ANDHRA UNIVERSITY:: VISAKHAPATNAM

B.Sc., Biotechnology Course Structure for the Academic year 2020-21

Semester		Title of the paper
I		Bio-molecules & Analytical Techniques
II		Microbiology, Cell & Molecular Biology
III		Immunology & r-DNA technology
IV	i	Plant &Animal Biotechnology
	ii	Environmental & Industrial Biotechnology

B.Sc., Biotechnology: Choice based credit system

B.Sc., I Semester W.E.F. 2020-21

BT-101: Bio-molecules & Analytical Techniques

Course Objectives: To ensure students gain knowledge about the structure, properties and functions of biomolecules and characterization of biomolecules using analytical techniques.

Unit-I-Carbohydrates, Protein and Lipids

Classification, structure, properties of carbohydrates. Classification, structure and properties of amino acids, peptide bond and peptides. Classification, structure (primary, secondary, tertiary, quaternary) and functions of proteins. Denaturation and renaturation of proteins. Classification structure and properties of saturated and unsaturated fatty acids. Structure and functions of glycolipids, phospholipids, and cholesterol.

Unit-II- Nucleic acid, Vitamins and Bioenergetics

Structure and functions of DNA and RNA. Source, structure, biological role and deficiency manifestation of vitamin A, B, C, D, E and K. Free energy, entropy, enthalpy and redox potential. High energy compounds, Glycolysis, TCA cycle, Electron-Transport System and Oxidative Phosphorylation.

Unit-III-Centrifugation, Chromatography and Electrophoresis

Basic principles of sedimentation and types of centrifugations. Principle, instrumentation and application of partition, absorption, paper, TLC, ion exchange, gel permeation, affinity chromatography. Introduction to HPLC, GCMS and LCMS. Basic principles and types of electrophoresis, factors affecting electrophoretic migration. PAGE (Native, SDS-PAGE). Introduction to 2D & Isoelectric Focusing.

Unit - IV-Spectroscopy, Microscopy and Laser Techniques

Beer-Lambert law, light absorption and transmission. Extinction coefficient, Design and application of photoelectric calorimeter and UV-visible spectrophotometer. Introduction to crystallography and application. Types and design of microscopes - compound, phase contrast, fluorescent electron microscopy (TEM, SEM). Introduction to radioisotopes, measurement of radioactivity (scintillation counter and autoradiography).

Unit –V- Biostatistics

Mean, median, mode, standard deviation, One-way Anova, Two-way Anova, t-test, F-test and chi-square.

List of Practicals:-

1. Introduction to basic instruments (Principle standard operation procedure) demonstration and record
2. Calculation of molarity, normality and molecular weight of compounds.
3. Qualitative analysis of carbohydrates (sugars)
4. Quantitative analysis of carbohydrates
5. Quantitative estimation of protein - Lowery method
6. Estimation of DNA by diphenylamine reagent
7. Estimation of RNA by orcinol reagent
8. Assay of protease activity
9. Preparation of starch from potato and its hydrolyze by salivary amylase
10. Preparation of standard buffer and pH determination
11. Separation of amino acids by paper chromatography
12. Separation of lipids of TLC
13. Agarose gel electrophoresis
14. Calculation of mean, median and mode

Textbooks for Biomolecules and Analytical Techniques

1. Outlines of Biochemistry, 5th Edition, (2009), Erice Conn & Paul Stumpf; John Wiley and Sons, USA
2. Principles of Biochemistry, 4th edition, (1997), Jeffory Zubey; McGraw-Hill College, USA
3. Principles of Biochemistry, 5th Edition (2008), Lehninger, David Nelson & Michael Cox; W.H. Freeman and Company, NY
4. Fundamentals of Biochemistry, 3rd Edition (2008), Donald Voet & Judith Voet; John Wiley and Sons, Inc. USA
5. Biochemistry, 7th Edition, (2012), Jeremy Berg & Lubert Stryer; W.H.Freeman and Company, NY
6. An Introduction to Practical Biochemistry, 3rd Edition, (2001), David Plummer; Tata McGraw Hill Edu. Pvt.Ltd. New Delhi, India
7. Biochemical Methods,1st Edition, (1995), S.Sadashivam, A.Manickam; New Age International Publishers, India
8. Textbook of Biochemistry with Clinical Correlations, 7th Edition, (2010), Thomas M. Devlin; John Wiley and Sons, USA
9. Proteins: biotechnology and biochemistry, 1st edition, (2001), Gary Walsch; Wiley, USA
10. Biochemical Calculations, 2nd Ed., (1997), Segel Irvin H; John Wiley and Sons, NY
11. Biophysical Chemistry Principles & Techniques Handbook, (2003), A. Upadhyay, K. Upadhyay, and N. Nath

12. Enzymes: Biochemistry, Biotechnology & Clinical chemistry, (2001), Palmer Trevor, Publisher: Horwood Pub. Co., England.
13. Analytical Biochemistry, 3rdedition, (1998), David Holmes, H.Peck, Prentice-Hall, UK
14. Introductory Biostatistics, 1st edition, (2003), Chap T. Le; John Wiley, USA.
15. Methods in Biostatistics, (2002), B. K. Mahajan –Jaypee Brothers.
16. Statistical methods in biology, (1995), Bailey, N. T.; Cambridge university press

B.Sc., Biotechnology: Choice based credit system

B.Sc., -II Semester W.E.F. 2020-21

BT-201: Microbiology, Cell and Molecular Biology

Course Objectives: To acquaint students with concepts of microbiology, cell and molecular biology. This course is aimed to give an understanding of the basics of microbiology, dealing types of microbes, classification and their characterization, structure and function of prokaryotic and eukaryotic cell organelles, cell division and basics of molecular biology including DNA replication, transcription, translation and regulation of gene expression.

Unit-I- Scope and Techniques of Microbiology

History and contribution of Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister and Alexander Fleming. Ultrastructure of bacteria and growth curve. Pure culture techniques. Sterilization techniques, principles and application of physical methods (autoclave, hot air oven, incineration), chemical methods and radiation methods. Simple, gram and acid-fast staining.

Unit-II-Microbial Taxonomy and Metabolism

Concepts of microbial species and strains. Classification of bacteria based on morphology, nutrition and environment. General characteristics, transmission and cultivation of viruses. Structure and properties of plant (tobacco mosaic virus, TMV), animal (Newcastle disease virus, NDV), human (Human immunodeficiency virus, HIV) and bacterial viruses (T4 phage). Emerging and reemerging viruses (dengue virus), zoonotic viruses (rabies, SARS-CoV-2). Microbial production of penicillin. Bacterial toxins, tuberculosis, typhoid. Introduction to fungi, algae and mycoplasm.

Unit-III- Cell Structure and Functions

Structure, properties and functions of cellular organelles (E.R, Golgibodies, Mitochondria, Ribosomes and Vacuoles) of eukaryotic cells. Cell cycle and cell division (mitosis and meiosis). Chemical composition and dynamic nature of the membrane, cell signaling and communication, endocytic pathways.

Unit-IV- DNA Replication, Repair and Regulation of Gene Expression

DNA replication in prokaryotes and eukaryotes (semiconservative, dispersive, conservative, uni and bi-direction, rolling circle). Mechanism of DNA replication, enzymes and protein involved in DNA replication. DNA damage and repair. Regulation of gene expression in prokaryotes Lac and Trip operon concept.

Unit – V - Central Dogma of Molecular Biology

Genome organization of prokaryotic and eukaryotic organisms. Genetic code, prokaryotic and eukaryotic transcription, enzymes involved in transcription. Post-transcriptional modification (Capping Poly adenylation) and splicing.

