St Aloysius College (Autonomous)
Mangaluru

Re-accredited by NAAC with 'A++' Grade – CGPA 3.67/4 (Cycle IV)
Recognised as Centre for Research Capacity Building under UGC-STRIDE Scheme
Recognised under the DBT-BUILDER Scheme, Govt. of India
College with 'STAR STATUS' conferred by DBT, Govt. of India
Recognised by UGC as 'College with Potential for Excellence'

Course structure and syllabus of

B.Sc. BIOTECHNOLOGY (HONOUR'S)NEP SCHEME-2021 0NWARDS

SEMESTER – I

G 511 DC1.1 CELL BIOLOGY AND GENETICS 56 hours

Course Outcomes:

After successful completion of this Course, students will be able to:

CO 1. Acquire a deep insight on the concepts of cell biology and genetics.

CO 2. Describe the ultrastructure of cells, structure and function of organelles, cytosol and cytoskeleton

CO 3. Illustrate the phases of cell cycle, cell division, reductional division in gametes, molecular mechanisms that regulate life and death of a cell including programmed cell death or apoptosis and differentiation in plants

CO 4. Comprehend the organization and structure of chromosomes, banding techniques and Mendelian laws of inheritance, deviations, and exceptions to these laws.

CO 5. Describe mutations and its types, genetic or hereditary disorders.

Unit 1. Cell as a basic unit of living systems and cellular organelles: (14 hours)

Concept, Development and Scope of Biotechnology. Historical perspectives. Discovery of cell, the cell theory, Ultra structure of a prokaryotic and eukaryotic cell (Both plant and animal cells), Surface Architecture: Structural organization and functions of plasma membrane and cell wall of eukaryotes. Cellular Organelles: Structure and functions of cell organelles – Endoplasmic reticulum, Golgi complex, Mitochondria, Chloroplast, Ribosomes, Lysosomes, Peroxisomes, Nucleus (Nuclear envelope with nuclear pore complex, Nucleolus, Nucleoplasm and Chromatin). Vacuole, Cytosol and Cytoskeleton structures (Microtubules, Microfilaments, and Intermediate filaments).

Unit II. Chromosomes and cell division (14 hours)

General Introduction, Discovery, Morphology, and structural organization – Centromere, Secondary constriction, Telomere, Chromonema, Euchromatin and Heterochromatin, Chemical composition (molecular organization of chromosome and nucleosome model), Classification of chromosomes based on centromere position and Karyotyping (methods). Giant Chromosomes: Salivary gland and Lamp brush chromosomes.

Cell Division: Cell cycle, phases of cell division, Mitosis and meiosis, regulation of cell cycle, cell cycle checkpoints, and enzymes involved in regulation, Significance of cell

cycle, achromatic apparatus, synaptonemal complex. Cell Senescence and programmed cell death. Cell cycle disruption and Cancer

Unit III. Laws of inheritance and gene interaction (14 hours)

Terminologies in genetics: alleles, gene, genome, Genotype, Phenotype, character, traits, homozygous and heterozygous.

Mendelian theory: Laws of inheritance- dominance, segregation, incomplete dominance, codominance with an example. Law of independent assortment, test cross, back cross. Deviations to Mendelian inheritance, complementary, supplementary and interaction of genes (13:3 ratio).

Maternal Inheritance: Plastid inheritance in Mirabilis, Petite characters in yeast and Kappa particles in paramecium, Sex-linked inheritance (Haemophilia, Colour blindness), Chromosome theory of inheritance. Gene interaction: Supplementary factors: comb pattern in fowls, Complementary genes- Flower colour in sweet peas, Multiple factors–Skin colour in human beings, Epistasis– Plumage colour in poultry, Multiple allelism: Blood groups in Human beings.

Unit IV Human genetics and Sex Determination in Plants and animals: (14 hours)

Linkage and crossing over: Introduction, Coupling and repulsion hypothesis, Linkage in maize and Drosophila, Mechanism of crossing over and its importance, chromosome mapping-linkage map in maize.

