Course Curriculum of First Semester
as per the ICAR-Sixth Deans' Committee Report for the Academic Programmes in
BIOTECHNOLOGY

- UG-Certificate in Biotechnology
- UG-Diploma in Biotechnology
- UG-Degree: B.Tech. (Biotechnology)

Mahatma Phule Krishi Vidyapeeth, Rahuri

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani

Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli

Maharashtra Agricultural Universities Examination Board, Pune

Compiled & Submitted by

Dr. Anil A. Kale
Incharge, State-level Biotechnology Centre, MPKV, Rahuri.

UG Degree Syllabus State Coordinator

with

UG Degree Syllabus Discipline Coordinators &

DICC - UG Degree Syllabus Core Committee

Submitted to the

Directors of Instruction Coordination Committee

~ w.e.f. AY, 2024-25 ~

Course Layout

B.Tech. (Biotechnology)

Semester: I (New) ***w.e.f.*** **Academic Year: 2024-25**

Sr. No.	Course No.	Course Title	Credit Hrs.	Remark
1.	**CAC-111**	*Deeksharambh* (Induction-cum-Foundation Course)	2(0+2)	NG (2 Weeks)
2.	**AEC-111**	National Service Scheme (NSS-I)/ National Cadet Corps (NCC-I)	1(0+1)	
3.	**AEC-112**	Communication Skills	2(1+1)	
4.	**MDC-111**	Farming-based Livelihood Systems	3(2+1)	
5.	**MATH-111*/ BOT-111****	Basic Mathematics*/ Basic Botany**	2(2+0)	Need-based
6.	**BT-111**	Molecular Biology	3(3+0)	
7.	**BT-112**	Introductory Cell Biology	3(3+0)	
8.	**BT-113**	Fundamentals of Genetics	3(3+0)	
9.	**SEC-111**	Skill Enhancement Course-I *(To be offered from the bouquet of SEC Courses)*	2(0+2)	
10.	**SEC-112**	Skill Enhancement Course-II *(To be offered from the bouquet of SEC Courses)*	2(0+2)	
		Total Credits Hrs.	**21(14+7) G 2(0+2) NG**	

CAC: Common Academic Course, **AEC**: Ability Enhancement Course,
MDC: Multidisciplinary Course, **SEC**: Skill Enhancement Course,
G: Gradial, **NG**: Non-Gradial

Note: *MATH-111 for **PCB** student/ **BOT-111 for PCM student / **PCMB** students may opt any 1 choice-based course viz., MATH-111 or BOT-111 for completion of the mandatory gradial credits.

Course-wise Syllabus with Teaching Schedules

Semester	**:**	**I**	
Course No.	**:**	**CAC-111**	**Credit Hrs. : 2 (0+2) NG/ 2 Weeks**
Course Title	**:**	***Deeksharambh* (Induction-cum-Foundation Course)**	
Non-Gradial Common Academic Course for the said UG degree with the activities to be conducted during initial two weeks.			

Objectives:

(i) To create a platform for students to help for cultural Integration of students from different backgrounds,

(ii) To know about the operational framework of academic process in university, instilling life and social skills,

(iii) To create Social awareness, Ethics and Values, Team work, Leadership, Creativity,

(iv) To identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

ACTIVITIES

- Introduction/Orientation and Discussions on operational framework of academic process in University/ College, as well as interactions with Academic and Research Managers of the University.
- Interaction with Alumni, Business Leaders, Perspective Employers, Outstanding Achievers in related fields and people with inspiring life experiences.
- Group activities to identify the strength and weakness of students and to learn from each other's life experiences.
- Activities to enhance Cultural Integration of students from different backgrounds.
- Field visits to the relevant fields/ establishments.
- Sessions on Personality Development (Instilling Life and Social skills, Social awareness, Ethics and Values, Team work, Leadership etc.) and imbibing the Communication skills.

Note: *The details of the relevant activities will be decided by the parent University in line with the above-mentioned broad activities.*

Semester	**:**	**I**	
Course No.	**:**	**AEC-111**	**Credit Hrs. : 1 (0+1)**
Course Title	**:**	**National Service Scheme (NSS-I) / National Cadet Corps (NCC-I)**	
Gradial Common Course across all UG Degrees			

Course No.: AEC-111	**Course Title: National Service Scheme-I (NSS-I)**	**Credit Hrs: 1(0+1)**

SYLLABUS

PRACTICAL

Introduction and Basic Components of NSS

- Orientation: History, Objectives, Principles, Symbol, Badge; Regular Programs under NSS.
- Organizational structure of NSS, Code of conduct for NSS volunteers, Points to be considered by NSS Volunteers' awareness about Health.
- NSS program activities. Concept of regular activities, Special camping, Day camps, Basis of adoption of village/slums, Conducting survey, Analysing Guiding financial patterns of scheme, Youth program/schemes of GOI, Coordination with different agencies and maintenance of diary. Understanding youth. Definition, Profile, Categories, Issues and Challenges of youth; and Opportunities for youth who is agent of the social change.
- Community mobilization. Mapping of community stakeholders, Designing the message as per problems and their culture; Identifying methods of mobilization involving youth-adult partnership. Social harmony and National integration.
- Indian history and culture, role of youth in nation building, Conflict resolution and peace building. Volunteerism and Shramdaan. Indian tradition of volunteerism, its need, importance, motivation and constraints; Shaman as part of volunteerism.
- Citizenship, Constitution, and Human rights. Basic features of constitution of India, Fundamental rights and duties, Human rights, Consumer awareness and rights and Right to information. Family and Society. Concept of family, Community (PRIs and other community-based organizations) and Society.

TEACHING SCHEDULE

PRACTICAL

Exercise No.	Exercise Topic/ Title	Weightage (%)
1	Orientation, History, Objectives, Principles, Symbols, Badge	10
2	Regular Programmes under NSS	10
3	Organisational Structure of NSS	10
4	Code of Conduct of NSS Volunteer	10
5	Points to be considered about NSS Volunteers awareness about Health	5
6	NSS Programme Activities- Concept of Regular activities	5
7	NSS Programme Activities- Special Campaign	5
8	NSS Programme Activities- Day Camps	5
9	NSS Programme Activities- Adoption of village, Conducting survey, Analysing Guiding financial patterns of scheme	5
10	NSS Programme Activities- Youth programs/schemes of GOI, Coordination with different agencies and maintenance of diary. Understanding youth. Definition, Profile, Categories, Issues and Challenges of youth and Opportunities for youth who is agent of the social change.	5
11	Community Mobilization- Mapping of community stakeholders, Designing the message as per problems and their culture; Identifying methods of mobilization involving youth-adult partnership.	5
12	Community Mobilization-Culture, Social harmony and National integration.	5
13	Indian History and Culture- Role of youth in Nation Building	5
14	Volunteerism and Shramdaan: Indian tradition of volunteerism, its need, importance, motivation and constraints; Shaman as part of volunteerism.	5
15	Citizenship, Constitution and Human Rights: Basic features of constitution of India, Fundamental rights and duties, Human rights, Consumer awareness and rights and Right to information.	5
16	Family and Society: Concept of family, Community (PRIs and other community-based organizations) and Society.	5
	Total =	**100**

Course No.: AEC-111	Course Title: National Cadet Corps-I (NCC-I)	Credit Hrs.: 1(0+1)

SYLLABUS

Objective: To integrate and develop qualities of leadership, discipline, character and patriotism and foster the NCC Motto: **"Unity and Discipline"** among the youth.

PRACTICAL

- Aims, Objectives, Organization of NCC and NCC Song. DG's Cardinals of Discipline.
- Drill- aim, General words of command, Attention, Stands-at-ease, Stand-easy and Turning.
- Sizing, Numbering, Forming in three ranks, Open and Close order march and Dressing.
- Saluting at the halt, Getting on parade, Dismissing and Falling-out.
- Marching, Length of pace and time of marching in quick/slow time and halt. Side pace, Pace forward and to the rear. Turning on the march and wheeling. Saluting on the march.
- Marking time, Forward march and halt. Changing step, Formation of squad and squad drill.
- Command and control, Organization, Badges of rank, Honours and Awards.
- Nation Building- Cultural heritage, Religions, Traditions and Customs of India. National integration. Values and ethics, Perception, Communication, Motivation, Decision making, Discipline and duties of good citizens. Leadership traits, Types of leadership. Character/ Personality development. Civil defence organization, Types of emergencies, Fire-fighting, Protection. Maintenance of essential services, Disaster management, Aid during development projects.
- Basics of Social Service, Weaker sections of society and their needs, NGO's and their contribution, Contribution of youth towards Social welfare and Family planning.
- Structure and Function of human body, Diet and Exercise, Hygiene and Sanitation. Preventable diseases including AIDS, Safe blood donation, First aid, Physical and mental health. Adventure activities. Basic principles of Ecology, Environmental conservation, Pollution and its control.

TEACHING SCHEDULE

PRACTICAL [AEC-111]

Exercise No.	Exercise Topic	Exercise Sub-topics	Weightage (%)
1-2	**Introduction to NCC**	Aims, Objectives, NCC Organizational structure, NCC Song, DG's Cardinals of Discipline.	4
3-5	**Drill Basics**	Aim of drill, General words of command, Positions of attention, Stand-at-ease and Stand-easy, Turning.	8
6-8	**Formation Drills**	Sizing, Numbering, Forming in three ranks, Open and Close order march and Dressing.	8
9-11	**Saluting Drills and Parade Movements**	Saluting at halt, Getting on parade, Dismissing and Falling-out.	8
12-14	**Marching Techniques**	Length of pace and time of marching in Quick/slow march, Side pace, Forward/rear pace, Turning on the march, Wheeling and Saluting on the march	10
15-17	**Squad Formation and Control**	Marking time, Forward march, Halt, Changing step, Formation of squad and Squad drill.	10
18-19	**Command and Control in NCC**	Organization, Badges of rank, Honours and Awards.	4
20-22	**Nation Building and Citizenship; Leadership**	Cultural heritage, Religions, Traditions, Customs of India, National integration, Values and Ethics, Communication, Leadership traits, Discipline and Motivation, Character/ Personality Development.	12
23-24	**Civil Defence and Emergency Management**	Types of emergencies, Fire fighting techniques, Maintenance of essential services, Disaster management and Aid during development projects, Civil Defence Organizations.	10
25-26	**Social Service and Youth Welfare**	Weaker sections of society, Role of NGOs, Youth participation in Social welfare and Family planning	8
27-29	**Health, Hygiene and First Aid**	Human body structure, Diet, Hygiene, Preventable diseases (including AIDS), Safe blood donation, First aid practices, Mental and Physical health.	10
30-32	**Environment and Ecology**	Basic Principles of Ecology, Environmental conservation, Pollution and its control, Adventure activities.	8
		Total =	**100**

Semester	**:**	**I**			
Course No.	**:**	**AEC-112**	**Credit Hrs.**	**:**	**2(1+1)**
Course Title	**:**	**Communication Skills**			
Gradial Common Course across all UG Degrees					

SYLLABUS

Objectives:(i) To acquire competence in oral, written and non-verbal communication,

(ii) To develop strong personal and professional communication and

(iii) To demonstrate positive group communication.