Translation: mechanism of translation in prokaryotic and eukaryotic cells (initiation, elongation, termination). Post-translational modification (glycosylation and phosphorylation).

List of Practicals:-

1. Cleaning and preparation of glassware
2. Preparation of nutrient agar medium for bacteria
3. Preparation of PDA medium for fungi
4. Sterilization techniques (autoclave, hot air oven, filter)
5. Isolation of bacteria from soil
6. Simple staining technique
7. Differential staining technique
8. Microbial counting by Haemocytometer
9. Identification of different bacteria
10. Motility test by hanging drop
11. Biochemical identification of bacteria
12. Preparation of pure culture by slab, slant, streak culture
13. Study of stages of mitotic cell division
14. Study of stages of meiotic cell division
15. Isolation of chloroplast
16. Extraction and isolation of DNA from bacteria.

Textbooks forMicrobiology, Cell and Molecular Biology

1. Microbiology–6th Edition, (2006), Pelczar M.J., Chan E.C.S., Krieg N.R.; The McGrawHill Companies Inc. NY
2. Prescott's Microbiology, 8th edition, (2010), Joanne M Willey, Joanne Willey, Linda Sherwood, Linda M Sherwood, Christopher J Woolverton, Chris Woolverton; McGrawHill Science Engineering, USA
3. Textbook of Microbiology, Anantnarayan and Paniker (2017)
4. Brock biology of microorganisms, 2003, Brock, T. D., Madigan, M. T., Martinko, J. M., & Parker, J.; Upper Saddle River (NJ): Prentice-Hall, 2003.

5. Genes XI, 11th edition, (2012), Benjamin Lewin; Publisher - Jones and Barlett Inc. USA
6. Molecular Biology of the Gene, 6th Edition, (2008), James D. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R.; Cold Spring Harbour Lab. Press, Pearson Pub.
7. Molecular Biology, 5th Edition, (2011), Weaver R.; McGraw Hill Science. USA
8. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi; Oxford University Press.
9. Molecular Biology: Genes to Proteins, 4th edition (2011), Burton E Tropp Jones& Bartlett Learning, USA.
10. Cell and Molecular Biology: Concepts and Experiments, 6th Edition, Karp, G. 2010.; John Wiley & Sons. Inc.
11. Cell and Molecular Biology, 8th edition. De Robertis, E.D.P. and De Robertis, E.M.F. 2006; Lippincott Williams and Wilkins, Philadelphia.
12. Cell Biology, (2017), De Robertis & De Roberis, Blaze Publishers & Distributors Pvt. Ltd.
13. The Cell: A Molecular Approach. 5th edition. Cooper, G.M. and Hausman, R.E. 2009. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
14. The World of the Cell, 7thedition, Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 Pearson Benjamin Cummings Publishing, San Francisco.
15. David A. Thompson. 2011. Cell and Molecular Biology Lab. Manual.
16. P.Gunasekaran. 2007. Laboratory Manual in Microbiology. New Age International.
17. D O Hall, S E Hawkins. 1974. Laboratory Manual of Cell Biology. British Society for Cell Biology, Published by Crane, Russia.
18. Mary L. Ledbetter. 1993. Cell Biology: Laboratory Manual. Edition: 2. Published by Ron Jon Publishing. Incorporated.
19. Gunasekaran, P. 2009. Laboratory Manual in Microbiology. 1st Edition. New Age International Publishers.
20. Dr. T. Sundararaj. Microbiology Laboratory Manual. 2005. Dr.A.L. MPGIBMS, University of Madras, Taramani, Chennai – 600 113.
21. James G. Cappuccino and Natalie Sherman. 2013. Microbiology: A Laboratory Manual. 10th Edition. Benjamin Cummings.
22. Dr. David A Thompson. 2011. Cell and Molecular Biology Lab Manual.
23. George M. Malacinski. 2013. Freifeder's Essentials of Molecular Biology. Narosa Publishing House.

B.Sc., Biotechnology: Choice based credit system

B.Sc., -III- Semester W.E.F. 2020-21

BT-301: Immunology and rDNA technology

Course Objectives: To acquaint students with concepts of immunology and recombinant DNA technology. This course is aimed to give an understanding of the basics of immunology dealing cells and organs of the immune system, types of immune responses, antigen-antibody interactions, vaccines and tools, techniques and strategies and applications of genetic engineering.

Unit- I –Concepts, Cells and Organs of the Immune System

Terminology, antigen, hapten, antibody (types), antigenicity, immunogenicity and types of immunity. Innate and adaptive immunity. Hematopoiesis, organs, tissues, cells and mediators of the immune system (primary and secondary lymphoid organs, lymphocytes and cytokines). Introduction to complement components, MHC. Basic concepts of humoraland cell-mediated immune response.

Unit-II-Vaccinology and Clinical Immunology

Live, killed, attenuated, subunit and recombinant vaccines. Role and properties of adjuvants. Hybridoma technology, monoclonal antibodies and their application in immunodiagnosis. Antigen and antibody interactions - precipitation, agglutination, immune diffusion and ELISA. Introduction to hypersensitivity and autoimmunity.

Unit-III –Introduction, Tools and Techniques of rDNA Technology

Introduction to rDNA technology, steps involved in cloning, tools of genetic engineering (Genes, Cloning vectors - plasmids and cosmids, Enzymes – restriction endonucleases and DNA Ligase, Hosts – bacteria and yeast). Principles and application of PCR. Southern, Northern and Western Blotting. Introduction to DNA sequencing (Sanger Sequencing) and Site-directed Mutagenesis.

Unit-IV-Cloning Strategies and Application of rDNA Technology

cDNA library, construction, methods of transformation, recombinant selection and screening methods. Applications of rDNA technology in agriculture (transgenic plants, edible vaccines and antibodies) and medicine (disease diagnosis and DNA fingerprinting).

Unit-V-Bioinformatics

Databases (PubMed, NCBI, EMBL and ExPASy), nucleotide and protein BLAST analysis, CLustal W and phylogenetic tree construction. Introduction to omics (proteomics, genomics and transcriptomics). Introduction to nanotechnology.

List of Practicals:-

1. Determination of Blood Groups
2. Pregnancy test
3. Widal test
4. Ocuteroloney immunodiffusion
5. Radial immune diffusion
6. ELISA
7. Production of antibodies (theory exercise)
8. Bleeding, separation of serum and storage
9. Lymphoid organs (theory exercise)
10. Isolation of plasmid DNA (alkaline lysis method)
11. Analysis of plasmid DNA by Agarose gel electrophoresis
12. Southern blotting (theory exercise)
13. PCR Amplification (theory exercise)

Textbooks forImmunology and rDNA technology

1. Kuby immunology, Judy Owen, Jenni Punt, Sharon Stranford., 7th edition (2012), Freeman and Co., NY
2. Textbook of basic and clinical immunology, 1st edition (2013), Sudha Gangal and Shubhangi Sontakke, University Press, India
3. Immunology, 7th edition (2006), David Male, Jonathan Brostoff, David Roth, Ivan Roitt, Mosby, USA.
4. Immuno diagnostics, 1996, By S.C. Rastogi, Publ: New Age
5. Introduction to Immunology- 2002, C. V. Rao- Narosa Publishing House
6. Textbook of Biotechnology - 2007, By H.K. Das (Wiley Publications)
7. Principles of Gene Manipulation - 7th edition, 2006, By R.W. Old & S.B. Primrose, Publ: Blackwell
8. Molecular Biology & Biotechnology- 1996, By H.D. Kumar, Publ: Vikas
9. Molecular Biotechnology - 4th edition, 2010, G.R. Click and J.J. Pasternak, Publ: Panima

