
# St Aloysius College (Autonomous)

# Mangaluru

**Re-accredited by NAAC "A" Grade**

## Course structure and syllabus of

# B.Sc.

# BIOTECHNOLOGY

**CHOICE BASED CREDIT SYSTEM**

**(2020 – 21ONWARDS)**

ಸಂತ ಅಲೋಶಿಯಸ್ ಕಾಲೇಜು
(ಸ್ವಾಯತ್ತ)
ಮಂಗಳೂರು– 575 003

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**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

| 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 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.

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| **Unit 1** | | **12hrs** |
| | **1.1: Introduction:**<br>Definition, scope of microbiology.<br>History of Microbiology: Discovery era, transition period, golden age<br>Contributions of Antony van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, | 3hrs |
| | **1.2: Classification of Microorganisms:**<br>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**<br>**Sterilization Techniques:**<br>Principle and methods of sterilization.<br>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.<br>Chemical methods - Use of Alcohols, aldehydes, dyes, halogens, hypochlorites, phenols, Phenol coefficient, metallic salts, detergents, gaseous agents. | 3hrs |
| | **1.4: Culturing of Microorganisms:**<br>**Culture Media:** | 5hr |

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| | Characteristics of a culture medium, Types ,preparation and uses of media: Simple medium, complex media and selective media<br>**Isolation, Culturing and Preservation Techniques:**<br>Culture of Bacteria and Fungi: Sources, methods of Isolation and identification techniques –Serial Dilution, plating: Pour, streak-plate, spread-plate Technique, pure culture.<br>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 .<br>**Identification:** Study of colony characteristics.<br>**Staining of Microorganisms:**<br>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:**<br>**Prokaryotes:**GeneralFeatures with examples<br>**Morphology and ultra structure of Bacteria:**<br>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.,<br>Features of archaebacteria, cyanobacteria, mycoplasmas with examples | 3hrs |
| | **2.2: Nutrition and reproduction in bacteria:**<br>**Nutrition: Nutritional Classifications:**<br>Autotrophs -Photolithotrophs and Chemolithotrophs, and heterotrophs with examples.<br>Bacterial Growth Curve.Factors affecting bacterial growth.<br>Measurement of Cell growth: Viable count: Standard plate count, Total count: Turbidity method, haemocytometer method.<br>**Chemotherapeutic Agents:** Antibiotics, classification and their mechanism of action in brief.<br>**Reproduction** -Vegetative and asexual methods (Budding ,fission). | 5hrs |
| | **2.3** Economic importance of bacteria | 1hrs |

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| | **2.4: Study of Viruses and Eukaryotes:**<br>**Viruses**:General characteristics and classification of viruses -Plant, animal and bacterial types with examples.<br>Importance of viruses- (Mention of interferons, vectors, viral diseases in plant animal and humans) | 3hrs |

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| **Unit III** | **Part B– IMMUNOLOGY** | **12hrs** |
| | **3.1.Introduction:**<br>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:**<br>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 :**<br>Principle, Antigenrecognition by B-cells andT cells.<br>Types: Precipitation reactions, agglutination reactions, radioimmunoassay, ELISA, western blotting, immunofluorescence | 3hrs |
| | 3.4 . Hypersensitive reactions :<br>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 :**<br>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:**<br>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:**<br>Active and passive immunization, types of vaccines – whole organism vaccine, purified macromolecules, recombinant –vector, DNA vaccines and multivalent subunit vaccines. | 2hrs |

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| | **4.4. Immunodeficiency and immune system:**<br>Brief account on HIV, mechanism of infection, immune responses (AIDS as an example). | 2hrs |
| | **4.5. Cancer** and **Immune responses:**<br>Introduction to oncogene and cancer induction, tumor antigens, immune response, cancer immunotherapy. | 2hr |

| **G 511.3P –Microbiology and Immunology (based on G 511.3)**<br>**(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 | **Practicaltest** |
| **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. |

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| 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.