THEORY

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and Non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication. Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/Abstracting/Summarizing; Style of technical communication, Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions; Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; Phrases and clauses; Case: subjective case, possessive case, objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

PRACTICAL

Listening and note taking; Writing skills: précis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; Vocabulary building exercises; Interview techniques; Organization of events.

TEACHING SCHEDULE

THEORY [AEC-112]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1	**Communication Process: The Magic of Effective Communication**	Elements of Communication process such as Communicator, Message, Channel treatment of message, Audience and Audience response.	5
2	**Building Self-esteem and Overcoming Fears**	Points to build Self-esteem, Build social connections, Encourage yourself, Focus on solutions and Set realistic goals, Strategies to overcome fears, Practice, Visualise Success, Preparation, Know your audience, Seek feedback and Active listening.	5
3	**Communication**	Concept, Nature and Significance of Communication process	10
4		Meaning, Types and Models of communication	10
5		Verbal and Non-verbal communication, Linguistic and Non-linguistic communication	10
6		Barriers to communication and Reasons behind communication gap/ miscommunication	5
7	**Basic Communication Skills**	Listening, Speaking, Reading, Writing skills	5
8		Précis writing/ Abstracting/ summarizing- Styles of technical communication, Curriculum Vitae/resume writing	10
9		Innovative methods to enhance vocabulary, analogy questions	5
10	**Structural and Functional Grammar**	Sentence structure, modifiers, connecting words and verbal; Phrases and Clauses	5
11		Case: Subjective case, Possessive case, Objective case	5
12		Correct usage of nouns, Pronouns and Antecedents	5
13		Adjectives, Adverbs and Articles	5
14		Agreement of verbs with the subject: Tense, Mood, Voice	5
15		Writing effective sentences	5
16		Basic sentence faults	5
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [AEC-112]

Exercise No.	Exercise Topic/ Title
1	Listening and Note taking
2	Writing skills- Précis writing
3	Writing skills- Abstracting
4	Writing skills- Summarizing
5	Reading and Comprehension (written and oral) of general and technical articles
6	Micro-presentations
7	Impromptu presentations
8	Feedback on presentations
9	Stage manners- Grooming
10	Stage manners- Body language
11	Stage manners- Voice modulations, speed
12	Group discussions
13	Public speaking exercise
14	Vocabulary building exercises
15	Interview techniques
16	Organisation of events

Suggested Readings:

1. Allport, G W, 1937. Personality: A Psychological Interpretation. Holt, New York.
2. Brown Michele & Gyles Brandreth, 1994, How to Interview and be Interviewed. Sheldon Press, London.
3. Carnegie Dale, 1997. The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
4. Francis Peter S J, 2012. Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.
5. Kumar S and Pushpa Lata, 2011. Communication Skills. Oxford University Press.
6. Neuliep James W, 2003. Intercultural Communication- A Contextual Approach. Houghton Mifflin Co Boston.
7. Pease, Allan, 1998, Body Language. Sudha Publications, Delhi.
8. Raman M and Singh P, 2000. Business Communication. Oxford University Press.
9. Ray G L, 2008. Extension, Communication and Management. Kalyani Publishers, Ludhiana
10. Ray G. Land Mondal Sagar, 2012. Textbook on Rural Development Entrepreneurship and Communication Skills. Kalyani Publishers, Ludhiana.
11. Seely J, 2013, Oxford Guide to Effective Writing and Speaking. Oxford University Press.
12. Thomson A J and Martinet A V, 1977, A Practical English Grammar. Oxford University.

Semester	**:**	**I**		
Course No.	**:**	**MDC-111**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Farming-based Livelihood Systems**		
Gradial Common Course across all UG Degrees				

SYLLABUS

Objectives: (i) To make the students aware about farming-based livelihood systems in Agriculture,

(ii) To disseminate the knowledge and skills that how farming-based systems can be a source of livelihood.

THEORY

Status of Agriculture in India and different States, Income of farmers and rural people in India, Livelihood- Definition, Concept and Livelihood patterns in urban and rural areas, Different indicators to study livelihood systems. Agricultural Livelihood Systems (ALS): Meaning, approach, approaches and framework, Definition of farming systems and farming-based livelihood systems, Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems: Crops and cropping systems, Livestock, (Dairy, Piggery, Goatry, Poultry, Duckry etc.), Horticultural crops, Agroforestry systems, Aquaculture, Duck/Poultry-cum-Fish, Dairy-cum-Fish, Piggery-cum-Fish etc.; Small, medium and large enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country; Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems, Schemes and programs by Central and State Governments; Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing lifestyle.

PRACTICAL

Survey of farming systems and agriculture-based livelihood enterprises, Study of components of important farming-based livelihood models/systems in different agro-climatic zones, Study of production and profitability of crop based, livestock based, processing-based and integrated farming-based livelihood models, Field Visit of innovative farming system models. Visit of Agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models), Learning about concept of project formulation on farming-based livelihood systems along with cost and profit analysis, Case study of Start-Ups in agri-sectors.

TEACHING SCHEDULE

THEORY [MDC-111]

Lecture No.	Topic	Sub-topics/Key Points	Weightage (%)
1	Status of Agriculture in India	Historical background, Current status, Role of Agriculture in Indian Economy	4
2	Status of Agriculture in Different States	State-wise scenario, Major crops, Regional diversity	4
3	Income of Farmers and Rural People in India	Factors affecting income, Rural-urban income gap, Government initiatives	4
4	Livelihood: Definition, Concept, and livelihood Patterns in urban and rural areas	Livelihood-Definition and its Concept, Urban vs Rural livelihood patterns, Sources of income	4
5	Different Indicators to Study Livelihood Systems	Economic, Social and Environmental indicators, Measuring livelihood resilience	4
6	Agricultural Livelihood Systems (ALS): Meaning and Approaches	Definition, Significance of ALS, Integrated farming systems, Approaches	4
7	ALS Framework and Case studies	Framework for ALS, Case studies in India	4
8	Definition of Farming Systems and farming based Livelihood Systems	Definition and Role of farming systems in rural livelihoods, Examples of systems	4
9	Prevalent Farming Systems in India contributing to livelihood	Traditional vs. Modern farming systems, Regional differences	4
10	Types of Traditional and Modern Farming Systems	Types; Differences; Strengths, Limitations, Case studies	4
11	Components of farming system/farming-based livelihood systems - Crops and Cropping Systems	Components, Crop diversification, Cropping pattern, Mixed cropping, Importance for rural livelihoods	4
12	Livestock-based Farming Systems	Importance and Management of dairy, piggery, poultry, goatry, duckry, etc.	4
13	Horticultural Crops and Livelihoods	Role of fruits, vegetables and spices in rural income generation	4
14	Agroforestry Systems	Agroforestry- Definition, Combining trees and crops, Agroforestry models in India	2
15	Aquaculture as a Livelihood System	Importance of Aquaculture, Integrated systems (e.g. Duck/Poultry-cum-Fish, Dairy-cum-Fish, Piggery-cum-Fish etc.)	4
16	Challenges in Aquaculture-based Systems	Feasibility, Government support and Market access	2

Continued…

17	Small Enterprises in Farming	Role of small enterprises, Value addition, Local processing	2
18	Medium and Large Enterprises in Farming	Value chains, Secondary enterprises as livelihood components for farmers, Agri-processing.	2
19	Factors affecting Integration of various enterprises of farming for livelihood	Technology, Market access, Credit and infrastructure challenges etc.	4
20	Strategies for Enterprise Integration	Successful integration, Government policies, Examples.	2
21	Overview of Agro-Climatic Zones in India	Characteristics of different zones and their agricultural potential.	2
22	Feasibility of different Farming Systems for different Agro-Climatic Zones	Suitable farming systems for different zones, Climate adaptation.	2
23	Commercial Farming Based Livelihood Models by NABARD, ICAR and other organizations across the country	Role of NABARD, ICAR and other Organizations in promoting commercial models, Successful cases.	4
24	Case studies on different Livelihood Enterprises associated with farming	Analysis of successful enterprises, Dairy Cooperatives etc.	4
25	Risk Factors in Farming-based Livelihood Systems	Climate, Market fluctuations, Input costs; Mitigation strategies etc.	4
26	Success Factors in Farming-based Livelihood Systems	Innovation, Market access, Government support, Social capital etc.	2
27	Schemes and Programmes by the Central Government	Overview of schemes like, PM-KISAN, National Rural Livelihood Mission.	2
28	Schemes and programmes by State Governments	State-specific programs promoting rural livelihoods, Case examples.	2
29	Role of Private Sector in Livelihood Promotion	Public-Private Partnerships, Role of private agribusiness.	2
30	Public-Private Partnerships in Agriculture	Successful collaborations in rural development and farming systems	2
31	Farming-based Livelihoods in the 21st Century	Circular economy, Green economy, Climate change, Sustainability.	2
32	Impact of Digitalization and Changing Lifestyles	Technology in Agriculture, Future prospects for rural livelihoods.	2
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [MDC-111]

Exercise No.	Exercise Topic	Exercise Sub-topics/ Titles
1	Survey of Farming Systems and Agriculture-based Livelihood Enterprises	Methods of data collection; Field survey techniques; Preparing reports on surveyed farms.
2	Study of Components of Farming-based Livelihood Models in Different Agro-Climatic Zones	Components: Crop, livestock, fishery, agroforestry; Identifying models suited to specific zones.
3	Study of Production and Profitability of Crop-based Models	Analysis of input-output relations; Identifying profitable crops
4	Study of Livestock-based Models	Livestock systems: Dairy, poultry, goat farming; Profitability and market access
5	Study of Processing-based Models	Value addition in agriculture; Studying small-scale food processing units
6	Study of Integrated Farming-based Models	Study of crop-livestock-aquaculture integration; Synergies and challenges
7	Field Visit to Innovative Farming System Models	Visit to farms using modern technologies; Documenting practices
8	Visit to Agri-based Enterprises	Enterprises involved in input supply or value addition
9	Study of Functional Aspects: Integration of Production, Processing and Distribution	Backward and forward linkages; Assessing supply chain models
10	Agri-Enterprises in Industry and Service Sectors (Value Chain Models)	Studying value chain enterprises; Evaluating sustainability models
11	Concept of Project Formulation on Farming-based Livelihood Systems	Identifying project objectives; Structuring budgets and timelines
12	Cost and Profit Analysis of Farming-based Livelihood Projects	Developing Cost-Benefit analysis; Identifying Break-Even points
13	Case Study of Start-ups in Agri-sectors	Analysing real-world Start-ups; Identifying success factors
14	Group Project: Develop a Farming-based Livelihood Model	Formulating a working model; Feasibility and sustainability analysis
15	Preparation of Report on Farming Systems Survey and Livelihood Models	Compiling field data; Preparing reports with recommendations
16	Presentation and Evaluation of Practical Project Reports	Group presentations; Internal assessment of reports and participation

Suggested Readings [MDC-111]:

1. **Ashley, C., & Carney, D. (1999)**. *Sustainable Livelihoods: Lessons from Early Experience.* Department for International Development, London, UK.
    - **Relevance**: This book explores sustainable livelihood frameworks, which are key to understanding livelihood patterns and rural income systems.
2. **Agarwal, A., & Narain, S. (1989)**. *Towards Green Villages: A Strategy for Environmentally Sound and Participatory Rural Development.* Centre for Science and Environment, New Delhi, India.
    - **Relevance**: Provides strategies for participatory rural development, focusing on environmental sustainability—a core concept in farming systems.
3. **Carloni, A. (2001)**. *Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa.* FAO, Rome, Italy.
    - **Relevance**: Offers insights into global farming system challenges, with lessons that can be adapted for Indian contexts in agricultural development.
4. **Dixon, J., Gulliver, A., & Gibbon, D. (2001)**. *Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World.* FAO & World Bank, Rome & Washington, DC.
    - **Relevance**: Focuses on farming systems' role in poverty alleviation and rural livelihood improvement.
5. **Evenson, R.E. (2000)**. *Agricultural Productivity and Production in Developing Countries.* In *FAO, The State of Food and Agriculture.* FAO, Rome, Italy.
    - **Relevance**: Discusses agricultural productivity, a critical factor in sustainable farming and improved livelihoods.
6. **Bhatt, B.P., *et al.* (ICAR Research Complex for Eastern Region)**. *Livelihood Improvement of Underprivileged Farming Community: Experiences from Bihar.* Patna, Bihar.
    - **Relevance**: Case studies on improving livelihoods in rural India, relevant to learning about region-specific agricultural interventions.
7. **Panwar *et al.* (2020)**. *Integrated Farming System Models for Agricultural Diversification, Enhanced Income, and Employment.* Indian Council of Agricultural Research, New Delhi.
    - **Relevance**: Provides models for agricultural diversification and income enhancement, which align with farming system topics.
8. **Reddy, S.R. (2016)**. *Farming System and Sustainable Agriculture.* Kalyani Publishers, New Delhi.
    - **Relevance**: Covers sustainable agriculture principles and farming system models, essential for sustainable livelihood systems.
9. **Singh, J.P. *et al.* (2016)**. *Region Specific Synthesized Integrated Farming System Models for Improved Production, Profitability and Nutrition (Series-1).* Bulletin, ICAR-Indian Institute of Farming Systems Research, Modipuram, Meerut (U.P.).
    - **Relevance**: Discusses integrated farming models tailored to different agro-climatic regions of India, essential for practical learning.
10. **Walia, S.S., & Walia, U.S. (2020)**. *Farming System and Sustainable Agriculture.* Scientific Publishers, Jodhpur, Rajasthan.
    - **Relevance:** Provides insights into sustainable agricultural practices and integrated farming systems with regional focus.

Semester	**:**	**I**	
Course No.	**:**	**MATH-111***	**Credit Hrs. : 2(2+0) Need-based; G/NG**
Course Title	**:**	**Basic Mathematics**	
***Gradial** Need-based Common Course for **B.Tech. (Biotechnology)**; ***Non-Gradial** Need-based Common Course for **B.Tech. (Agril. Engg.)** & **B.Tech. (Food Technology)**			

SYLLABUS

Objectives:

(i) To study the basic principles and functions in mathematics like limits and continuity,

(ii) To study differentiation and integration,

(iii) To study matrices and determinants.

THEORY

Functions:

Function and types of functions, Limit: Introduction, left-handed and right-handed limits, Algebra of limits, Standard limits. Continuity: Definition of continuity, continuity of algebraic functions. Continuity of trigonometric and exponential functions.

Differentiation:

Differentiation by the first principle, Rules of Differentiation: sum, difference, product and quotient formulae, differentiation using the chain rule, differentiation of functions in parametric and implicit form, logarithmic differentiation, geometrical interpretation of derivative. Successive differentiation, maxima and minima.

Integration:

Definition of indefinite integrals, Integrals of elementary functions (Formulae only), Theorems of integration (without proof), Integration by substitution, integration by partial fractions, integration by parts, Definition of definite Integral with examples, properties of definite integral (without proof).

Matrices and Determinants:

Definition of determinants, example up to Third order determinant, properties of determinant (statements only), Definition of matrix, types of matrices, Algebra of Matrix (addition, subtraction and multiplication), inverse of matrix, Solution of linear equations by Crammer's rule.

TEACHING SCHEDULE

THEORY [MATH-111]

Lecture No.	Topic	Subtopics/ Key Points	Weightage (%)
1-5	**Functions:**	Definition of Function, Types of functions	15
		Some Basic Functions: Definition and Properties of: Constant Function, Identity Function, Power Function. Polynomial Function, Linear, quadratic and cubic function, Radical Function, Rational Function. Exponential, Logarithmic and Trigonometric Function	
	Limit:	Introduction, Definition of Limit, Left-handed and Right-handed limits, Algebra of limits	
		Standard limits: Method of Factorization, Rationalization, Limit of Trigonometric, Exponential Logarithmic and Functions. Limit of Infinity	
	Continuity:	Definition of continuity, Continuity of algebraic functions, Continuity of trigonometric and exponential functions.	
6 -15	**Differentiation:**	Definition, Differentiation by the first principle, Derivative of some standard functions (Formulae only), Rules of Differentiation (Sum, Difference, Product and quotient without proof), Differentiation using the chain rule, Differentiation of functions in parametric and implicit form, Logarithmic Differentiation, Successive differentiation, Maxima and minima	30
16 -25	**Indefinite and Definite Integration**:	Definition of indefinite Integral, Integrals elementary functions (Formulae only) Theorems of integration (without proof) Methods of Integration: Integration by Substitution, Integration by parts, Integration by partial fractions Some special integrals formulae only. Definition of definite Integral with examples Properties of definite integral (without proof)	30
26 -32	**Determinants and Matrices:**	Definition of determinants, Expansion up to third order determinant, Properties of determinant (Statements only) Definition of matrix, Order of Matrix, Types of matrices, Algebra of Matrices, Inverse of matrix by elementary transformations, Solution of linear equations by Crammer's rule	25
		Total=	**100**

Suggested Readings:

1. NCERT, 2012, Mathematics of Class XII, NCERT, India.
2. A Textbook of Mathematics XI and XII (Part I and II) Maharashtra State Board of Secondary and Higher Secondary Education, Pune.
3. Sharma RD, 2014, Mathematics of Class XII, Dhanpat Rai Publisher.

Semester	**:**	**I**		
Course No.	**:**	**BOT-111****	**Credit Hrs. : 2(2+0)**	**Need-based; G/NG**
Course Title	**:**	**Basic Botany**		

**Need-based Common Course among 3 UG Degrees:

B.Tech. (Biotech.) - Gradial / B.Sc. (Hons.) A.B.M. - Gradial / B.Tech. (Food Tech.) - Non-Gradial

SYLLABUS

Objectives:
i. To study the basic taxonomy and classification of plants,
ii. To study the features of plant kingdom and morphology,
iii. To study the internal structures of plants.

THEORY

Plant Kingdom and Features of each group. Plant taxonomy, Systems of classification. Morphology, Modifications and Functions of Root, Stem, Leaf, Flower and Inflorescence. Pollination and Fertilization. Fruit types. Structure of dicot and monocot seed, and seed germination. Cell structure. Chromosome, DNA and Genes. Cell and tissue types. Internal structure of root, stem and leaf. Characteristics and economic importance of Poaceae, Brassicaceae, Fabaceae, Malvaceae, Rutaceae, Rosaceae, Asteraceae and Solanaceae families.

TEACHING SCHEDULE

THEORY [BOT-111]

Lecture No.	Topics	Sub-topics/ Key Points	Weightage (%)
1-3	**Plant Kingdom and Features:**	Classification of Plant Kingdom (Major plant groups: Bryophytes, Pteridophytes, Gymnosperms, and Angiosperms.) Key distinguishing features/ characteristics of each group with examples. Plantae Kingdom.	8
4-5	**Plant Taxonomy and Systems of Classification:**	Binomial nomenclature and other systems of classification (in brief)	5
6-7	**Plant Cell and Tissue Types:**	Basic Structure of a Plant Cell and Tissue, Types of Plant Cells and Tissues; Plant Cell Functions.	8
8-9	**Chromosome:**	Definition and Overview, Chemical Composition; Chromosome Morphology, Types of Chromosomes**.**	8

Continued…

10-11	**DNA:**	Brief historical overview of DNA discovery, Watson-Crick model of DNA, Chemical composition, Components of a nucleotide, Structures of Purines and Pyrimidines.	8
12	**Genes:**	Definitions (Gene, Allele, Genotype, Phenotype, Exon, Intron, Codon) and Historical Overview; Structure: Basic layout of a gene- (Exon, Intron, etc.); Types of genes, Codons (Start/ Stop).	8
13-14	**Pollination and Fertilization:**	Definitions/Terminology, Types, Agents of pollination, Processes/Events, Significances, Barriers to Fertilization, Differences between their types.	10
15-16	**Root and Stem:**	Morphology, Modifications with examples and Functions	8
17-19	**Leaf, Flower and Inflorescence:**	Morphology, Modifications with examples and Functions	8
20	**Fruits:**	Types of fruits with examples	3
21-22	**Structures of Monocot and Dicot Seeds:**	Structure, Diagrams, Differences	5
23-24	**Seed Germination:**	Definitions, Types, Differences and Stages of seed germination	5
Plant taxonomy-Classification; Characteristics and Economic Importance; Members/ Examples of following Families viz.,			
25-26	Poaceae and Brassicaceae		4
27-28	Fabaceae and Malvaceae		4
29-30	Rutaceae and Rosaceae		4
31-32	Asteraceae and Solanaceae		4
		Total=	**100**

Suggested Readings [BOT-111]:

1. Bendre AM and Kumar A, 1999, Textbook of Practical Botany. Vol. 2, 7th Edn, Rastogi Publications.
2. Bendre AM and Pande PC, 2009, Introduction to Botany, Rastogi Publications.
3. Bhatia KN and Tyagi MP, 2020, Elementary Biology. A Truemen Publication.
4. David M Hillis, H Craig Heller, Sally D Hacker, David W Hall, David E Sadava, 2020. (eBook) Life: The Science of Biology, 12th Edn, Sunderland Publication.
5. Dutta AC, 1995, A Class-Book of Botany, 16th Edn, Oxford University Press.
6. NCERT, 2021. Biology of Class XI. NCERT, India.
7. Pande PC and Jain DK, 2022, A Textbook of Botany Angiosperm. S. Chand Publications.

Semester	**:**	**I**	
Course No.	**:**	**BT-111**	**Credit Hrs : 3(3+0)**
Course Title	**:**	**Molecular Biology**	

SYLLABUS

Objectives:

(i) To study the principles and techniques of Molecular Biology.

(ii) To study the Central dogma of life.

(iii) To study the tools in Molecular Biology.

THEORY

History of Molecular Biology. Central Dogma of Life. Structures of DNA and RNA. Gene structure and function. DNA replication and transcription. Genetic code and translation. Structure of prokaryotic and eukaryotic nuclear, and organelle genomes. Gene regulation in prokaryotes. *Lac* Operon concept and *Tryp* Operon concept. Introduction to Microbial Genetics; Conjugation, transformation and transduction. Tools in Molecular Biology. Role of enzymes in Molecular Biology. Principles of Polymerase Chain Reaction and Electrophoresis.