Mutations: Types of mutations, Spontaneous and induced, Mutagens: Physical and chemical, Mutations in plants, animals, and microbes for economic benefit of man (one example each).

Sex Determination in Plants and animals: Concept of allosomes and autosomes, XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types.

Human Genetics: A general account of structural and numerical aberrations, inherited disorders – Allosomal (Klinefelter syndrome and Turner's syndrome), Autosomal (Down's syndrome and Cri-Du-Chat Syndrome).

References

1. Alberts, B., Hopkin, K., Johnson, A., Morgan, D., Lewis J., Raff M., Roberts, K., & Walter, P., (2019). Essential Cell Biology, International student edition 5th ed.,WW Norton & Co.
2. Brooker, R.J., (2017). Genetic analysis and principle, 6th ed., Mc Graw Hill.

3. Cooper & Sinauer G.M., (2019). The Cell: A Molecular Approach, International 8th ed., Oxford University Press.
4. Hardin, J. & Bertoni, G P., (2018). Becker's World of The Cell, 9th ed., Pearson Education Ltd, USA.
5. Karp, G., Iwasa, J. & Marshall W., (2016). Cell and Molecular Biology: Concepts and Experiments, 8th ed., Wiley & sons. New York.
6. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. & Martin, K., (2016). Molecular Cell Biology, 8th ed., W.H. Freeman & Co., New York.
7. Gupta ML. and ML. Jangir. (2002) Cell Biology-Fundamentals and Applications. Argosies, Jodhpur, India.
8. Powar C.B(2019). Cell Biology 3rd edition. Himalaya Publishing House, Mumbai.Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.Gupta, P.K. (2019) Genetics, 5th Ed., Rastogi Publication, Meerut, India
9. Krebs, J.E., Goldstein, E.S. & Kilpartick, S.T., (2017). Lewin genes- XII, Jones and Bartlett Publishers.
10. Tamarin, R.., (2017). Principles of Genetics, 7th ed., Mc-Graw – Hill Publication.
11. J. Brooker (2017). Genetics: Analysis and Principles., 6th ed., McGraw-Hill Education

G 511 DC2.1P CELL BIOLOGY AND GENETICS PRACTICAL 56 hours

Course outcome:

After successful completion of this Course, students will be able to:

CO 1. Interpret the different stages of cell division and to calculate the mitotic index.

CO.2.Meaure the size of cells and to count the number of cells using haemocytometer.

CO 3. Demonstrate the handling of Drosophila melanogaster, the model organism for genetic studies.

CO 4. Describe the principles and procedures of genetic techniques in biological experiments.

CO 5. Perform the perform the karyotyping analysis and solve various genetics problems

List of Practical

1. Handling and maintenance of simple and compound microscope
2. Use of Micrometer and calibration, measurement of onion epidermal cells and yeast
3. Cell counting using haemocytometer.
4. Study of divisional stages in mitosis from onion root tips
5. Determination of mitotic index in onion root tips.
6. Effect of osmotic pressure on RBC.
7. Study of divisional stages in meiosis in grasshopper testes/onion or Rheo flower buds.
8. Isolation and staining of Mitochondria
9. Isolation and staining of Chloroplast
10. Mounting of polytene chromosomes
11. Buccal smear – Barr bodies
12. Karyotype analysis – Human – Normal and Abnormal – Down and Turner's syndromes
13. Mounting of the Sex Comb in Drosophila melanogaster
14. Study of mutants in Drosophila melanogaster
15. Separation of eye pigments of Drosophila melanogaster.
16. Genetic problems based on theory

References:

1. Vilas Parmar (2018). Practicals of Cell Biology & Genetics. LAP Lambert Academic Publishing
2. Debarati D. (2017). Essential Practical Handbook of Cell Biology & Genetics, Biometry & Microbiology: A Laboratory Manual. Academic Publishers.
3. Amit Gupta and Bipin Kumar Sati (2019). Practical laboratory manual- Cell Biology. Lambert Academic Publishing
4. Rina M. and Rama S. (2018). Laboratory Manual of Cell Biology. Prestige Publishers