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

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| | **2.2 Transcription in prokaryotes and eukaryotes:**<br>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**:<br>Mechanism of Translation in prokaryotes and Mechanism of Translation and types of Post translational modification in eukaryotes. | 2hrs |
| | **2.4 Regulation of gene expression:**<br>Prokaryotic gene regulation-operons (e.g. lac)<br>Eukaryotic gene regulation at genome, transcriptional and post transcriptional levels. | 3hrs |
| **Unit III** | **Part – B rDNA TECHNOLOGY** | **12hrs** |
| | **3.1 Introduction:**<br><br>Aims, objective and scope of gene cloning and recombinant DNA technology. | 1hr |
| | **3.2 Isolation and purification of DNA:**<br><br>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:**<br>Introduction, Tools - restriction enzymes. DNA modifying enzymes (Nucleases, Ligases, Alkaline Phosphatases,Topoisomerases, Polymerases).<br>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).<br>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:**<br>Introduction, tools, techniques, Screening and selection of recombinants by selection media (X-gal and IPTG, Ampicilin and Tetracycline Resistance), probes, PCR and blotting techniques<br>( Southern, Western and Northern Blotting). | 3hrs |
| | **4.2 DNA libraries:**<br>Introduction to genomic and cDNA libraries-construction of cDNA libraries and its applications. | 2hrs |
| | **4.3 Applications of gene cloning:**<br>In agriculture – introduction, transgenic plants - Bt cotton.<br>In medicine - brief account on recombinant vaccines, Interferons.<br>Genetically engineered products – tPA, Insulin, Factor VIII, Human growth hormone. | 4hrs |

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| | **4.4Biosafety and IPR:**<br>Biosafety:Hazards and biosafety measures for recombinant DNA technology and GMOs.<br>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) | 2hrs |

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

**(Each Practical session is of 3 hours duration)**

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| 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**


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|---|---|
| 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. |

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**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

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

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| | **2.2. Somatic hybridization:**<br>Methods of protoplast fusion, selection of hybrid cells. Cybrids, Protoplast culture and regeneration. | 3hrs |
| | **2.3. Single cell culture and production of secondary metabolites:**<br>Single cell culture, types of suspension culture ,growth kinetics, growth measurements, Bergman's plating technique for single cell culture, and applications.<br>Introduction to secondary metabolite, bioreactors in plant cell culture, and applications in secondary metabolite production | 5hrs |
| | **2.4. Haploid culture:**<br>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:**<br>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:**<br>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:**<br>Virus elimination methods – heat treatment, callus culture and meristem tip culture, factors affecting virus eradication by meristem tip culture. | 3hrs |
| | **3.4. Germplasm conservation:**<br>Introduction, methods and types of cryoprotectants and applications. | 3hrs |

**REFERENCES**


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|---|---|
| 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. |

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| 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.

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| **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 |

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| | **2.3 Genetic engineering techniques:**<br>Methods used in transfer of foreign gene to host cell, production of monoclonal antibodies by hybridoma technology. | 2hrs |
| | **2.4 Gene expression in Transformants:**<br>Expression vector, immunostaining, reporter genes-GFP, antibiotic resistance markers (thymidine kinase, Dihydrofolatereductase, CAD protein, Xanthine guanine phosphoribosyltransferase, Neomycin phosphoribosyltransferase), DNA microarray, fish antifreeze protein. | 4hrs |
| **Unit III** | | **14hrs** |
| | **3.1:Cloning:**<br>Introduction, Dilution cloning and suspension cloning, methods of cloning, Applications and limitations of cloning.<br>Reproductive cloning (nuclear transplantation- Cloning of Dolly) and therapeutic cloning(xenotransplantation) | 4hrs |
| | **3.2 Gene therapy and applications:**<br>Stem cell-Introduction, types. Stem cell cultures-methodology ,their applications and limitations.<br>Somatic therapy and germline therapy with examples – SCID, CF. Tissue engineering and applications (e.g. artificial skin, ovarian). | 4hrs |
| | **3.3Biopharming:**<br>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**