TEACHING SCHEDULE

THEORY [BT-111]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
Unit-I			
1	**History of Molecular Biology**	Concept, Historical evidences and prospects	2
2-3	**Central Dogma of Life**	Concept Evidences for DNA as the genetic material- the transformation experiments.	6
4-7	**Structures of DNA and RNA**	History, Watson and Crick model of DNA, Structure of DNA and RNA; its types and function of nucleic acids (DNA and RNA).	6
8-9	**Gene Structure and Function**	Gene: Gene concept, Unit of function, One gene - one enzyme hypothesis	3
10-14	**DNA Replication**	Outline of DNA replication, Meselson and Stahl experiment, Mechanism of DNA replication in prokaryotes and eukaryotes.	8
15-17	**Transcription**	Prokaryotic and Eukaryotic transcription.	6
18-19		Post-transcriptional modifications mechanism.	3

Continued…

20-21	**Genetic Code**	Amino acids involved in Protein synthesis, Characteristics of Genetic code *viz*; Triplet code, Non-overlapping, Comma less, Polarity, Codons and anticodons, Initiation codons, Termination codons, Degenerate and universal, Wobble hypothesis.	4
22-24	**Translation**	Prokaryotic and Eukaryotic translation	6
25-26		Post-translational modification mechanism	2
Unit-II			
27-29	**Prokaryotes and Eukaryotes Nuclear and Organelle Genomes**	Genome organization in Prokaryotes and Eukaryotes, Special features of eukaryotic gene structure and organization, Genome organization of mitochondria and chloroplast.	6
30-31	**Gene Regulation in Prokaryotes**	Concept of Operon, *Lac* Operon and *Tryptophan* Operon.	6
32-34	**Introduction to Microbial Genetics**	Scope and development, Recombination in bacteria and viruses, Conjugation, Transformation, Transduction- generalized and specialized.	8
Unit-III			
35-36	**Tools in Molecular Biology**	Types, nomenclature, characteristics and uses of restriction endonucleases	6
37-38	**Role of enzymes/ DNA Modifying Enzymes in Molecular Biology**	Nuclease, Ligases, Polymerase, Topoisomerase, Alkaline phosphatase etc.	4
39-41	**Vectors**	Concept, Properties and Vectors i.e. Plasmid (pBR 322, pUC 18/19, Bacteriophage and Cosmid.	8
42-43		Construction of Genomic and c-DNA Libraries.	4
44-46	**Principles of Polymerase Chain Reaction**	Concept, Components, Procedure and Applications of PCR.	7
47-48	**Principles of Electrophoresis**	Principles and its Types *viz*; SDS-PAGE, Agarose gel and 2D Electrophoresis.	5
		Total=	**100**

Suggested Readings [BT-111]:

1. Lewin B, 2017, Gene XII, Oxford University Press.
2. Cooper GM and Hausman RE, 2018, The Cell: A Molecular Approach. Sinauer Associates Inc, 8th Edn.
3. Nelson DL and Cox MM, 2017, Lehninger Principles of Biochemistry, 7th Edn, W. H. Freeman.
4. Satyanarayana U and Chakrapani U, 2021, Essentials of Biochemistry, Elsevier.

Semester	**:**	**I**	
Course No.	**:**	**BT-112**	**Credit Hrs. : 3(3+0)**
Course Title	**:**	**Introductory Cell Biology**	

SYLLABUS

Objectives:

(i) To understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.

(ii) To understand how these cellular components are used to generate and utilize energy in cells.

(iii) To understand the cellular components underlying mitotic cell division.

(iv) To apply the basic knowledge of cell biology to selected examples of changes or losses in cell function that include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

THEORY

Origin and evolution of cell. Introduction to microscopy. Sub-cellular structure of prokaryotic and eukaryotic cells. Membrane structure and function: Plasma membrane, cell wall and extracellular matrix. Structural organization and function of intracellular organelles and organelle biogenesis. Nucleus, Mitochondria, Endoplasmic reticulum, Golgi apparatus, Lysosomes, Peroxisomes, Plastids and Vacuoles. Structure and function of the cytoskeleton and its role in motility. Cell membrane transport. Introduction to cell signaling. Cell growth, Cell cycle and its control. Cell death and cell renewal.

Suggested Readings [BT-112]:

1. Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P. 2008. Molecular Biology of the Cell. 5th Ed. Garland Science/ Taylor and Francis Group.
2. Lodish H, Berk A, Kaiser CA, Krieger M, Bretscher A, Ploegh H, Amon A & Scott MP. 2012. Molecular Cell Biology. WH Freeman.
3. Sadava DE. 1993. Cell Biology: Organelle Structure and Function. Jones and Bartlett Publishers
4. Verma PS and Agarwal VK, 2016, Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S Chand and Sons.
5. Cooper GM and Hausman RE, 2018, The Cell: A Molecular Approach. Sinauer Associates Inc.

TEACHING SCHEDULE

THEORY [BT-112]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
Unit-I			
1-2	**Origin and Evolution of Cell**	a. Evolution of molecules and first cell b. Evolution from Prokaryotes to Eukaryotes c. Evolution of single cells to multicellular organisms d. Cell theory	4
3-4	**Introduction to Microscopy**	Principles and Applications of ~ a. Light microscopy- b. Compound microscopy-	4
5-8		Principles and Applications of ~ c. Phase contrast microscopy d. Dark-field microscopy e. Fluorescence microscopy f. Differential interference microscopy g. Confocal laser scanning microscopy (CLSM) h. Electron microscopy	6
9-11	**Sub-cellular Structure of Prokaryotic and Eukaryotic Cells**	a. Sub-cellular structure of prokaryotic cells b. Sub-cellular structure of eukaryotic cells c. Differences between Prokaryotic and Eukaryotic cells	4
12-14	**Membrane Structure and Function - Plasma membrane**	a. Origin of plasma membrane b. Chemical composition of Plasma membrane (lipids, proteins, carbohydrates) c. Different models of plasma membrane structure d. Functions of plasma membrane	8
15-17	**Cell wall and Extracellular matrix**	a. Cell wall composition and structure: Prokaryotic and Eukaryotic b. Functions of cell wall c. Cell-cell junctions, cell adhesion and extracellular matrix.	4
18-20	**Structural Organization; Functions of Intracellular Organelles and Organelle Biogenesis:**	a. Structural organization and function of intracellular organelles and organelle biogenesis b. Structure and Functions of Nucleus	6
21-22		Structure and Functions of Plastids	8
23-24		Structure and Functions of Mitochondria	
25-26		Structure and Functions of Endoplasmic reticulum	8
		Structure and Functions of Golgi apparatus	
		Structure and Functions of Lysosomes, Peroxisomes, Vacuoles.	2

Continued…

Unit-II			
27-28	**Structure and Functions of Cytoskeleton and its Role in motility**	a. Origin of cytoskeleton b. Cytoskeleton structure- Microtubules, Microfilaments and Intermediate filaments	4
29-30		c. Cilia and centrioles d. Function of cytoskeleton and its role in motility	4
31-34	**Cell Membrane Transport**	a. Principles of membrane transport b. Active transport and its types c. Passive transport and its types d. Transporter, Channels: Types and function	8
35-39	**Introduction to Cell Signaling**	a. General principles of signaling b. Stages of cell signaling c. Types of cell signaling d. Signaling molecules e. Receptor and its types f. Functions of cell surface receptors	10
40-41	**Cell Growth, Cell Cycle and its Control**	a. Overview of Cell cycle	4
42-43		b. Mitosis and Cytokinesis c. Meiosis	4
44-45		d. Components of cell cycle control system e. Regulation of cell cycle	4
46-47	**Cell Death and Cell Renewal**	a. Programmed cell death/ Apoptosis	4
48		b. Cell renewal: stem cells and maintenance of adult tissues	4
		Total =	**100**

Semester	**:**	**I**	
Course No.	**:**	**BT-113**	**Credit Hrs. : 3(3+0)**
Course Title	**:**	**Fundamentals of Genetics**	

SYLLABUS

Objectives:

i. To study the history of Genetics,
ii. To study the principles of inheritance and variation,
iii. To study chromosomes and cell division,
iv. To study the genetic basis of traits.

THEORY

History of Genetics. Mendel's principles and rediscovery. Cell division. Chromosomes structure and function. Chromosomal theory of inheritance. Sex-linked, sex-limited and sex-influenced inheritance. Sex determination and sex differentiation. Multiple allelism. Linkage and crossing-over. Gene-gene interaction. Genetic analysis in prokaryotes and eukaryotes. Extra chromosomal inheritance. Mutations. Hardy-Weinberg law. Quantitative inheritance. Genetic basis of evolution. Introduction to Human Genetics.

Suggested Readings (BT-113):

1. Singh B. D., Fundamentals of Genetics, Kalyani Publication, New Delhi.
2. Phundan Singh, Elements of Genetics, Kalyani Publication, New Delhi.
3. Gardner E. J., Simmons M. J., Snustad D. P., 1991, Principle of Genetics, Wiley India (P) Ltd.
4. Brah G. S., 2014, Animal Genetics: Concepts and Implications, 2nd Edn., Kalyani Publication, New Delhi.

TEACHING SCHEDULE

THEORY [BT-113]

Lecture No.	Topic	Subtopics/ Key Points	Weightage (%)
Unit-I			
1-2	**History of Genetics**	Pre-Mendelian, Mendelian and Post-Mendelian era	4
3-5	**Mendel's Principles and Rediscovery**	Law of dominance, Law of segregation, Law of independent assortment, Reasons of Mendel's success and Mendelian deviations	4
6-9	**Cell Division**	Mitosis definition, Stages of mitosis and Importance of mitosis, Meiosis definition, Stages of meiosis and Significance of meiosis	4
10	**Chromosome Structure and Function**	Morphological structure, Chemical composition and function	4
11-12		**Models of chromosomes structure:** Multi-stranded model, Folded fiber model and Nucleosome solenoid model. **Special chromosomes:** Lampbrush chromosome, Salivary gland chromosome or Giant chromosome.	4
13	**Chromosomal Theory of Inheritance**	Chromosomal theory of inheritance	4
14-16	**Sex-linked, Sex-limited and Sex-influenced inheritance**	Sex-linked, Sex-limited and Sex-influenced inheritance: Definitions, Brief explanations, Examples.	4
17-18	**Sex Determination and Sex Differentiation**	Sex determination and Sex differentiation- Definitions, Brief explanations, Examples.	4
Unit-II			
19	**Multiple Allelism**	**Multiple alleles**: Def'n, Characters of multiple alleles, Examples: Blood groups, Rh factor in humans	4
20-21	**Linkage and Crossing Over**	**Linkage:** Def'n, History, Types of linkage; complete and incomplete linkage **Detection of linkage:** Detection in test cross generation, Detection in F_2 generation	4
22		**Crossing over:** Def'n, Factors affecting recombination frequency, Cytological basis of crossing over	4
23		**Crossing over:** Crossing over in four-strand stage, Relationship between chiasma and crossing over, Molecular mechanisms of c.o., Linkage maps and Linkage groups	4
24-26	**Gene Interaction**	**Gene interaction and its types:** Def'n, Types of gene interactions and allelic gene interactions; Complete dominance, Incomplete dominance, Codominance	6
27-29		**Gene interaction and its types:** Non-allelic, Supplementary, Masking, Complementary gene interactions etc.; Molecular basis of gene interaction	6