Open Elective Courses SEMESTER – I

G 511 OE1.1 BIOTECHNOLOGY FOR HUMAN WELFARE 42 hours

Course Outcomes:

After successful completion of this Course, students will be able to: CO 1. Apply the biotechnological concepts in the industry

CO 2. Implement the biotechnological techniques in environmental management

CO 3. Describe application of biotechnology to forensic science

CO 4. Comprehend contributions of biotechnology to biomedical fields, such as diagnostics, genomics and therapeutics

Unit I (14 hours)

Environment: Application of biotechnology in environmental aspects: Degradation organic pollutants – chlorinated and non-chlorinated compounds; degradation of hydrocarbons and agricultural wastes, PHB –production and its futuristic applications.

Unit II (14 hours)

Industry: Application of biotechnology in industry: Industrial production of alcoholic beverages (wine), antibiotics (Penicillin), enzymes (lipase). Applications in food, detergent and pharmaceutical industry.

Unit III (14 hours)

Forensic science: Application of biotechnology in forensic science: Solving crimes of murder and rape; solving claims of paternity and theft by using DNA finger printing techniques

Health: Application of biotechnology in health: Genetically engineered insulin, recombinant vaccines, gene therapy, molecular diagnostics using ELISA and PCR. Monoclonal antibodies and their use in cancer. Human genome project.

References:

1. Bhasin M.K. and Nath, S. (2002). Role of Forensic Science in the New Millennium, University of Delhi, Delhi
2. Crueger W. and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd Ed., Panima Publishing Co. New Delhi.
3. Eckert W.G. (1997) Introduction to Forensic Sciences, 2nd Ed., CRC Press, Boca Raton
4. James S.H. and Nordby, J.J. (2005). Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton

5. Joerdening H.-J. and Winter J. (2005). Environmental Biotechnology – Concepts and Applications,
6. Mohapatra, P.K. (2006) Textbook of Environmental Biotechnology, I.K. International Publishing House Pvt. Ltd., New Delhi
7. Nanda B.B. and Tiwari R.K. (2001). Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi
8. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
9. Stanbury P.F, Whitaker A and Hall S.J. (2006). Principles of Fermentation Technology. 2nd Ed., Elsevier Science Ltd.

Skill Enhancement Course SEMESTER – I

BIOTECHNOLOGICAL SKILLS AND ANALYTICAL TECHNIQUES **14 hours**

Course Outcomes:

After successful completion of this Course, students will demonstrate the:

CO 1. Skill enhancement as per National Occupational Standards (NOS) of "Lab Technician/ Assistant" Qualification Pack issued by Life Sciences Sector Skill Development Council – LFS/Q0509, Level 3.

CO 2. Knowledge about major activities of biotech industry, regulations, and compliance, environment, health, and safety (EHS), good laboratory practices (GLP), standard operating procedures (SOP) and GMP as per the industry standards.

CO 3. Soft skills, such as decision making, planning, organizing, problem solving, analytical thinking, critical thinking, and documentation.

1. Insights into biotechnology industry: Biotechnology Industry in Indian and Global context – organization in context of large /medium/ small enterprises, their structure, and benefits.
2. Industry professional skills to be acquired: Planning and organizing skills, decision- making, problem-solving skills, analytical thinking, critical thinking, team management, risk assessment.
3. Interpersonal skills: Writing skills, reading skills, oral communication, conflict-resolution techniques, interpretation of research data, trouble shooting in workplace

4. Digital skills: Basic Computer Skills (MS Office, Excel, Power point, Internet) for Workplace. Professional Email drafting skills and PowerPoint presentation skills

Analytical Skills in laboratory:

Solutions: Molarity, Molality, Normality, Mass percent % (w/w), Percent by volume (% v/v), parts per million (ppm), parts per billion (ppb), Dilution of concentrated solutions. Standard solutions, stock solution, solution of acids. Reagent bottle label reading and precautions

1. Methods and practices of cleaning and management of lab: Learning and Practice of Integrated clean-in-place (CIP) and sterilize-in-place (SIP) as per industry standards, material requirements for cleaning specific area, equipment, ventilation area, personal protective requirements
2. Procedure of cleaning and storage of Labware:
   Methodology for storage area, cleaning procedure and materials to be used for various surfaces. Sign boards, labelling do's & don'ts. Knowledge about standard procedures of cleaning or glass ware, plastic ware. Maintenance of inventory
3. Principles and practices of lab safety:
   Knowledge about safety symbols and hazard signs. Personal safety gears, utility, and disposal. Equipment safety protocols, chemical safety protocols. Documentation of chemical and equipment usage records. Handling hazardous chemicals. MSDS.
4. Best practices of usage and storage of chemicals:
   Knowledge and practice in handling of chemicals, labelling and stock maintenance. SOP and material handling. Procedures to maintain chemicals, labelling, storage, and disposal.
5. Record maintenance as per SOP's
   Labelling of samples and reagents as per SOP's. Recording detail of work done for research experiments. Importance of study of manuals, health, and safety instructions.
6. Usage and maintenance of basic equipment of biotechnology lab: Principles, calibrations, and SOPs of weighing balances, pH meters, autoclaves, laminar flows and biosafety cabinets, basic microscopes, homogenizers, stirrers, colorimeters, UV, and Visible spectrophotometers.
7. Preparation of solutions and standards: Properties and uses of chemicals commonly used in life sciences laboratories. Maintaining safety standards for handling various solutions and chemicals. Preparation of test reagents and buffers, Protocols for proper

mixing of chemicals. Safety precautions while preparation and storage of incompatible chemicals and reagents.

8. Preparation of media: Maintenance and storage of purified water for media (Plant Tissue culture media, Microbiological media, and Animal cell culture media) preparation. Preparation and storage of concentrated stock solutions. Documentation and disposal of expired stocks. Collection of indents of media requirement, preparation, and storage. Media coding, documentation, and purpose of usage.
9. Practical methods for decontamination and disposal: Decontamination methods, Safe disposal practices of decontaminated media or materials.
10. Laboratory record writing: Method of record writing, data collection and recording, reporting of result, discussion of result, summary writing, effective powerpoint presentation taking any experiment as example
11. Industry visits or Analytical laboratory visits

SEMESTER – II

G 511DC1.2 MICROBIOLOGICAL METHODS AND TECHNIQUES 56 hours

Course Outcomes:

After successful completion of this Course, students will be able to: CO 1. Employ the principles of microscopy to study microorganisms CO 2. Apply the analytical techniques in microbiology.

CO 3. Comprehend the importance and methods of sterilization in microbiological work

CO 4. Delineate the formulation of media, culture methods and staining techniques for isolation, characterization of microbes

CO 5. Apply the knowledge of antimicrobial agents in anti- microbial assays.

Unit I (14 hours)

Introduction to microbes and methods to study: Classification of major groups of microorganisms- Bacteria, Fungi, Algae and viruses. binomial nomenclature of microbes, Phylogenetic classification;16S rDNA sequencing.

Microscopy: Principles of Microscopy- Magnification, resolving power, numerical aperture, working principle and applications and limitations of Compound microscope, Dark field microscope, Phase contrast microscope, Fluorescence Microscope, confocal microscope, Electron Microscopes- TEM and SEM.

Analytical techniques: Working principles and applications: Centrifuge, Ultracentrifuge, UV-Vis Spectrophotometer, Chromatography- Paper and TLC.

Unit II **(14 hours)**

Sterilization techniques: Definition of terms-sterilization, disinfectant, antiseptic, sanitizer, germicide, microbicidal agents, microbiostatic agent and antimicrobial agent.