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|---|---|
| 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<br>(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** |
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| | **1.1 Environmental pollution and laws**<br>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**:<br>Interaction among microorganisms in Soil: Positive and Negative interactions: Neutralism, Commensalisms, Synergism (proto-cooperation), Mutualism (symbiotic), Competition, Amensalism, Parasitism and Predation. | 5hrs |

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| | **1.3 Aerobiology**:<br>Microbial composition of air ,Sampling Techniques of trapping of indoor and air borne microbes in brief: agar plate, Gravity slide. Anderson, Burkard.<br>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:**<br>Aquatic microbiology –Microorganisms in fresh water, marine water, estuaries (mangroves).<br>**Analysis of Water** –sampling, qualitative (Presumptive,Confirmed and completed coliform test) and quantitative -Membrane filter technique.<br>Standards of water quality for drinking and industry; especially food and pharmaceutical.<br>**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:**<br>Introduction: solid, semisolid and liquid wastes, BOD, COD.<br>Waste treatment methods for solid and liquid wastes – primary treatment (Screening, sedimentation),<br>Secondary Treatment (Trickling Filters, Activated sludge process, Oxidation ponds, Rotating biological contactor, Fluidised bed reactor)<br>Tertiary treatment, advanced treatment and solids processing - Composting (types and vermicompost), landfilling | 5hrs |
| | **2.3Bioremediation:**<br>Introduction,Types -Phytoremediation, microbial bioremediation .<br>Methods of *In situ* and *ex situ* bioremediation.<br>Biodegaradation of Hazardous wastes -e.g. textiles (dyes), paper(lignin), leather (chemicals), Petroleum products( hydrocarbons)<br>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 :**<br>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**<br>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**<br>Renewable and non-renewable resources (solar, wind and tidal energy), biomass energy (e.g. firewood, plant and animal wastes, animal oils coal and gas ) | 6hrs |

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| | **Biofuels:** Methanogenic bacteria and biogas production, microbial hydrogen production, conversion of sugars to ethanol, gasohol<br>Energy gardens (e.g. *Pongamia, Jatropha*). | |

| **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,. |
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| 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.

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| **Unit 1** | | **14hrs** |
| | **1.1 Bioprocessing:**<br>Introduction to bioprocess technology, Concept of primary and secondary metabolites, Growth kinetics, upstream and downstream processing. Advantages of bioprocess over chemical process with suitable examples. | 3hrs |
| | **1.2: Fermentation technology:**<br>Concepts of aerobic and anaerobic fermentations. Bioprocessor- Basic design and various parts of the fermentor and their functions,<br>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:**<br>Cell lysis techniques: Physical and Chemical Techniques, Product separation and recovery of products<br>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 |

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| | 2.2: Industrial production of antibiotics (penicillins), vitamins, amino acids (lysine), citric acid, alcohol, alpha-amylase | 6hrs |
| | **2.3.Protein Immobilization**<br>Techniques of immobilization, applications (few examples), Abzymes, Biosensors. | 3hrs |
| | **2.4.Applicationof enzymes:**<br>In Therapeutics and diagnostics, HRP, streptokinase, SGOT and SGPT<br>In industry- food and brewing industry, starch industry, textiles, and dairy industries. | 3hrs |
| **Unit III** | **Applied biotechnology** | **14hrs** |
| | **3.1:- Microbial flora of food**:<br>Meat, Poultry, Eggs, Fruits and Vegetables.<br>Microbes as food:,Mushroom culture and their nutritional value.<br>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:**<br>Microscopic examination and culture, phosphatase test of Pasteurized milk.<br>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**


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|---|---|
| 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. |
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| 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<br><br>(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 |