10. Genes and Genomes – 1991, By Maxine Singer and Paul Berg
11. Genes VII- 2000, By B. Lewin - Oxford Univ. Press
12. Molecular Biology - 4th Edition, 2008, By D. Freifelder, Publ: Narosa Publishing house New York, Delhi
13. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
14. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
15. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
16. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7thedition. Blackwell Publishing, Oxford, U.K.
17. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rdedition. Cold Spring Harbor Laboratory Press.
18. Introduction to Bioinformatics – 2007, By V. Kothekar
19. Introduction to Bioinformatics – 2013, By Arthur M. Lesk
20. Bioinformatics: 2001, Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press
21. Biological Sequence Analysis: 1st Edition, 1998, Probabilistic Models of Proteins and Nucleic Acids by Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, Cambridge University Press
22. Bioinformatics: 2004, A Practical Guide to the Analysis of Genes and Proteins, Andreas D. Baxevanis, B. F. Francis Ouellette, Wiley-Interscience
23. Bioinformatics tools and Resources – free online tools, software packages, Bioinformatics books and Journals, Bioinformatics web-portals

B.Sc., Biotechnology: Choice based credit system

B.Sc., -IV Semester W.E.F. 2020-21

BT-401 (i) Plant and Animal Biotechnology

Course Objectives

The objectives of this course are to introduce students to the principles, practices and application of animal biotechnology, plant tissue culture, plant and animal genomics, genetic transformation.

Unit – I

Plant tissue culture techniques & secondary metabolites production

Plant tissue culture: totipotency , media preparation – nutrients and plant hormones; sterilization techniques; establishment of cultures – callus culture, cell suspension culture ,applications of tissue culture-micro propagation; Somatic embryogenesis; synthetic seed production; protoplast culture and somatic hybridization - applications. Cryopreservation,Plant secondary metabolites- concept and their importance

Unit – II

Transgenesis and Molecular markers

Plant transformation technology-- Agrobacterium mediated Gene transfer (Ti plasmid), hairy root features of Ri plasmid,Transgenic plants as bioreactors. Herbicide resistance – glyphosphate, Insect resistance- Bt cotton,,**Molecular markers - RAPD, RFLP and DNA fingerprinting-principles and applications.**

Unit – III

Animal tissue culture techniques

Animal cell culture: cell culture media and reagents; culture of mammalian cells, tissues and organs; primary culture, secondary culture, cell lines,stem cell cultures; Tests: cell viability and cytotoxicity, Cryopreservation. Transfection methods (calcium phosphate precipitation, electroporation, Microinjection) and applications.

Unit – IV

Transgenic animals & Gene Therapy

Production of vaccines, diagnostics, hormones and other recombinant DNA products in medicine (insulin,somatostatin, vaccines),IVF, Concept of Gene therapy, Concept of transgenic animals – Merits and demerits -Ethical issues in animal biotechnology

Unit V

Bioethics,Biosafety and IPR

Bioethics in cloning and stem cell research, Human and animal experimentation, animal rights/welfare. Bio safety-introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GLP,GMP, Introduction to IP-Types of IP: patents, trademarks & copyright

Student Learning Outcomes

Students should be able to gain fundamental knowledge in animal and plant biotechnology and their applications.

PLANT AND ANIMAL BIOTECHNOLOGY-PRACTICALS

- plant culture media and composition of MS media
  - Raising of aseptic seedlings
  - Induction of callus from different explants
  - Plant propagation through Tissue culture (shoot tip and Nodal culture)
- Establishing a plant cell culture (both in solid and liquid media)
- suspension cell culture
- Cell count by hemocytometer.
- Establishing primary cell culture of chicken embryo fibroblasts.
- Animal tissue culture – maintenance of established cell lines.
- Animal tissue culture – virus cultivation.
- Estimation of cell viability by dye exclusion (Trypan blue).
- ELISA – Demonstration

List of Reference Books ;

1.Introduction to Plant Tissue Culture..M.K. Razdan ,2003,Science Publishers

2.Plant Tissue Culture, kalyan Kumar De,199 M7,New Central Book Agency

3.Plant Tissue Culture : Theory and Practice By S.S. Bhojwani and A. Razdan,1998

4. Biotechnology – By U. Satyanarayana ;1997

5. Plant Cell, Tissue and Organ Culture, Applied and Fundamental Aspects By Y.P.S. Bajaj and A. Reinhard ,2001

6. Introduction to Plant Tissue Culture,M. K. Razdan, 2003,Science Publishers

7. A Textbook of Biotechnology,R C Dubey,S. 2014,Chand Publishing

8. Elements of Biotechnology,P. K. Gupta, 1994,Rastogi Publications

9. R. Ian Freshney, "Culture of animal cells – A manual of basic techniques" 4th edition, John Wiley & Sons, 2000 ,Inc, publication, New York

10. Daniel R. Marshak, Richard L. Gardner, David Gottllieb "Stem cell Biology" edited by Daniel 2001,Cold Spring Harbour Laboratory press, New York

11. M.M. Ranga, Animal Biotechnology; Agrobios (India) ,2006.

B.Sc., Biotechnology: Choice based credit system

B.Sc., -IV Semester W.E.F. 2020-21

BT-401 (ii) Environmental & Industrial Biotechnology

Learning Objective

This course aims to introduce fundamentals of Environmental Biotechnology. The course will also give an insight in introducing major groups of microorganisms and their industrial applications

Unit – I

Pollution Types and Control

Environmental Biotechnology-Environmental Pollution : Types of pollution, air pollution & its control through Biotechnology, Biofilters, Bioscrubbers, Biotrickling filter.Water pollution and its management: Measurement of water, pollution, sources of water pollution. Microbiology of waste water treatment, aerobic processes, activated sludge, oxidation ponds, trickling filters,and rotating biological contactors. Anaerobic processes: Anaerobic digesters, upward flow anaerobic sludge blanket reactors.

UNIT-II

Bioremediation

Biodegradation and Bioremediation – Concepts & principles of Bioremediation ,Bioremediation of Hydrocarbons and its applications Degradation of pesticides and other toxic chemicals by microorganism.Role of genetically Engineered microbes, Concept of Phytoremediation, , environmental safety guidelines.

UNIT III

Biofuels

Bio fuels-biogas, microbial groups involved in biogas production & interactions, factors affecting biogas production, Biofertilizers, Vermiculture.

Unit IV

Basic principles of Microbial technology

Industrially important microbes, its screening, selection and identification. Maintenance and preservation of industrially important microbial cultures. Strain Improvement, Basic concepts of fermentation; Design of fermenter and applications

Unit V

Commercial Production of Microbial products

Microbial technology products and applications;Microbial production of Organic acids (Lactic acid, citric acid), Amino acids(Glutamicacid, Aspartic acid and Lysine). Fermentation by microbes for food additives: dairy products (Cheese, Yogurt), beverages (Beer,Wine) and antibiotics (Streptomycin, Pencillin)

Student Learning Outcomes Students should be able to gain fundamental knowledge in animal and plant biotechnology and their applications.