Physical methods of sterilization: Principle, construction, and applications of moist heat sterilization by using autoclave, Pasteurization and Fractional sterilization-Tyndallization. Dry heat sterilization- hot air oven. Incineration. Filter sterilization-membrane filter and HEPA. Radiation- Ionizing radiation-γ rays and non-ionizing radiation- UV rays. Chemical methods: Alcohol, aldehydes, phenols, halogen, metallic salts, Quaternary ammonium compounds and sterilizing gases as antimicrobial agents.

Unit III **(14 hours)**

Culture Media: Nutritional types of bacteria, Components of media, Culture media types (natural and synthetic media, chemically defined media, Complex, synthetic, differential, enrichment and selective media).

Pure culture methods: Serial dilution and plating methods (pour, spread, streak); cultivation, maintenance of aerobic and anaerobic bacteria. Preservation/stocking of pure cultures: Agar Slant Cultures, Agar Slant Culture Covered with Oil (Paraffin Method), Very Low Temperature(glycerol), Freeze Drying (lyophilization). Culture Collection Centers.

Stains and staining techniques: Principles of staining, Types of stains-simple stains, structural stains and differential stains.

Unit IV **(14 hours)**

Antibacterial agents: Antibiotics and mode of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism.

Antibiotic resistance: MDR, XDR, MRSA, NDM-1.

Antibiotic sensitivity testing methods: Kirby-Bauer method, Agar well diffusion techniques, and E-test, MIC.

Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin.

Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine.

References:

1. Black, J. G., & Black, L. J. (2017). Microbiology: Principles and Explorations, 10th ed., United States of America: John Wiley & sons, Inc.
2. Cann, A. J. (2016). Principles of Molecular Virology, 6th ed., London: Academic Press.
3. Dimmock, N. J., Easton, A. J., & Leppard, K. N. (2016). Introduction to Modern Virology, 7th ed., United Kingdom: Wiley-Blackwell.
4. Flint, J., Racaniello, V. R., Rall, G. F., & Skalka, A. M. (2015). Principles of Virology, 4th ed., Washington DC: ASM Press.
5. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2019). Brock Biology of Microorganisms, 15th ed., Harlow, United Kingdom: Pearson.
6. Pommerville, J. C. (2011). Alcamo's Fundamentals of Microbiology, 9th ed., Sudbury, Massachusetts: Jones and Bartlett Publishers.
7. Talaro, K. P. (2009). Foundations in Microbiology: Basic Principles, 7th ed., New York: McGraw-Hill.
8. Tortora, G. J., Funke, B. R., & Case, C. L. (2015). Microbiology: An Introduction, 12th ed., United States of America: Pearson Education Inc.
9. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2016). Prescott, Harley, and Klein's microbiology, 10th ed., Americas, New York: McGraw-Hill.
10. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology, 5th Ed., Tata McGraw Hill.
11. Atlas RM. (1997). Principles of Microbiology. 2nd edition. Wm C Brown Publishers.
12. Dubey R. C. and Maheshwari D. K. (2010). A Textbook of Microbiology. S Chand & Company
13. Ananthanarayan R, Jayaram Paniker CK and Reba Kanungo (2020). Textbook of Microbiology.11th Ed. Universities Press (India) Pvt. Ltd.

G 511 DC 2.2P Microbiological methods and techniques Practical

Course Outcomes:

After successful completion of this Course, students will be able to:

CO 1. Handle and use instruments used in Microbiology and Biotechnology laboratories

CO 2. Use analytical techniques for work using microorganisms

CO 3. Experiment with various methods of sterilization in microbiological work

CO 4. Prepare different types of media, perform culture methods and staining techniques for isolation, characterization of microbes

CO 5. Handle and use antimicrobial agents and perform anti-microbial assays

List of Practical:

1. Study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, hot air oven, compound microscope, pH meter) used in the microbiology laboratory.
2. Preparation of culture media for bacteria, fungi and their cultivation.
3. Isolation of bacteria and fungi from soil, water and air
4. Enumeration techniques – direct microscopic, serial dilution and standard plate count technique (Spread plate, pour plate) and study of colony characters of isolated microbes
5. Purification of bacterial and fungal cultures using streak plate technique/mycelial bit transfer
6. Culture preservation techniques – slant and stab culture
7. Study of colony characteristics bacteria from air exposure plate
8. Staining techniques: Bacteria– Gram, Negative, Capsule, Endospore staining. Fungi – Lactophenol / cotton blue staining
9. Study of Rhizopus, Penicillium, Aspergillus using temporary mounts
10. Water analysis – MPN test
11. Biochemical Tests – IMViC, Starch hydrolysis, Catalase test, oxidase and Gelatin hydrolysis
12. Bacterial motility – hanging drop technique
13. Antibiotic sensitivity test by disc diffusion method.

References:

1. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual, 9th Ed., Pearson Education Limited.
2. Saha, Rumpa Das and Shukla (2021). Microbiology Practical Manual, 2nd Ed. CBS.

3. Mukesh Kumar (2018). Practical Manual for Undergraduates Microbiology, Jain Brothers.
4. Maheshwari D.K. and Dubey R.C. (2010). Practical Microbiology, S Chand & Company

SEMESTER – II Open Elective Courses

G 511 OE1.2 APPLICATIONS OF BIOTECHNOLOGY IN AGRICULTURE 42 hours

Course Outcomes:

After successful completion of this Course, students will be able to: CO 1. Employ the biotechnological approaches in agriculture

CO 2. Apply biotechnological methods in plant tissue culture

CO 3. Comprehend the pros and cons of GM crops and their plant products

Unit I (14 hours)

Agricultural Biotechnology: Concepts and scope of biotechnology in Agriculture. Plant tissue culture, micro propagation, entrepreneurship in commercial plant tissue culture. Banana tissue culture – primary and secondary commercial setups, small scale bioenterprises: Mushroom cultivation

Unit II (14 hours)

Transgenic plants: The GM crop debate – safety, ethics, perception and acceptance of GM crops GM crops case study: Bt cotton, Bt brinjal. Plants as biofactories for molecular pharming; edible vaccines, plantibodies, nutraceuticals.

Unit III (14 hours)

BT based pesticides: Baculovirus pesticides (NPV), Mycopesticides (Metarrhizium), Post-harvest Protection: Antisense RNA technology for extending shelf life of fruits and shelf life of flowers. Genetic engineering for quality improvement: Golden rice, Seed storage proteins (LEA), Flavours– capsaicin, vanillin

References:

1. Chrispeels M.J. and Sadava D.E. (1994) Plants, Genes and Crop Biotechnology, 2nd Ed., Jones and Bartlett Publishers, Boston.
2. Gamborg O.L. and Philips G.C. (1998) Plant cell, tissue and organ culture, 2nd Ed., Narosa Publishing House. New Delhi.
3. Gistou, P. and Klu, H. (2004). Handbook of Plant Biotechnology (Vol. I & II). John Publication.

4. Hammond J., McGarvy P. and Yusibov.V. (2000). Plant Biotechnology, Springer Publ.
5. Heldt. H.-W. (1997). Plant Biochemistry and Molecular Biology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
6. Kyte, L., Kleyn, J., Scoggins, H., and Bridgen M. (2003) Plants from test tubes. An introduction to micropropagation, 4th Ed., Timber Press, Portland.
7. Murray D.R. (1996) Advanced methods in plant breeding and biotechnology. Panima Publishing Corporation.
8. Nickoloff, J.A. (1995). Methods in molecular biology, Plant cell electroporation and electrofusion protocols-Humana Press Incorp, USA.
9. Sawahel, W.A. (1997). Plant genetic transformation technology. Daya Publishing House, Delhi.