Continued…

30-31	**Genetic Analysis in Prokaryotes and Eukaryotes**	Genetic analysis in prokaryotes and eukaryotes (in brief)	4
32	**Extrachromosomal Inheritance**	**Extrachromosomal inheritance:** Definition and Characteristic features of cytoplasmic inheritance with example of *Mirabilis jalapa*, Inheritance of mitochondrial DNA and chloroplast DNA	4
33		**Extra chromosomal inheritance:** Genetic maternal effect with examples of shell coiling in snails, kappa particles in paramecium, inheritance due to parasites, symbionts and viruses	4
34	**Mutation**	**Mutation:** Definition, History, Characters of mutation, Classification of mutation, Spontaneous mutation, Induced mutation,	4
35		**Mutation:** Molecular basis of mutation, Mutator, Antimutator genes and Mutable genes, Suppressor mutation and its Mechanism (Definitions, Brief emphasis)	4
36		**Mutagens and their types with e.g.:** Physical mutagens, Chemical mutagens, Mutation induction and detection, Applications of mutation	4
37	**Hardy-Weinberg Law**	**Hardy-Weinberg Law:** Gene frequency genotype frequency, Gene pool, Random union of gametes, Random mating among genotypes	**2**
38- 39		**Hardy-Weinberg Law:** Hardy-Weinberg equilibrium, Equilibrium for one gene with two alleles, Equilibrium for one gene with multiple alleles, Equilibrium for two genes	4
40-41	**Quantitative Inheritance**	**Quantitative inheritance:** Multiple factor hypothesis, Characters of quantitative traits and their inheritance, Effects of environment on quantitative traits	4
42-45	**Introduction to Human Genetics**	**Introduction to Human Genetics:** Man the organism, Cytogenetics of man: Chromosome banding chromosome aberration. Genetics studies, Genetic diseases, Blood groups, Disputed Parentages	4
46-48	**Genetic Basis of Evolution**	**Genetic basis of evolution and Origin of species:** Theories of evolution: Lamarckism, Darwinism, Mutation theory, Neo-Darwinism.	2
		Total=	**100**

List/ Bouquet of Skill Enhancement Courses (SECs):

Sr. No.	Course No.	Course Title	Credit Hrs.
1.	**SEC-xxx**	Practices in Plant Tissue	2(0+2)
2.	**SEC-xxx**	Laboratory Management and Instrumentation	2(0+2)
3.	**SEC-xxx**	*(To be added)*	2(0+2)
4.	**SEC-xxx**	*(To be added)*	2(0+2)

Note: Skill Enhancement Courses can be added/ offered as per the facilities and resources available at the respective universities/colleges based on the relevance to the region and the UG degree subject.

The detailed course-wise syllabus of above or other relevant SEC courses can be primarily developed and followed at College/ University level in the academic year, 2024-25; However, the same will be obtained from the respective UG Degree Coordinator/ Discipline Coordinators and can be followed w.e.f. AY, 2025-26.

[Above list is an indicative list/bouquet of SEC courses and subject to modification as applicable therein]

Semester	**:**	**I**	
Course No.	**:**	**SEC-xxx**	**Credit Hrs : 2(0+2)**
Course Title	**:**	**Practices in Plant Tissue Culture**	

SYLLABUS

Objectives:

(i) This course aims at imparting hands-on training on the calculation of per cent solutions, molarity, molality, normality; and preparation of buffers.

(ii) To study basic equipments used in Plant Molecular Biology and Cell Culture Laboratories; washing, packing and sterilization of glass and plastic wares for cell culture.

(iii) To study preparation of media and reagents for cell culture, primary culture technique, culturing and sub-culturing of continuous cell lines, viability assay by trypan blue dye exclusion method, micropropagation, haploid production, embryo rescue, cryopreservation of primary cultures and cell lines.

(iv) To prepare the phytohormones and their sterilization.

(v) To study Tissue Culture Laboratory management.

PRACTICAL

Laboratory safety and aseptic techniques, sterilization methods for equipment and media, media preparation, preparation of solid and liquid media, pH adjustment and sterilization of media. Culture initiation and explant selection. Selection of explants; meristem, node, leaf, embryo etc. Surface sterilization of plant material. Techniques for explant preparation and inoculation on to culture media. Callus induction and subculture. Subculture techniques: transfer of cultures to fresh media, monitoring and maintenance of cultures, organogenesis and embryogenesis. Micropropagation. Genetic transformation. Cryopreservation and conservation.

Project Work: Students design and conduct of a small-scale tissue culture project. (Students will choose a plant species, select appropriate explants, culture them *in vitro*, and document the progress and results).

TEACHING SCHEDULE

[Practices in Plant Tissue Culture]

PRACTICAL

Exercise No.	Exercise Title
1-2	Laboratory safety and aseptic techniques
3-5	Preparation of Standard Solution: (Percent solutions, molarity, molality, normality and preparation of buffers)
6-8	Media preparation: Solid and liquid media and pH adjustment
9-10	Sterilization methods for equipments and media
11-12	Culture initiation and explant selection: meristem, node, leaf, embryo etc.
13-14	Surface sterilization of plant material; Techniques for explant preparation and Inoculation on to the culture media.
15-16	Callus induction and subculture to the fresh media
17-18	Micropropagation: a) Organogenesis b) Embryogenesis
19-20	Monitoring and Maintenance of cultures
21-22	Demonstration of genetic transformation techniques
23-24	Demonstration of cryopreservation and conservation techniques
25-30	Project Work – Micropropagation studies: (Ornamental, Horticultural and Medicinal Plants)
31-32	Visit(s) to Commercial Plant Tissue Culture Units

Note: Project work tasks may be conducted from start to end of the semester with group of 10-20 students.

Suggested Readings [SEC-111]:

1. Bhojwani SS and Razdan MK, 1996, Plant Tissue Culture: Theory and Practice, Elsevier.
2. Reinert J and Bajaj YPS (Ed), 1989, Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture, Springer-Verlag.

Semester : I		
Course No. : SEC-xxx	**Credit Hrs : 2(0+2)**	
Course Title : Laboratory Management and Instrumentation		

SYLLABUS

Objectives:

(i) To study the establishment and management of different molecular biology laboratories.

(ii) To impart hands-on training on good laboratory practices, calculation of per cent solutions, molarity, molality, normality; and preparation of buffers.

(iii) To study basic equipments used in Plant molecular biology and cell culture laboratories, record keeping, teamwork, and SOP of different instruments of the labs.

(iv) Safe disposal of laboratory chemicals and reagents as per the biosafety guidelines.

PRACTICAL

Importance of laboratory safety and regulatory compliance. Quality management systems: ISO9001, GLP, GMP, laboratory safety and regulatory compliance. Risk assessment and hazard identification. Inventory management and equipment maintenance. Principles of laboratory inventory management. Equipment calibration and preventive maintenance. Documentation and record-keeping for regulatory compliance. Quality assurance and control. Introduction to quality assurance (QA) and quality control (QC). Quality control checks for laboratory reagents and instruments, Troubleshooting common laboratory errors and deviations.

Spectroscopy and spectrophotometry, applications in quantitative analysis and molecular biology. Chromatography techniques, microscopy and imaging. Molecular biology techniques. Instrumentation project : students design and conduct a small-scale project using one of the laboratory instruments covered in the course. They will collect data, analyze results, and present their findings.

TEACHING SCHEDULE

[Laboratory Management and Instrumentation]

PRACTICAL

Exercise No.	Exercise Title
1-2	General Laboratory Safety Rules and Laboratory Compliance
3-4	Quality Management Systems: ISO 9001, GLP and GMP
5-6	Risk assessment and Hazard identification; Principles of laboratory inventory management.
7	Calibration of Weighing balance, pH meter and Micropipettes
8	Documentation and Record-keeping for Regulatory Compliance.
9	Calculations of Per cent Solutions, Molarity, Molality, Normality etc.
10	Preparation and Quality Control Checks for laboratory Reagents and Standards.
11-13	Determination of the Concentration of DNA, RNA and Proteins in Solutions by Spectrophotometer.
14-15	Separation and Identification of Amino acids/ Sugars by Paper Chromatography/ TLC.
16-17	Observation of Microorganisms: Bacterial cell identification by Gram staining
18-26	Extraction of Plant Genomic DNA, Plasmid DNA and Agarose gel electrophoresis, Restriction Digestion, PCR and Agarose gel electrophoresis of PCR products
27-32	**Instrumentation Project:** DNA isolation from different crops/ microbes/ animal cells/ blood, Chromatography, Spectrometry, PCR-based project etc.

Suggested Readings:

1. Gakhar S K, Miglani M and Ashwani K, 2013, Molecular Biology: A Laboratory Manual, ISBN: 9789382332305.
2. Fulekar MH and Pandey B, 2013, Bioinstrumentation, ISBN: 9789382332398.
3. Green MR and Sambrook J, 2012, Molecular cloning: A Laboratory Manual 4th Ed, Cold, Spring Harbor.
4. Rapley R and Whitehouse D, (Eds), 2015, Molecular Biology and Biotechnology, Royal Society of Chemistry.
5. Kreuzer H and Massey A, 2008, Molecular Biology and Biotechnology: A Guide for Students, 3rd Edn., ASM Press.

Course Curriculum of Second Semester as per the ICAR-Sixth Deans' Committee Report for the Academic Programmes in

BIOTECHNOLOGY

- UG-Certificate in Biotechnology
- UG-Diploma in Biotechnology
- UG-Degree: B.Tech. (Biotechnology)

Mahatma Phule Krishi Vidyapeeth, Rahuri

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani

Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli

Maharashtra Agricultural Universities Examination Board, Pune

Compiled & Submitted by

Dr. Anil A. Kale

Incharge, State-level Biotechnology Centre, MPKV, Rahuri.