ENVIRONMENTAL AND INDUSTRIAL BIOTECHNOLOGY -PRACTICALS

- Detection of coliforms for determination of the purity of potable water.
- Determination of total dissolved solids of water
- Determination of Hardness and alkalinity of water sample.
- Determination of dissolved oxygen concentration of water sample
- Determination of biological oxygen demand of sewage sample
- Determination of chemical oxygen demand (COD) of sewage sample.
- Isolation of industrially important microorganisms from soil.
- Isolation of amylase producing organisms from soil.
- Production of α – amylase from Bacillus Spp. by shake flask culture.
- Production of alcohol or wine using different substrates.
- Estimation of citric acid by titrimetry.

List of reference books;

1. K. Vijaya Ramesh, Environmental Microbiology, 2004,MJP Publishers, Chennai.
2. A.G. Murugesan, C. Raja Kumari, Environmental Science & Biotechnology - Theory & Techniques, 2005,MJP Publishers
3. Environmental microbiology by Raina M.Maier Ian L.Pepper & Charles P.Gerba,2000,Academic press
4. Environmental Chemistry, A.K. De. Wiley Eastern Ltd.,2001, New Delhi
5. Introduction of Biodeterioration, D. Allsopp and K.J. Seal, ELBS/Edward Arnold,2008
6. Power un seen: How microbes rule the world. By Dixon, B. Freeman/ Spectrum, 1994,Oxford.
7. Environmental Microbiology. By. Mitchell. R. Wiley,1992, New York
8. Introduction to Environmental Sciences, Y. Anjaneyulu ,2004, BS Publications
9. Industrial Microbiology by A.H.Patel,2009
10. Prescott & Dum (2002) Industrial Micrbiology, Agrabios (India) ,2005,Publishers
11. Creueger W. & Crueger A.A Text of Industrial Microbiology,2000, 2nd Edition, Panima Publishers corp.

REVISED UG SYLLABUS UNDER CBCS
(Implemented from Academic Year 2020-21)
PROGRAMME: FOUR YEAR B.Sc.

Domain Subject**: BIOTECHNOLOGY**
Skill Enhancement Courses (SECs) for Semester V, from 2022-23
(Syllabus-Curriculum)

Structure of SECs for Semester – V
(To choose One pair from the Three alternate pairs of SECs)

Univ. Code	Courses 6&7	Name of Course	Th. Hrs/ Week	IE Marks	EE Marks	Credits	Prac. Hrs/wk	Marks	Credits
	6A	Techniques in nursery development	3	25	75	3	3	50	2
	7A	Hydroponics cultivation	3	25	75	3	3	50	2

OR

Univ. Code	Courses 6&7	Name of Course	Th. Hrs/ Week	IE Marks	EE Marks	Credits	Prac. Hrs/wk	Marks	Credits
	6B	Organic Farming	3	25	75	3	3	50	2
	7B	Biofertilizers and Biopesticides production	3	25	75	3	3	50	2

OR

Univ. Code	Courses 6&7	Name of Course	Th. Hrs/ Week	IE Marks	EE Marks	Credits	Prac. Hrs/wk	Marks	Credits
	6C	Apiculture	3	25	75	3	3	50	2
	7C	Pearl Culture	3	25	75	3	3	50	2

Note-1: *For Semester–V, for the domain subject Biotechnology any, any one of the three pairs of SECs shall be chosen as courses 6 and 7, i.e., 6A & 7A or 6B & 7B or 6C & 7C. The pair shall not be broken (ABCD allotment is random, not on any priority basis).*

Note-2: *One of the main objectives of Skill Enhancement Courses (SEC) is to inculcate field skills related to the domain subject in students. The syllabus of SEC will be partially skill oriented. Hence, teachers shall also impart practical training to students on the field skills embedded in the syllabus citing related real field situations*

Semester-wise Revised Syllabus under CBCS, 2020-21

Four Year B.Sc. Course Code:
Domain Subject: Biotechnology
IV year B.Sc.-Semester-V

Course: 6 A -Techniques in Nursery Development

(Skill enhancement course (Elective), 05 credits)
Maximum Marks Theory: 100 + Practical: 50

I. Learning outcomes:

Students after successful completion of the course will be able to

1. Understand different types of nurseries
2. Identify various facilities required to set up of a nursery
3. Understood expertise related to various practices in a nursery
4. Acquire skills to get an employment or to become an entrepreneur.

***II*. Syllabus:** (*Total 90 hrs. (including Teaching, Lab, Field Training and unit tests etc.)*

UNIT -1: **Introduction to Nursery** (10h)

Definition, objectives and importance. Basic requirements for a nursery layout and components of a good nursery. Types of nurseries. Bureau of Indian standards (BIS - 2008) related to nursery.

UNIT-2: **Nursery inputs** (10h)

Tools, implements and containers. Nursery media. Electricity, equipment and machinery management. Types of nursery beds and their preparations. Precautions and maintenance of nursery beds.

UNIT -3: **Seeds and Propagules** (10h)

Selection of seed and different sowing methods. Use of different plant parts for vegetative propagation to raise nursery. Different techniques of vegetative propagation.

UNIT- 4: Management Practices (10h)

Routine seasonal operations in a nursery. Supply of water, nutrients and removal of weeds. Identification of pests and diseases, control and prevention methods.

UNIT – 5: Grafting techniques (10h)

Introduction to grafting, definition, types and tools for grafting. Steps involved in simple, splice graft, tongue graft, Whip graft, cleft graft and wedge graft. Grafting of horticultural & floricultural crops and applications.

Practical syllabus: Course 6A: Techniques in Nursery Development

III. Skill outcomes:

On successful completion of the practical course, student shall be able to

1. List out different types of nurseries and beds.
2. Identify the nursery tools, implements and containers.
3. Develop skill on potting media preparation and plant production.
4. Learn the technique of establishing cutting, layering, grafting etc

IV. Practical syllabus:

1. Demonstration of different types of nurseries
2. Handling of nursery tools, equipment and types of containers
3. Laying of nursery bed with soil and compost

4. Seed collection, treatment and rising of seedlings on nursery bed
5. Handling of grafting and layering techniques in the nursery
6. Watering, weeding and management of nursery
7. Maintaining of the seedlings / cuttings in the nursery

V. References:

1. Ratha Krishnan, M.,*et al.*(2014) Plant Nursery
2. Management: Principles and Practices, Central Arid Zone Research Institute – ICMR, Jodhpur, Rajasthan.
3. Vikas Kumar, Anjali Tiwari, Practical manual of Nursery management, Agri – biotech Press, New Delhi.
4. Tarai Ranjan Kumar, (2020) Plant propagation and nursery management, New India Publishers.
5. P.K.Ray,(2020)Essentials of plant nursery managemet.
6. P.K.Ray,(2012) How to start and operate a Plant Nursery.

VI. Co-curricular activities:

a) Mandatory: (Training of students by teacher on field related skills: 15hrs)

1. **For teachers:** Training of students by teacher in laboratory and field for a total of 15hrs on nursery types and infrastructure of a nursery. Presowing treatment and seed sowing methods. Plucking, transplantation, layering and grafting methods
2. **For students**; Visit to local nursery farm, observing the crop growth raised in nurseries. Submission of field work report of 10 pages in the prescribed format.
3. Maximum marks for field work report: 05
4. Suggested format for field work report: Title page, student details, content page, introduction, work done, findings, conclusion and acknowledgements.
5. Unit test (IE)

b) Suggested co-curricular activities:

1. Visit to local nurseries
2. Learning techniques of basic tools and instruments handling related to field work
3. Sowing of seeds by adopting different methods, grafting and layering techniques
4. Training of students by related subject experts
5. Attending special lectures, group discussions and seminars on related topics
6. Preparation of videos on nursery media preparation and application

VII. Suggested Question Paper Pattern:

Max. Marks: 75 Time: 3 hrs

SECTION A (Total: 15 Marks)

Very Short Answer Questions (10 Marks: 5 x2)

SECTION B (Total: 5x5=25 Marks)

(Answer any four questions. Each answer carries 5 marks

(At least 1 question should be given from each Unit)

1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	

SECTION C (Total: 4x10 = 40 Marks)

(Answer any four questions. Each answer carries 10 marks

(At least 1 question should be given from each Unit)

1.	
2.	
3.	
4.	
5.	
6.	

