment	

a)	Internal Practical test	8 marks
b)	Continuous assessment	2 marks
	Total –	**10 marks**
	Total (external + internal) = 50 marks	

Scheme for practical examination for semester V

Practical exam (external)		**Time: 4hrs**
a	Major experiments -2 (1 from each paper)	12marks X 2 = 24 marks
b	Minor experiments-2 (1 from each paper)	8marks X 2 = 16 marks
c	Spotters A, B, C and D (2X8, 4 from each paper)	2marks X 8 = 16 marks
d	Viva	4 marks
e	Class record (10 for each paper)	20 marks
	Total –	**80 marks**
	Practical internal assessment	
a)	Internal Practical test(1 test including both the papers)	8 marks X 2 = 16 marks
b)	Continuous assessment	2 marks X 2 = 04 marks
	Total –	**20 marks**
	Total (external + internal) = 100 marks	

Scheme for practical examination for Semester VI

Practical exam (external)		**Time: 4hrs**
a	Major experiment	12 marks
b	Minor experiment	8 marks
c	Spotters A, B, C and D	(2X4) = 8 marks
d	Viva	2 marks
	Class record	10 marks
	Total –	**40 marks**
	Practical internal assessment	
a)	Internal Practical test (1 test including both the papers)	8 marks
b)	Continuous assessment	2 marks

	Total –	**10 marks**
	Total (external + internal) = 50 marks	

COMPONENTS	**Proposed Scheme**						
A	**Practical**	**4**	**4**	**10**	**40**	**50**	**1**
B	**Project**			**10**	**40**	**50**	**1**
OR							
C	**Independent Practical Skill Development (IPSD)**	**4**	**4**	**10**	**40**	**50**	**1**

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