UG Degree Syllabus State Coordinator

with

UG Degree Syllabus Discipline Coordinators &

DICC - UG Degree Syllabus Core Committee

Submitted to the

Directors of Instruction Coordination Committee

~ w.e.f. AY, 2024-25 ~

Course Curriculum of Second Semester as per the ICAR-Sixth Deans' Committee Report for Academic Programmes in BIOTECHNOLOGY

Course Layout

B.Tech. (Biotechnology)

Semester: II (New) ***w.e.f.*** **Academic Year: 2024-25**

Sr. No.	Course No.	Course Title	Credit Hrs.	Remark (if any)
1.	**AEC-123**	National Service Scheme (NSS-II)/ National Cadet Corps (NCC-II)	1(0+1)	--
2.	**AEC-124**	Personality Development	2(1+1)	--
3.	**MDC-122**	Entrepreneurship Development and Business Management	3(2+1)	--
4.	**VAC-121**	Environmental Studies and Disaster Management	3(2+1)	--
5.	**BT-124**	Introduction to Biotechnology	3(3+0)	--
6.	**BT-125**	Elementary Microbiology	2(1+1)	--
7.	**PB-121**	Introduction to Plant Breeding	3(2+1)	--
8.	**SEC-123**	Skill Enhancement Course-III[#] (Basic Techniques of Molecular Biology and Biotechnology)	2(0+2)	--
9.	**SEC-124**	Skill Enhancement Course-IV[#] (Bioinformatics and Biocomputation)	2(0+2)	--
		Total Credits Hrs.	**21(11+10)**	**G**
AEC: Ability Enhancement Course, **MDC**: Multidisciplinary Course, **SEC**: Skill Enhancement Course, **VAC**: Value Added Course, **G**: Gradial				
Post-II Semester (Only for Exit option for award of UG-Certificate)				
10.	**INT-121**	Internship (10 Weeks)	10(0+10)	--

Semester	**:**	**II**	
Course No.	**:**	**AEC-123**	**Credit Hrs. : 1(0+1)**
Course Title	**:**	**National Service Scheme-II (NSS-II)/ National Cadet Corps-II (NCC-II)**	
Gradial Common Course across all UG Degrees			

Course No.: AEC-123	**Course Title: National Service Scheme-II (NSS-II)**	**Credit Hrs.:1(0+1)**

SYLLABUS

Objectives :

(i) To evoke social consciousness among students through various activities viz., working together, constructive and creative social work,

(ii) To be skilful in executing democratic leadership and developing skill in program,

(iii) To be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

PRACTICAL

Importance and role of youth leadership. Meaning, types and traits of leadership, qualities of good leaders; Importance and roles of youth leadership, Life competencies. Definition and importance of life competencies, Problem-solving and Decision-making, Interpersonal communication. Youth development programs Development of youth programs and policy at the national level, state level and voluntary sector; Youth-focused and youth-led organizations Health, hygiene and sanitation. Definition Needs and Scope of health education; Role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; National health programs and reproductive health. Youth health, lifestyle, HIV-AIDS and first aid. Healthy lifestyles, HIV-AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths and misconceptions about yoga; Yoga traditions and its impacts, Yoga as a tool for healthy lifestyle, preventive and curative method.

TEACHING SCHEDULE

PRACTICAL [AEC-123 / NSS-II]

Exercise No.	Topic	Exercise Title/ Sub-topics
1	**Orientation on NSS**	Introduction to NSS, its Objectives, History and Role in community service.
2	**Youth Leadership**	Discuss the importance and role of youth leadership, types and traits of leadership and qualities of good leaders.
3	**Life Competencies**	Understanding life competencies, their importance and Practical exercises in problem-solving and decision-making.
4	**Interpersonal Communication**	Practice exercises to improve interpersonal communication skills, Focusing on active listening and effective communication.
5	**Youth Development Programs**	Overview of youth development programs, Policies at national and state levels and Understanding youth-led organizations.
6	**Health, Hygiene, and Sanitation**	Practical activities on the importance of hygiene and sanitation, including Swachh Bharat Abhiyan tasks.
7	**Nutrition and Health Education**	Discuss the role of food, nutrition, and safe drinking water in health; Explore the impact of waterborne diseases.
8	**National Health Programs**	Introduction to key national health programs and their roles in promoting public health and awareness on reproductive health.
9	**Youth Health and Lifestyle**	Sessions on healthy lifestyle choices including exercise, balanced diet and stress management.
10	**HIV/AIDS Awareness**	Educational activities on HIV/AIDS, its prevention, and reducing stigma; Awareness on reproductive health.
11	**Substance Abuse Awareness**	Discussing the dangers of drug and substance abuse, its impact on health and practical ways to prevent addiction.
12	**First Aid and Home Nursing**	Hands-on training in first aid techniques including handling injuries, CPR basics and home nursing care.
13	**Introduction to Yoga**	Introduction to the History, Philosophy and various Traditions of Yoga as a Holistic health practice.
14	**Yoga Practice**	Practical Yoga Sessions focusing on Asanas, Pranayama and Meditation for a healthy lifestyle.
15	**Yoga as Preventive and Curative Tool**	Understanding and Practicing Yoga as a preventive and curative approach for physical and mental health.
16	**Reflection on NSS and Youth Development**	Group Discussion and Reflection on the role of NSS in community building and personal growth, Focusing on youth leadership.

Course No.: AEC-123	Course Title: National Cadet Corps-II (NCC-II)	Credit Hrs.:1(0+1)

SYLLABUS

Objectives: (i) To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen,

(ii) To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation.

PRACTICAL

Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice-versa. Guard mounting, Guard of honor, Platoon/Coy Drill. Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding. Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG. Introduction to map, scales, and conventional signs. Topographical forms and technical terms. The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs. Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

TEACHING SCHEDULE

PRACTICAL (AEC-123/ NCC-II)

Exercise No.	Topic	Exercise Title/ Sub-topics
1	**Basic Arms Drill**	Attention, stand at ease, stand easy, getting on parade, dismissing and falling out.
2	**Advanced Arms Drill**	Ground/take up arms, examine arms, shoulder from the order and vice versa.
3	**Saluting with Arms**	Saluting at the shoulder both at a halt and while on the march.
4	**Rifle Handling Techniques**	Short/long trail from the order and vice-versa, guard mounting and guard of honor procedures.
5	**Platoon and Company Drill**	Practice and demonstration of platoon and company drill formations.
6	**Rifle Characteristics and Handling**	Characteristics of rifles (.22/.303/SLR), ammunition, firepower, and basic care, cleaning and sight setting.
7	**Rifle Operations and Safety**	Loading, cocking, unloading, safety procedures; lying position, trigger control and firing a shot.
8	**Range Procedures and Target Practice**	Range procedures, aiming, sight alteration, theory of groups, snap shooting and firing at moving targets.
9	**Map Reading Basics**	Introduction to maps, scales, conventional signs, topographical forms and the grid system.
10	**Advanced Map Skills**	Relief, contours, gradients, cardinal points, bearings, and use of the service protractor.
11	**Field Navigation with Compass**	Use of prismatic compass, setting a map, finding north, positioning, map-to-ground and ground-to-map.
12	**Field Engineering Skills**	Knots and lashings, camouflage, handling explosives, IEDs, field defenses, obstacles and mines.
13	**Watermanship and Field Water Supplies**	Bridging techniques, field water supplies, track construction and distance judgment.
14	**Target Recognition and Indication**	Identifying and describing targets, observing, concealment, field signals and indication of landmarks.
15	**Section Battle Drills and Movement**	Section formations, fire control orders, fire and movement, movement with/without arms, section battle drill.
16	**Communication Skills and Modern Trends**	Types of communication, media and latest trends in NCC communication.

Semester	**:**	**II**		
Course No.	**:**	**AEC-124**	**Credit Hrs.**	**: 2(1+1)**
Course Title	**:**	**Personality Development**		
Gradial Common Course across all UG Degrees				

SYLLABUS

Objectives: To make students realize their potential strengths and cultivate their inter-personal skills and improve employability.

THEORY

Personality: Definition, Nature of personality, Theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, Shaping of personality, Determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, Personality and Organizational Behaviour. Foundations of individual behavior and Factors influencing individual behavior, Models of individual behavior, Perception and Attributes; Factors affecting perception, Attribution theory and Case studies on Perception and Attribution. Learning: Meaning and Definition, Theories and Principles of Learning, Learning and Organizational behavior, Learning and Training, Learning feedback. Attitude and Values, Intelligence- Types of Intelligence, Theories of intelligence, Measurements of intelligence, Factors influencing intelligence, Intelligence and Organizational behavior, Emotional intelligence. Motivation- Theories and Principles, Teamwork and Group dynamics.

PRACTICAL

MBTI Personality Analysis, Learning Styles and Strategies, Motivational Needs, Firo-B, Interpersonal Communication, Teamwork and Team Building, Group Dynamics, Win-Win Game, Conflict Management, Leadership Styles, Case Studies on Personality and Organizational Behavior.

TEACHING SCHEDULE

THEORY [AEC-124]

Lecture No.	Topic	Sub-topics / Key Points	Weightage (%)
1	**Personality**	Definition, Nature of Personality	5
2	**Theories of Personality and its Types**	The Humanistic Approach- Maslow's self-actualization theory; Types-Extroversion, Introversion, Conscientiousness, Agreeableness	10
3		Shaping of Personality - improving communication skills, stepping out of comfort zone, learning to say no, tapping into creativity, getting curious, giving yourself a daily affirmation, practicing self-care. Determinants of Personality- Physical, Intellectual, Social and Psychological	10
4		Myers- Briggs Typology indicator Four Indicators- Introvert/Extrovert, Thinking/ Feeling, Sensing/ Intuiting, Judging/ Perception, Locus of Control and Performance	10
5		Type A and Type B Behaviours Theory	5
6	**Personality and Organizational Behaviours**	Difference between Personality and Organizational Behaviours	5
7		Foundations of individual behaviours, Factors influencing individual behaviour- Personality, Values, Motivation, Perspectives and Social impacts	5
8		Models of Individual Behaviour- Rational Economic man, Social man, The Self Actuating man, Complex man	5
9	**Perception**	Attributes and Factors affecting perception; Attribution theory and Case studies on Perception and Attribution	10
10	**Learning**	Meaning, Definition; Theories and Principles of Learning	10
11		Difference between Learning and Organizational behavior; Difference between Learning and Training; Feedback of Learning	5
12	**Attitude and Value**	Meaning, Definitions, Concept	5
13	**Intelligence**	Types of Intelligence, Theories of intelligence	
14		Measurement of intelligence Factors affecting intelligence Difference between intelligence and organizational behaviour, Emotional intelligence	5
15	**Motivation**	Meaning, Theories and Principles	5
16	**Team & Group Dynamics**	Meaning, Definitions, Concept	5
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [AEC-124]

Exercise No.	Exercise Topic
1	Myers- Briggs Type Indicator (MBTI) analysis- Extroversion/ Introversion
2	Myers- Briggs Type Indicator (MBTI) analysis- Sensing/ Intuition
3	Myers- Briggs Type Indicator (MBTI) analysis- Thinking/Feeling
4	Myers- Briggs Type Indicator (MBTI) analysis- Judging/ Perception
5	Learning Styles and Strategies
6	Motivational Needs
7	Fundamental Interpersonal Relations Orientation Behaviour (FIRO-B)
8	Interpersonal Communication
9	Team Work
10	Team Building
11	Group Dynamics
12	Win-Win Game
13	Conflict Management
14	Leadership Styles
15	Case Studies on Personality
16	Case Studies on Organizational Behaviour

Suggested Readings [AEC-124]:

1. **Andrews, Sudhir, 1988,** How to Succeed at Interviews. 21st(rep.) New Delhi. Tata -McGraw Hill.
2. **Heller, Robert, 2002,** Effective Leadership. Essential Manager Series. DK Publishing.
3. **Hindle, Tim, 2003,** Reducing Stress. Essential Manager Series. DK Publishing.
4. **Kumar, Pravesh, 2005,** All about Self- Motivation. New Delhi. Goodwill Publishing House.
5. **Lucas, Stephen, 2001,** Art of Public Speaking. New Delhi. Tata - McGraw Hill.
6. **Mile, D.J., 2004,** Power of Positive Thinking. Delhi. Rohan Book Company.
7. **Smith, B., 2004,** Body Language. Delhi: Rohan Book Company.
8. **Shaffer, D. R., 2009,** Social and Personality Development (6th Edn). Belmont, CA: Wadswo.