Suggested Question Paper Model for Practical Examination

Semester – V/ Biotechnology **Course – 6 A** (Skill Enhancement Course)

Techniques in Nursery Development

Max. Time: 3 Hrs. Max. Marks: 50

1. Perform the pre-treatment method for given seed 'A' 8 M
2. Identify the graft and perform grafting 'B' 8 M
3. Demonstration of handling of nursery tools, equipment and containers 'C' 12 M

4. Scientific observation and data analysis 4 x 3 = 12 M
   - A. Whip graft/photograph
   - B. Propagule / photograph
   - C. Nursery container/ photograph
   - D. Sucker/photograph

5. Record + Viva-voce 6+4 = 10 M

========

Semester-wise Revised Syllabus under CBCS, 2020-21

Four Year B.Sc. Course Code:
Domain subject: Biotechnology
IV year B.Sc.-Semester-V

Course: 7 A - Hydroponics cultivation

(Skill enhancement course (Elective), 05 credits)
Maximum Marks Theory: 100 + Practical: 50

I. Learning outcomes:

Students after successful completion of the course will be able to

1. Understand the concept of hydroponics
2. Acquire the knowledge on soilless cultivation system
3. Prepare media for hydroponics cultivation
4. Learn the hydroponic cultivation technique

***II*. Syllabus:** *(Total 90 hrs. including Teaching, Lab, Field Training and unit tests etc.)*

UNIT -1 - Introduction to Soilless culture **(**10h)

Definition, History and origin of soilless culture, Present status of hydroponics-contrasts with soil based culture, Applications & future developments.

UNIT-2- Macronutrients, micronutrients **(**10h)

Functions and effect on plants, deficiency symptoms of the following essential minerals N, P, Mg, Ca, K, S, Fe, Mn, Cu, Zn, B, Mo, Physical factors, light (Quantity, energy, photoperiodism *etc*),Temperature (Heating and cooling), Humidity, CO2, ppm, pH and TDS.

UNIT –3 - Cultural conditions **(**10h)

Plant nutrition. Inorganic salts (fertilizers) major and minor nutrients formulating, monitoring and analysing. Selection of fertilizers, media used for hydroponics-expanded clay, rock wool, coir, perlite, pumice, vermiculite, sand gravel *etc*. Weed management, diseases and pest control.

UNIT- 4 - Techniques in hydroponics **(**10h)

Static solution culture, continuous-flow solution culture and aeroponics.

UNIT –5 - Cultivation of crop plants by hydroponics **(**10h)

Passive sub-irrigation, Ebb and flow or flood and chain irrigation. Deep water culture protocols for –Tomato cultivation through Dutch bucket method, chilly cultivation through NFT system, Spinach through raft System and measurements of yield.

Practical syllabus: Course 7A: Hydroponics cultivation

III. Skill outcomes:

On successful completion of the practical course student shall be able to

1. List out macronutrients, micronutrients- functions and effect on plants, deficiency symptoms**.**
2. Demonstrate the importance of temperature and light in hydroponics
3. Develop skill of media production for Hydroponics cultivation
4. Equip with the skill of weed management, diseases and pest management

IV. Practical syllabus:

1. Handling of tools required for hydroponic set up
2. Preparation of macronutrients and micronutrients solutions/stock cultures
3. Preparation of different media for hydroponic system.
4. Evaluating the effect of bio fertilizers on hydroponic cultivation
5. Weeding management techniques - demonstration
6. Demonstration of pests and diseases control and prevention methods
7. Cultivation of tomato by hydroponic system
8. Cultivation of chilli through hydroponic cultivation

V. References:

1. Keith Roberto, *How to Hydroponics*. The future Garden Press New York.4th Edition
2. Howard M. Resh. *Hobby Hydoponics*. CRC Press, USA.
3. Prasad S and Kumar U. *Green House management for Horticultural crops*. Agro-Bios India.
4. Dahama A.K. *Organic Farming for Sustainable Agriculture.* Agrobios, India
5. Subba Rao N.S. (1995).*Biofertilizers in Agriculture and Forestry.* Oxford and IBH Publishing Company. Pvt. Ltd New Delhi.

VI .Co-curricular activities:

a) Mandatory: (Training of students by teacher on field related skills:15hrs)

1. **For teachers:** Training of students by teacher in laboratory and field for a total of 15hrs on soilless culture system. Demonstrating importance of nutrients/light/temperature for successful hydroponic cultivation.
2. **For students**: Visit to local Hydroponics cultivation farm, observing the crop growths. Submission of field work report of 10 pages in the prescribed format.
3. Maximum marks for field work report: 05
4. Suggested format for field work report: Title page, student details, content page, introduction, work done, findings, conclusion and acknowledgements.
5. Unit test (IE)

b) Suggested co curricular activities:

1. Visit to local hydroponics cultivation farm
2. Learning techniques of basic tools and instruments handling related to hydroponics
3. Training of students by related subject experts
4. Preparation of videos on media preparation and application in hydroponics
5. Attending special lectures, group discussions and seminars on related topics

VII. Suggested Question Paper Pattern:

Max. Marks: 75 Time: 3 hrs

SECTION A (Total: 15 Marks)

Very Short Answer Questions (10 Marks: 5 x2)

SECTION B (Total: 5x5=25 Marks)

(Answer any four questions. Each answer carries 5 marks

(At least 1 question should be given from each Unit)

1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	

SECTION C (Total: 4x10 = 40 Marks)

(Answer any four questions. Each answer carries 10 marks

(At least 1 question should be given from each Unit)

1.	
2.	
3.	
4.	
5.	
6.	

Suggested Question Paper Model for Practical Examination

Semester – V/ Biotechnology **Course – 7 A** (Skill Enhancement Course)

Hydroponics cultivation

Max. Time: 3 Hrs. Max. Marks: 50

1. Demonstrate the preparation of macronutrients and micronutrients stock solutions for hydroponics cultivation 'A' 8 M
2. Establish hydroponic set up with given tools 'B' 8 M
3. Prepare complete media for effective hydroponic cultivation 'C' 12 M
4. Scientific observation and data analysis 4 x 3 = 12 M
   - A. Chilli cultivation /photograph
   - B. Tomato cultivation / photograph
   - C. Zinc deficiency symptom / photograph
   - D. Static solution culture /photograph
5. Record + Viva-voce 6+4 = 10 M

========

Semester-wise Revised Syllabus under CBCS, 2020-21

Four Year B.Sc. Course Code:

Domain subject: Biotechnology

IV year B.Sc., - Semester-V

Course 6B Organic Farming

(Skill enhancement course (Elective), 05 credits)

Maximum Marks Theory: 100 + practical: 50

I. Learning outcomes

Students after successful completion of the course will be able to

1. Understand the soil profile and nutrients in soil
2. Appreciate the importance of organic manure and bio fertilizers
3. Produce vermi compost, farmyard manure from bio waste
4. Acquire skill on isolation and maintenance of bio fertilizers

***II*. Syllabus:** *(Total 90 hrs. (including Teaching, Lab, Field Training and unit tests etc.)*

UNIT -1 - Soil: **(**10h)

Definition, soil formation, composition and characteristics. Types of soils. Distribution of soil groups in India. Acidic, Alkaline and heavy metal contaminated soil. Methods of reclamation. Effects of chemical dependant farming on yield and soil health.