Semester : II		
Course No. : MDC-122	**Credit Hrs. : 3(2+1)**	
Course Title : Entrepreneurship Development and Business Management		
Gradial Common Course among 5 UG Degrees viz., **B.Sc. (Hons.) Horti. / B.Tech. (Biotech.)/ B.Sc. (Hons.) Forestry / B.F.Sc. (Hons.) / B.Sc. (Hons.) C.S.**		

SYLLABUS

Objectives:

(i) To provide an insight into the concept and scope of entrepreneurship.
(ii) To expose the student to various aspects of establishment and management of a small business unit.
(iii) To enable the student to develop financially viable agribusiness proposal.

THEORY

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product/ service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection and formulation of project; project report preparation, Enterprise management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management / Accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement and taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

PRACTICAL

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

TEACHING SCHEDULE

THEORY [MDC-122]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1	Introduction to Entrepreneurship	Meaning and Definitions of an Entrepreneur, Entrepreneurship; Concept & Scope of Entrepreneurship	6
2	Importance of Entrepreneurship	Importance of Entrepreneurship in Agribusiness	
3	Entrepreneurship Development	Need for and objectives of Entrepreneurial development	4
4	Motivational Factors	Types of motivational factors, Role of social and environmental factors in entrepreneurship	4
5	Characteristics of Entrepreneurs	Characteristics, Entrepreneurial attributes and Competencies	4
6	Types of Entrepreneurs	Various types and their significance	4
7	Functions of Entrepreneurs	Key roles and Responsibilities	2
8	Evolution of Entrepreneurship	Historical perspective and Growth	3
9	Process of Entrepreneurship Development	Stages and Approaches in developing entrepreneurship	4
10	Environmental Scanning	Need for scanning, Techniques	2
11	Opportunity Identification	Spotting and Analysing opportunities	2
12	Infrastructure and Support Systems	Policies, Schemes and Role of financial and other agencies in entrepreneurship development	4
13	Enterprise Functioning Steps	Steps to establish an enterprise	4
14	Selection of Products/Services	Choosing products, Services and Business forms	3
15	Enterprise Location and Capital Sources	Registration, Site selection, Capital sources / Acquisition	3
16	Manufacturing and Distribution	Acquiring manufacturing know-how, Packaging and Distribution essentials	3
17	Planning of an Enterprise	Short term and Long-term planning of an enterprise	3
18-19	Project Formulation	Project identification, Selection, Steps in project formulation and Report preparation, etc.	8
20	Enterprise Management	Basics and Importance of managing an enterprise	3

Continued….

21	Production Management	Product types, Levels of products, Product mix, Quality control, Cost of production, Production control	4
22	Material Management	Raw material costing and Inventory control strategies	4
23	Personnel Management / Human Resource Management	Manpower planning, Labour turnover, Wages / Salaries	4
24	Financial Management	Funds, Fixed and Working capital, Costing, Pricing, Book-keeping basics	4
25-26	Accounting and Taxation	Journals, Ledgers, Subsidiary books, Annual financial statements, Taxation basics	4
27	Marketing Management	Market, Types of markets, Marketing assistance	4
28-29	Market Strategies and Pricing	Marketing strategies, Pricing strategies and Market penetration	4
30	Crisis Management	Crisis types, Strategies for managing raw material, etc.	2
31	Leadership in Crisis Situations	Role of leadership in handling crises	2
32	Financial Crises and Solutions	Strategies for financial crisis management	2
		Total=	**100**

TEACHING SCHEDULE

PRACTICAL [MDC-122]

Exercise No.	Exercise Topic/Title
1	Visit to Small-Scale Industries/ Agro-Industries. (Objective: To understand setup and operations of small-scale units)
2	Interaction with Successful Entrepreneurs. (Objective: To gain insights from real-life entrepreneurial experiences)
3	Case Study on Agro-Entrepreneurs. (Objective: To analyse successful agribusiness ventures)
4	Visit to Financial Institutions. (Objective: To learn about funding options and financial support)
5	Identification of Agribusiness Ideas. (Objective: To identify viable agribusiness ideas based on demand)
6	Analysing Project Proposals. (Objective: To study structure and elements of project proposals)

Continued…

7	Preparing a Project Proposal. (Objective: To develop a basic proposal for an agribusiness venture)
8	Project Report Writing Techniques. (Objective: To practice format and structure for project reports)
9	Marketing Strategies Case Study. (Objective: To analyse effective marketing strategies in agribusiness)
10	Production and Cost Control Analysis (Objective: To study basic cost control measures in production)
11	Inventory Control Simulation (Objective: To apply inventory management methods in a hypothetical setup)
12	Basic Bookkeeping (Objective: To practice fundamental bookkeeping for small businesses)
13	Market Research Techniques (Objective: To use surveys and questionnaires for market insights)
14	Project Proposal Presentation (Objective: To present project ideas for feedback)
15	Review of Project Proposal (Objective: To refine project proposals based on feedback)
16	Final Evaluation of Proposals (Objective: To assess and finalize projects)

Suggested Readings [MDC-122]:

1. **Charantimath P.M. 2009.** Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
2. **Desai V. 2015.** Entrepreneurship: Development and Management, Himalaya Publishing House.
3. **Desai Vasant. 1997.** Small Scale Industries and Entrepreneurship. Himalaya Publ. House.
4. **Gupta C.B. 2001.** Management Theory and Practice. Sultan Chand and Sons.
5. **Indu Grover. 2008.** Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
6. **Khanka S.S. 1999.** Entrepreneurial Development. S. Chand and Co.
7. **Mehra P. 2016.** Business Communication for Managers. Pearson India, New Delhi.
8. **Pandey M. and Tewari D. 2010.** The Agribusiness Book. IBDC Publishers, Lucknow.
9. **Singh D. 1995.** Effective Managerial Leadership. Deep and Deep Publ.
10. **Singhal R.K. 2013.** Entrepreneurship Development and Management, Katson Books.
11. **Tripathi P.C and Reddy P.N. 1991.** Principles of Management. Tata McGraw Hill.

Semester	**:**	**II**	
Course No.	**:**	**VAC-121**	**Credit Hrs. : 3(2+1)**
Course Title	**:**	**Environmental Studies and Disaster Management**	
Gradial Common Course across all UG Degrees			

SYLLABUS

Objectives : (i) To expose and acquire the knowledge on the environment,
(ii) To gain the state-of-the-art skill and expertise on management of disasters.

THEORY

Introduction to Environment - Environmental studies - Definition, scope and importance - Multidisciplinary nature of Environmental Studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources, Food resources. Energy resources. Land resources. Soil resources. Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of Ecosystems. Biodiversity and its conservation: Introduction, Definition, Types. Biogeographical Classification of India. Importance and Value of Biodiversity. Biodiversity Hotspots. Threats and Conservation of Biodiversity.

Environmental Pollution: Definition, Cause, Effects and Control measures of: (a) Air pollution. (b) Water pollution. (c) Soil pollution. (d) Marine pollution. (e) Noise pollution. (f) Thermal pollution. (g) Light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, Effects and Control measures of urban and industrial wastes. Social Issues and the Environment: Urban problems related to energy. Water conservation, Rain water harvesting, Watershed management. Environmental Ethics: Issues and possible solutions, Climate change, Global warming, Acid rain, Ozone layer depletion, Nuclear accidents and Holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment: Environment and Human Health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and Human health.

VAC-121…..

Disaster Management– Disaster: Definition - Types - Natural Disasters: Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves. Man-made Disasters: Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, National disaster management framework; Financial arrangements; Role of NGOs, Community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed Forces in disaster response; Police and other organizations in disaster management.

PRACTICAL

Visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain. Energy: Biogas production from organic wastes. Visit to wind mill/hydro power/solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and un polluted system. Visit to local polluted site- Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of *E. coli* in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystems – Visit to pond /river / hills. Visit to areas affected by natural disaster.

TEACHING SCHEDULE

THEORY [VAC-121]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1	Introduction to Environmental Studies	Definition, Scope and Importance; Multidisciplinary nature	4
2	Segments of Environment	Spheres of Earth – Lithosphere, Hydrosphere, Atmosphere and Different Layers of Atmosphere.	4
3-5	Natural Resources	Classification of resources; Forest, water, mineral, food, energy, land, and soil resources	10
6-7	Concept of an Ecosystem	Concept, Structure, Function and Energy flow in ecosystems	5
8-9	Types of Ecosystems	Terrestrial, Aquatic, Agro-ecosystems, Forest ecosystems and Human-modified ecosystems	5
10-12	Biodiversity and its Conservation	Importance, Value, Types, Bio-geographical classification, Hotspots, Threats, Conservation strategies	8
13-16	Environmental Pollution	Definition, Causes, Effects, Control measures: Air, Water, Soil, Marine, Noise, Thermal and Light pollution	12
17-18	Solid Waste Management	Classification of solid wastes; Management methods like, Composting, Incineration, Pyrolysis, Biogas production	6
19	Urban and Industrial waste	Causes, Effects and Control measures of Urban and Industrial waste	4
20	Social Issues Related to the Environment	Urban energy problems, Water conservation, Rainwater harvesting, Watershed management	4
21-22	Environmental Ethics	Issues, Possible solutions, Climate change, Global warming, Acid rain, Ozone layer depletion, Nuclear accidents and Holocaust.	6
23	Environment Protection Laws	Environment Protection Act, Air and Water (Pollution) Acts, Wildlife Protection Act, Forest Conservation Act	4

Continued….

24-25	Human Population and Environment	Environment and human health, Human rights, Value education, Women and child welfare, Role of IT in environment and health	5
26-28	Introduction to Disaster Management	Definition, Types of natural and man-made disasters; Floods, Droughts, Cyclones, Earthquakes, Landslides, Fires	10
29-30	Disaster Management Framework	National and International strategies, disaster response framework, Financial arrangements, Role of NGOs and media	5
31	Central and Local Administration in Disasters	Role of Central, State, District and Local Administrations; Coordination in disaster response	4
32	Disaster Response Organizations	Central, State, District and Local Administrations in Disaster Control; Role of Armed Forces, Police and Other organizations in disaster response &control	4
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [VAC-121]

Exercise No.	Exercise Title
1	Visit to a local area to document environmental assets: River /Forest / Grassland / Hill / Mountain.
2	Visit to Biogas production, Windmill, Hydro/Solar power generation units
3	To assess floral and faunal diversity in farming systems.
4	Assessment of biodiversity in farming system.
5	Floral and faunal diversity assessment in polluted and unpolluted system.
6	Visit to Local Polluted Site - Urban/Rural/Industrial/Agricultural to study the common plants, insects and birds. Environmental sampling and preservation.
7	Water quality analysis: pH and electrical conductivity (EC) in water samples.

Continued…

8	Estimation of total dissolved solids (TDS) in water samples
9	Estimation of acidity and alkalinity in water samples.
10	Estimation of water hardness in water samples.
11	Determination of dissolved oxygen (DO) and biological oxygen demand (BOD) in water samples.
12	Performing COD estimation on water samples.
13	Enumeration of *E. coli* in water samples to check for contamination.
14	Assessment of Suspended Particulate Matter (SPM) in an environmental sample.
15	Study of simple ecosystem – Visit to Pond/ River/ Hills.
16	Visit to areas affected by natural disaster.