UNIT-2 - Plant Nutrition **(**10h)

Macro and micro nutrients, functions of nutrients in plant growth and development. Nutrient uptake and utilization by plant. Types of fertilizers. Organic, inorganic and bio fertilizers. Chemical fertilizer. Advantages & disadvantages of their use. Importance of organic and bio fertilizers.

UNIT -3 - Organic Farming **(**10h)

Definition, concept, benefits. Integrated farming system (combination of organic and inorganic). Mixed farming system. Concept of different cropping systems in relation to organic farming, Inter cropping, crop rotation. Organic farming process. Organic fertilizers, crop nutrients and effective microorganisms in Organic farming.

UNIT- 4 - Organic compost **(**10h)

Definition, types of compost, farm yard compost, green leaf compost, animal husbandry, animal housing, animal feeding, animal health, breeding goals.

Vermi compost: Introduction, vermi composting material, species of earthworms, small scale, large scale composting process. Vermi castings, harvesting, processing and drying. Nutrient content of vermi compost. Field application methods.

UNIT – 5- Biofertilizers **(**10h)

Introduction, status and scope. Structure and characteristic features of bacterial bio fertilizers- *Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium* and *Frankia*. Cynobacterial biofertilizers- *Anabaena, Nostoc, Hapalosiphon* and fungal biofertilizers- AM mycorrhiza and ectomycorrhiza. Mechanism of nitrogen fixation and phosphorus solubilization.

Practical syllabus: Course 6B Organic farming

III. Skill outcomes:

On successful completion of the practical course, student shall be able to

1. Estimate NPK levels in the soil
2. Demonstrate the collection and processing of raw material
3. Develop skill of vermi compost production
4. Learn the technique of establishing organic farms
5. Equip with the skill of preparation of microbial media

IV. Practical syllabus:

1. Collection of different soil samples
2. Qualitative estimation of nitrogen, phosphorus and potassium in soil samples
3. Collection of fruit, vegetable and other domestic waste
4. Preparation of compost beds and introducing earthworms
5. Collection of vermi castings
6. Sieving, drying and packing of vermi compost
7. Visit to animal shed and observing farm yard manure production
8. Preparation of media and isolation of bio fertilizers

V. References:

1. Principles of Organic Farming:: by E Somasundaram,D Udhaya Nandhini,M Meyyappan **;2021**
2. Organic farming in India:: by Arpita Mukherjee; 2017
3. Biofertizer and biocontrol agents for agriculture;; by AM Pirttilä · 2021
4. Trends in Organic Farming in India;; by S. S. Purohit, 2006
5. Biofertilizers for Sustainable Agriculture and Environment;; by Bhoopander Giri
Ram Prasad, Qiang-Sheng Wu, Ajit Varma; 2019

VI. Co-curricular activities:

a) Mandatory:(Training of students by teacher on field related skills;15hrs)

1. **For teacher;** Training of students by teacher in laboratory and field for a total of 15hrs on soil sample collection, NPK analysis, collection of biodegradable waste, vermi composting, collection of castings, processing, drying& packing. In addition teacher should demonstrate the media preparation, sterilization, and isolation of microorganisms from soil.
2. **For students:** Visit to local organic farm, collection of earthworms, observing the crop growth raised in organic farms. Submission of field work report of 10 pages in the prescribed format.
3. Maximum marks for field work report:05
4. Suggested format for field work report: Title page, student details, content page, introduction, work done, findings, conclusion and acknowledgements.
5. Unit test (IE)

b) Suggested co-curricular activities:

1. Comparing mineral content in different agricultural soil
2. Learning techniques of basic instruments handling related to field work
3. Preparation of videos on compost preparation and application
4. Visit to local organic fields
5. Attending special lectures, group discussions and seminars on organic farming.

VII. Suggested Question Paper Pattern:

Max. Marks: 75 Time: 3 hrs.

SECTION A (Total: 15 Marks)

Very Short Answer Questions (10 Marks: 5 x2)

SECTION B (Total: 5x5=25 Marks)

(Answer any four questions. Each answer carries 5 marks
(At least 1 question should be given from each Unit)

1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	

SECTION C (Total: 4x10 = 40 Marks)

(Answer any four questions. Each answer carries 10 marks
(At least 1 question should be given from each Unit)

1.	
2.	
3.	
4.	
5.	
6.	

Suggested Question Paper Model for Practical Examination
Semester – V/ Biotechnology **Course – 6B** (Skill Enhancement Course)

Organic Farming

Max. Time: 3 Hrs. Max. Marks: 50

1. Estimate the pH of soil in given sample 'A' 8 M
2. Estimate the nitrogen content in given soil sample 'B' 8 M
3. Perform streak plate technique for isolation 'C' 12 M

4. Scientific observation and data analysis 4 x 3 = 12 M
   A. Identify different earth worm species /photograph
   B. Sieving and processing of vermi compost - photograph
   C. VAM identification
   D. Farmyard manure
5. Record + Viva-voce 6+4 = 10 M

========

Semester-wise Revised Syllabus under CBCS, 2020-21

Four Year B.Sc. Course Code:
Domain subject: Biotechnology
IV year B.Sc. -Semester-V

Course 7B: Bio fertilizers and Bio pesticides production

(Skill enhancement course (Elective), 05 credits)
Maximum Marks Theory: 100 + practical: 50

I. Learning outcomes:

On successful completion of the practical course, student shall be able to

1. Understand the importance of bio fertilizers for sustainable agriculture.
2. Appreciate the role of VAM in P solubilisation
3. Define bio pesticide and its nature
4. Produce bio fertilizers and bio pesticides on large scale
5. Able to prepare inoculums for field application

II. **Syllabus:** (*Total 90 hrs (including Teaching, Lab, Field Training and unit tests etc.)*

UNIT -1- Bio fertilizers (10h)

Introduction, history, concept, scope of bio fertilizers in India. Classification, microorganisms used as bio fertilizers. Bacterial, fungal and algal bio fertilizers. Symbiotic and a symbiotic microorganisms. Mechanism of nodulation and nitrogen fixation.

UNIT – 2- Mycorrhizal bio fertilizers (10h)

Importance, types, characteristic features of ecto and endo mycorrhiza. Mechanism of phosphorus solubilisation. Uptake of phosphates by the roots. Consortium based inoculums and significance.

UNIT-3 - Bio pesticides (10h)

Definition, concept, history, scope and importance of bio pesticides.
Classification - botanicals, bacterial, fungal and viral based bio pesticides. Mechanism of action of *Bacillus thuringiensis* and *Trichoderma viridae* as bio control agents.

UNIT -4 - Mass production techniques (10h)

Media, types, preparation. Methods of isolation, streak plate, spread plate and pour plate techniques, purification and identification of microorganisms used as bio fertilizers and bio pesticides. Mass production and packing techniques.

UNIT- 5 - Field application methods (10h)

Preparation of carrier based inoculum. Sphagnum, peat, vermiculite as inoculums carriers. Dosage standardisation. Seed treatment, foliar application, root dressing and soil application techniques. Storage and maintenance of inoculum.

Practical syllabus: Course 7B Bio fertilizers and Bio pesticides Production

III. Skill outcomes:

On successful completion of the practical course, student shall be able to

1. Prepare bacterial and fungal media
2. Isolate and identify symbiotic and free living nitrogen fixing bacteria
3. Isolate fungal bio control agents from soil samples.
4. Develop skill for large scale production of micro organisms

5. Learn field application techniques of biofertilizers and biopesticides

IV. Practical syllabus:

1. Preparation of Nutrient agar, YEMA, and PDA media
2. Isolation of *Rhizobium* from root nodules
3. Isolation of *Azatobacter* from soil samples
4. Isolation of *Trichoderma*
5. Gram staining of bacteria
6. VAM root staining
7. Raising of legume seedlings with *Rhizobium* treatment
8. Visit to commercial bio control units and Krishi seva Kendra

V. References:

1. Biofertilizers: Commercial Production Technology and Quality Control, 2017 by Dr. P.Hyma
2. Biofertilizers Technology, 2010, by S.Kaniyan, K.Kumar and K. Govinda rajan
3. Biofertilizers for Sustainable Agriculture, 2017; by Arun K Sharma
4. Advances In Plant Biopesticides 2021, by Dwijendra Singh, Springer India
5. A Textbook of Integrated Pest Management, 2013by Ram Singh & Vikas Jindal G.S. Dhaliwal

VI. Cocurricular activities:

a) **Mandatory:** (Training of students by teacher on field related skills: 15hrs)

1. **For teacher:** Training of students by teacher on preparation of different microbial media, isolation techniques – streak plate , spread plate, pour plate, Grams staining of bacteria , VAM and Trichoderma observation. Preparation of Rhizobium inoculum and application to legume seedlings.
2. **For students:** Raising of seedlings of Leguminaceae species, maintaining of the seedlings in nursery/green house. Comparing the growth of seedlings treated with biofertilizer and chemical fertilizer. Visit to Bio fertilizer and Bio pesticides commercial lab. Submission of field work report of 10 pages in the prescribed format.
3. Maximum marks for field work report:05
4. Suggested format for field work book; Title page, student details, content page, introduction, work done, findings, conclusion and acknowledgements.
5. Unit test (IE).

b) Suggested co-curricular activities;

1. Training of students by the industrial experts
2. Identification and collection of botanical pesticides
3. Assignments/seminars/group discussion /quiz on bio fertilizers and bio pesticides
4. Preparation of videos, charts on inoculum development and field application
5. Attending invited guest lectures on the concern topics

VII. Suggested Question Paper Pattern:

Max. Marks: 75 Time: 3 hrs.

SECTION A (Total: 15 Marks)

Very Short Answer Questions (10 Marks: 5 x2)

SECTION B (Total: 5x5=25 Marks)

(Answer any four questions. Each answer carries 5 marks
(At least 1 question should be given from each Unit)

1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	

SECTION C (Total: 4x10 = 40 Marks)

(Answer any four questions. Each answer carries 10 marks
(At least 1 question should be given from each Unit)

1.	
2.	
3.	
4.	
5.	
6.	

Suggested Question Paper Model for Practical Examination
Semester – V/ Biotechnology **Course – 7B** (Skill Enhancement Course)

Bio fertilizers and Bio pesticides Production

Max. Time: 3 Hrs. Max. Marks: 50

1. Identify the given microbial sample based on morphological characteristics 'A' 8 M
2. Identify the given culture based on microscopic observation 'B' 8 M
3. Perform the section cutting of root nodule 'C' 12 M

4. Scientific observation and data analysis 4 x 3 = 12 M
   A. Identify the given algal fertilizer /photograph
   B. Identify the fungal biofertilizer - photograph
   C. VAM identification
   D. Seed treatment

5. Record + Viva-voce 6+4 = 10 M

========

Semester-wise Revised Syllabus under CBCS, 2020-21

Four-year B.Sc. Course Code:
Domain Subject: BIOTECHNOLOGY
IV year B. Sc. – Semester – V

Course 6C Apiculture

(Skill Enhancement Course (Elective), 05 Credits)
Max Marks: Theory:100 + Practical:50

I. Learning outcomes

Students after successful completion of the course will be able to

1. Understand the basic concepts of Apiculture.
2. Obtain the elementary knowledge of different species and races of honey bees
3. Appreciate the importance of health and hygiene in Bee keeping
4. Maintain the Bee hives in a scientific way

II. **Syllabus:** *(Total Hours: 90 including Teaching, Lab, Field Training and unit tests etc.)*

Unit 1: Biology of Bees **10 hrs**

History, Classification and Life Cycle of Honey Bees. Social Organization of Bee Colony.

Unit 2: Rearing of Bees **10 hrs**

Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth. Methods of Extraction of Honey (Indigenous and Modern).

Unit 3: Diseases and Enemies **10 hrs**

Bee Diseases and Enemies. Control and Preventive measures.

Unit 4: Economy and Entrepreneurship **10 hrs**

Products of Apiculture Industry and its Uses (Honey, Bee Wax, Propolis) and Pollen.

Unit 5. Entrepreneurship in Apiculture **10 hrs**

Bee Keeping Industry: Present and future, Role of Bees in cross pollination in horticulture and agriculture. Prospects of apiculture as self-employment venture.

Practical Syllabus: Course 6C **Apiculture**

III. Skills Outcomes:

On successful completion of this practical course, student shall be able to:

1. Maintain the Bee hives in a scientific way.
2. Clean & Maintain Bee Boxes
3. Use of other tools required in Bee Keeping
4. Building and division of colony
5. Understand the methodologies of extracting, preservation and marketing of honey and other products of honey bee

IV. Practical syllabus

1. Handling of tools and techniques for Apiculture
2. To study the morphological and anatomical characteristics of queen and worker bees
3. Identification of different species of honey bees
4. Preparation of honey bee trays for beekeeping, maintenance and colony inspection
5. Extraction of honey and bee wax

6. Processing of honey, packing and storing
7. Identification of honey adulteration

V. References:

1. Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
2. Graham, J M (1992) The hive and the honey bee. Dadant and Sons, Hamilton, IIIinois.
3. Mishra R.C. (1995) Honey bees and their management in India. ICAR Publication New Delhi.
4. Singh, S. (1971) Beekeeping in India, ICAR publication..
5. Bisht, D.S. (2004). Agricultural Development in India, Anmol Pub. Pvt. Ltd.
6. Singh S.(1964). Beekeeping in India, Indian council of Agricultural Research, NewDelhi
7. Mehrotra, K.N. Bisht, D.S. (1981). Twenty-five years of apiculture research at IARI. Apiculture in relation to agriculture.

VI. Co-Curricular Activities

a) **Mandatory**: *(Training of students by teacher on field related skills: 15 hrs)*

1. For Teacher: Training of students by teacher in laboratory and field for a total of 15 hours in Preparation of honey bee trays for beekeeping, maintenance and colony inspection. Extraction, processing, packing and storing of honey and bee wax
2. For Student: Individual visit to an Apiculture facility or related field or to a laboratory in a university/research organization/private sector and study of Apiculture practices. Submission of a hand-written Fieldwork Report not exceeding 10 pages in the given format.
3. Max marks for Field Work Report: 05.
4. Suggested Format for Field work: Title page, student details, content page, introduction, work done, findings, conclusions and acknowledgements.
5. Unit tests (IE).

b) <u>Suggested Co-Curricular Activities</u>

1. Training of students by related industrial experts.
2. Assignments (including technical assignments like Identification of flora and location of site, procurement of bee box and other tools, building & division of comb and colony, manage insects and diseases and nuisance in bee hives, knowledge of the scientific methods of bee keeping)
3. Seminars, Group discussions, Quiz, Debates etc. (on related topics).
4. Preparation of videos on tools and techniques on bee keeping.
5. Collection of material/figures/photos related to products of Apiculture, writing and organizing them in a systematic way in a file.
6. Visits to Apiculture facilities, firms, research organizations etc.
7. Invited lectures and presentations on related topics by field/industrial experts.

VII. Suggested Question Paper Pattern:

Max. Marks: 75 Time: 3 hrs

SECTION A (Total: 15 Marks)

Very Short Answer Questions (10 Marks:: 5 x2)

SECTION B (Total: 5x5=25 Marks)

(Answer any four questions. Each answer carries 5 marks

(At least 1 question should be given from each Unit)

1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	

SECTION C (Total: 4x10 = 40 Marks)

(Answer any four questions. Each answer carries 10 marks

(At least 1 question should be given from each Unit)

1.	
2.	
3.	
4.	
5.	
6.	

Suggested Question Paper Model for Practical Examination

Semester – V/ Biotechnology **Course – 6C** (Skill Enhancement Course)

Apiculture

Max. Time: 3 Hrs. Max. Marks: 50

1. Identification of different species of honey bees 'A' 8 M
2. Demonstration of use of different boxes and other tools in Bee Keeping 'B' 8 M
3. Methods of harvesting, processing and preservation of honey 'C' 12 M

4. Scientific observation and data analysis 4 x 3 = 12 M
   A. Identify tools for Apiculture /photograph
   B. Identification of morphological and anatomical characteristics of queen and worker bees / photograph
   C. Identify Common pests that attack honey bees and hives / photograph
   D. Building of comb and colony /photograph
5. Record + Viva-voce 6+4 = 10 M

========

Semester-wise Revised Syllabus under CBCS, 2020-21

Four-year B.Sc. Course Code:
Domain Subject: BIOTECHNOLOGY
IV year B. Sc., – Semester – V

Course 7C Pearl Culture

(Skill Enhancement Course (Elective), 05 Credits)
Max Marks: Theory: 100 + Practical: 50

I. Learning outcomes

Students after successful completion of the course will be able to

1. Understand the basic concept of pearl culture.
2. Obtain the elementary knowledge regarding the Anatomical and Physiological aspects of fresh water oysters.
3. Acquaint with the various types of implantation methods and pearl culture surgery techniques.
4. Acquire skill on production of pearl and its marketing for economic gain

***II.* Syllabus:** *(Total Hours: 90 including Teaching, Lab, Field Training and unit tests etc.)*

Unit 1: Overview of Pearl oyster (**10h)**

Biology of Pearl oyster: Pearl producing molluscs. Morphology and anatomy of Pearl oyster, Life cycle of pearl oyster.

Unit 2: Process of Pearl formation (**10h)**

Structure and Histology of mantle. Natural Process of Pearl formation. Chemical composition of Pearls. Economic importance of pearls.

Unit 3: Pearl oyster culture (**10h)**

Pearl oyster culture Techniques of pearl oyster culture (Fresh water and Marine water) for artificial production of pearls. Pearl culture techniques -Rafts, long lines, Pearls oyster baskets, under water platforms, mother oyster culture/Collection of oysters, rearing of oysters, Environmental parameters.

Unit 4: Pearl Oyster surgery (**10h)**

Selection of Oyster, Graft tissue preparation, Nucleus insertion, Conditioning for surgery, Post-operative culture, harvesting of pearl, clearing of pearl.

Unit 5: Pearl culture Economy (**10h)**

Diseases and Predators of Pearl oysters' Present status, prospects and problems of pearl industry in India.

Practical Syllabus: Course 7C Pearl Culture

III. Skills Outcomes:

On successful completion of this practical course, student shall be able to:

1. Execute pre- pearl culture activities
2. **Learn the technique of** surgical operation
3. **Develop skill of** Post operation activities
4. Implement culture activities
5. Perform pearl harvesting

IV. Practical syllabus

1. Technique for measurement of soil and water
2. Culture technique of microorganism for pond maintenance. Surgical techniques
3. Graft tissue preparation, implantation techniques, post operation care
4. Designed pearl culture techniques, bleaching, collection of pearls, cleaning of pearls
5. Sorting of pearls, marketing of pearls.

V. References:

1. Haws Maria (2002). The basics of pearl farming: a Layman's manual: (U.S.A). CTSA publications.
2. Alexander E .Farn (1986) pearls :(U.S.A.).Butterworth Heinemann publications.
3. Le Jia Li (2014) new technologies to promote freshwater pearl culture (China) Ocean Press publications.
4. Bardach, J.E.W (1972) Aquaculture farming and husbandry of freshwater and Sorting of Pearl. Marketing and economics concerned with Pearl Culture. Generation marine organisms
5. David Dobilet (1995) Pearl farming (Australia) Nat Geographic Mag publication
6. Yuan Cha Da (2014) Environmental effects Pearl farming (China) Jiangxi People publishing house.

VI. Co-Curricular Activities

a) **Mandatory**: *(Training of students by teacher on field related skills: 15 hrs)*

1. **For Teacher:** Training of students by teacher in laboratory and field for a total of 15 hours on construction of pearl farm, collecting oysters, seeding, caring the oyster and harvesting
2. **For Student:** Individual visit to a pearl culture facility or related field or to a laboratory in a university/research organization/private sector and study of pearl culture practices. Submission of a hand-written Fieldwork Report not exceeding 10 pages in the given format.
3. Max marks for Field Work Report: 05.
4. Suggested Format for Field work: Title page, student details, content page, introduction, work done, findings, conclusions and acknowledgements.
5. Unit tests (IE).

b) <u>Suggested Co-Curricular Activities</u>

1. Training of students by related industrial experts.
2. Assignments (including technical assignments like identifying tools in pearl culture and their handling, operational techniques with safety and security, IPR)
3. Seminars, Group discussions, Quiz, Debates etc. (on related topics).
4. Preparation of videos on tools and techniques in pearl culture.
5. Collection of material/figures/photos related to products of pearl culture, writing and organizing them in a systematic way in a file.
6. Visits to pearl culture facilities, firms, research organizations etc.
7. Invited lectures and presentations on related topics by field/industrial experts.

VII. Suggested Question Paper Pattern:

Max. Marks: 75 Time: 3 hrs

SECTION A (Total: 15 Marks)

Very Short Answer Questions (10 Marks : 5 x2)

SECTION B (Total: 5x5=25 Marks)

(Answer any four questions. Each answer carries 5 marks

(At least 1 question should be given from each Unit)

1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	

SECTION C (Total: 4x10 = 40 Marks)

(Answer any four questions. Each answer carries 10 marks

(At least 1 question should be given from each Unit)

1.	
2.	
3.	
4.	
5.	
6.	

Suggested Question Paper Model for Practical Examination

Semester – V/ Biotechnology **Course – 7C** (Skill Enhancement Course)

Pearl Culture

Max. Time: 3 Hrs. Max. Marks: 50

1. Identify pearl producing oyster, preparation of nuclei 'A' 8 M
2. Prepare graft tissue, perform surgical implantations. 'B' 8 M
3. Implantation of live graft pieces into the mantle of mussel 'C' 12 M

4. Scientific observation and data analysis 4 x 3 = 12 M
   - A. Pearl culture surgical instruments /photograph
   - B. Identification of Pearl/ photograph
   - C. Classification of pearls / photograph
   - D. Biomineralisation of pearls /photograph
5. Record + Viva-voce 6+4 = 10 M

========