Suggested Readings (VAC-121):

1. **De, A.K. 2010.** Environmental Chemistry. Published by New Age International Publishers, New Delhi. ISBN:139788122426175.384 pp.
2. **Dhar Chakrabarti, P.G. 2011.** Disaster Management - India's Risk Management Policy Frameworks and Key Challenges. Published by Centre for Social Markets (India), Bangaluru. 36 pp.
3. **Erach Bharucha,** Text Book for Environmental Studies. University Grants Commission, New Delhi.
4. **Parthiban, K.T., Vennila, S., Prasanthrajan, M. and Umesh Kanna, S. 2023**. Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi, India.
5. **Prasanthrajan, M. and Mahendran, P.P. 2008.** A Text Book on Ecology and Environmental Science.1st Edn. ISBN 8183211046. Agrotech Publishing Academy, Udaipur - 313 002.
6. **Prasanthrajan, M. 2018.** Objective Environmental Studies and Disaster Management, ISBN 9789387893825. Scientific Publishers, Jodhpur, India. 146 pp.
7. **Sharma, P.D. 2009.** Ecology and Environment, Rastogi Publications, Meerut, India.
8. **Tyler Miller and Scot Spoolman. 2009.** Living in the Environment (Concepts, Connections, and Solutions). Brooks/Cole, Cengage Learning Publication, Belmont, USA.

Semester	**:**	**II**		
Course No.	**:**	**BT-124**	**Credit Hrs.**	**: 3(3+0)**
Course Title	**:**	**Introduction to Biotechnology**		

SYLLABUS

Objectives:

(i) To understand the basic concepts of Molecular Biology and methods used in the manipulation of nucleic acids to isolate and characterize genes.

(ii) To understand how molecular tools are used to modify an organism. To study the history, concepts and scope of Biotechnology.

(iii) To study the applications of Biotechnology.

THEORY

Introduction to genetic material, History of genetic material, Physical and chemical basis of genetic material. Structure of DNA and RNA, Scope and importance of Biotechnology. Plant, Microbial, Animal, Medical, Environmental, Industrial, Marine, Agricultural and Food Biotechnology. Nanobiotechnology. Introduction to recombinant DNA technology. Vectors, DNA manipulating and modifying enzymes, Gene cloning. Introduction to Genomics and Proteomics. Molecular markers, DNA sequencing. Genetic transformation and transgenic organisms. Bioinformatics. Biosafety guidelines.

TEACHING SCHEDULE

THEORY (BT-124)

Lecture No.	Topic	Sub-topics/ Key points	Weightage (%)
Unit-I			
1-3	Introduction to Genetic Material	Definition, Types of genetic material, History of genetic material, Physical and Chemical basis of genetic material, Structure of DNA and RNA.	6
4-6	Scope and Importance of Biotechnology	History, Definitions, Concepts, Branches of Biotechnology, Scope and Importance within its branches	5
7-10	Plant Biotechnology	Basic concepts, Various techniques of Plant Biotechnology and Applications	8
11-12	Microbial Biotechnology	Basic concepts, Various techniques and Industrial applications	4
13-14	Medical and Animal Biotechnology	Basic concepts, Various techniques and Industrial applications	4
15-16	Environmental, Industrial and Marine Biotechnology	Basic concepts, Various techniques and Industrial applications	4

Continued…

17-18	Food Biotechnology	Basic concepts, Various techniques and Industrial applications	4
19-20	Nanobiotechnology	Nano-particles, Nano-fertilizers, Applications and Future aspects of Nano-biotechnology	4
		Unit-II	
21-23	Recombinant DNA Technology	Definition, Introduction, Requirements and Tools, Steps involved in rDNA technology	5
24-27	Vectors	Definition, Properties of good vector, Types of vector and its properties - Plasmid (pBR322, pUC18, pUC19) Cosmid, Phage vector (lambda phage, M13), BAC, YAC and MAC	8
28-29	The Range of Manipulative Enzymes	Restriction enzymes, Nucleases, ligases, polymerases, topoisomerase and DNA modifying enzymes	5
30-31	Gene Cloning	Concept, Importance, Steps and Methods of gene cloning	5
32-33	Introduction to Genomics	Basics of Genomics, Structural and Functional Genomics and Applications	5
34-35	Proteomics	Basics of proteomics, Methods of protein analysis and Applications	5
36-38	Molecular Markers	Concept, Introduction and Types of markers (Biochemical, Morphological and Molecular), and Applications	5
39-41	DNA Sequencing	Introduction, Methods of sequencing (Maxam-Gilbert method, Sanger's method and Next generation sequencing)	8
42-44	Genetic Transformation and Transgenic Organisms	Concept, Methods (Direct and Indirect) and Applications	8
45	Bioinformatics	Introduction, Scope and Importance	2
46-48	Biosafety Guidelines	Definition, Biosafety concerns, Levels of biosafety, Biosafety regulatory framework, Agencies and Their roles	5
		Total =	**100**

Suggested Readings (BT-124):

1. **Chawla HS, 2024,** Introduction to Plant Biotechnology, 4th edn, CBS Publishers and Distributors Pvt. Ltd.
2. **Singh B, Gautam SK, Chauhan MS and Singla SK, 2015,** Textbook of Animal Biotechnology the Energy and Resources Institute, TERI.
3. **Singh BD, 2020,** Biotechnology Expanding Horizons, Kalyani publishers.
4. **Thieman W and Palladino M, 2018,** Introduction to Biotechnology (What's New in Biology), 4th edn, Pearson ISBN 0134650190, 9780134650197.

Semester	**:**	**II**	
Course No.	**:**	**BT-125**	**Credit Hrs. : 2(1+1)**
Course Title	**:**	**Elementary Microbiology**	

SYLLABUS

Objectives:

(i) To study the history of Microbiology and major groups of Eukaryotes and Prokaryotes.

(ii) To study the preservation methods and repositories.

(iii) To study bacterial growth and metabolism.

(iv) To study the applications of microbes.

THEORY

History of Microbiology and its applied areas. Microorganisms and their role in health and environment. Control and prevention measures against microorganisms/diseases. Introduction to eukaryotic and prokaryotic cells. Major groups of eukaryotes; fungi, algae and protozoa. Major groups of Prokaryotes; bacteria, archaebacteria, rickettsia and chlamydia. Preservation of microorganisms, Microbial repositories at national and international level. Bacterial growth. Metabolism in bacteria, ATP generation, chemoautotrophy, photoautotrophy, respiration, fermentation. Viruses and Bacteriophages, structure and properties, lytic and lysogenic cycles, viroids, prions. Beneficial microorganisms in Agriculture, Biofertilizers, Microbial pesticides. Microbes in composting and biodegradation. Microbiology of water and food.

PRACTICAL

Microscope and other instruments in a Microbiological Laboratory. Media preparation, sterilization and aseptic methods for isolation, identification, preservation and storage. Identification of bacteria by staining methods. Enumeration of bacteria by pour plate and spread plate methods. Micrometry.

TEACHING SCHEDULE

THEORY (BT-125)

Lect. No.	Topic	Sub-topics/ Key Points	Weightage (%)
1	History of Microbiology and its Applied Areas	Milestones and Major events, Definition, Different concepts in Microbiology, Scope, Application(s), Prospects, Importance, Approach(es),	7
2	Microorganisms and their Role in Health and Environment	Roles of microorganisms in the environment, Roles of microorganisms in health, Types of different microorganisms playing important role in health and environment	6
3	Control and Prevention Measures against Microorganisms/ Diseases	Prevention and Control of microorganisms, Different diseases caused by microorganisms, Prevention and Control of infectious diseases,	6
4	Introduction to Eukaryotic and Prokaryotic cells	Definition, Differences between Prokaryotic and Eukaryotic cells	7
5	Major Groups of Eukaryotes and Prokaryotes	Definition, Uses and Types of Fungi, Algae and Protozoa of Eukaryotes Definitions, Uses and Types of Bacteria, Archaebacteria, Rickettsia and Chlamydia of Prokaryotes	6
6	Preservation of Microorganisms	Different methods of preservations of microbes, with Advantages and Disadvantages	7
7	National and International Microbial Repositories	Microbial culture collection centres at National and International levels	6
8	Bacterial Growth	Introduction of bacterial growths, Stages of bacterial growth	6
9	Metabolism in Bacteria	Definition, Function of microbial metabolism, Different types of bacterial metabolism	6
10	ATP Generation	Different methods of ATP generation, Importance of ATP generation	6
11	Chemoautotrophy	Definition, Concept and Application of Chemoheterotrophs	6
12	Photoautotrophy, Respiration	Definition, Concept and Application of Photoautotrophy, Differences between Photoautotrophy and Chemoautotrophy	6
13	Fermentation	Definition, Overview, Requirement	6
14	Viruses & Bacteriophages; their Structures and Properties	Definitions, Structure, Example, Properties Difference between Viruses and Bacteriophages	7
15	Lytic and Lysogenic Cycles	Properties, Definitions, Differences between Lysogenic and Lytic cycles	6
16	Viroids and Prions	Properties, Differences between Viroids and Prions	6
		Total=	**100**

TEACHING SCHEDULE

PRACTICAL (BT-125)

Exercise No.	Exercise Title
1-2	Introduction to various instruments used and their working principles.
3	Study of general guidelines and safety measures for working in laboratory.
4	Calculation and preparation of molar solution and per cent solution.
5-6	Different sterilization techniques and aseptic methods for isolation.
7-8	Preparation of different media for microbes' growth.
9-10	Different staining methods for identification of bacteria.
11-12	Enumeration of bacteria by pour plate method.
13-14	Enumeration of bacteria by spread plate method.
15-16	Application of micrometry in Microbiology.

Suggested Reading [BT-125]:

Woolverton C.J., Sherwood L.M., and Willey J.M., 2016, Prescott's Microbiology, McGraw-Hill Education.

Semester	**:**	**II**		
Course No.	**:**	**PB-121**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Introduction to Plant Breeding**		

SYLLABUS

Objectives:

(i) To study the development and goals of Plant Breeding,

(ii) To study modes of reproduction,

(iii) To study the methods of Plant Breeding.

THEORY

History, aims and objectives of Plant Breeding. Role of related Sciences in Plant Breeding. Modes of reproduction - sexual, asexual, apomixes and significance in Plant Breeding. Modes of pollination, Genetic consequences, Differences between self- and cross-pollinated crops. Germplasm resources and their utilization. Methods of Plant Breeding: Introduction and Acclimatization. Selection: Mass selection, Johannsen's pure line theory, genetic basis, Pure line selection. Hybridization: aims and objectives, types of hybridization. Methods of handling segregating generations. Pedigree method, Bulk method, Backcross method. Heterosis, inbreeding depression, various theories of heterosis, exploitation of hybrid vigour. Hardy-Weinberg law. Selection in cross-pollinated crops. Population improvement programmes. Synthetics and Composites. Methods of breeding vegetatively propagated crops. Incompatibility and Male sterility and their utilization in crop improvement. Mutation Breeding. Ploidy Breeding. Wide hybridization and its significance in crop improvement. Procedure for release of New Varieties.

PRACTICAL

Classification of plants. Botanical description and floral biology of field crops: Rice, Sorghum, Maize, Wheat, Bajra, Sugarcane, Brassicas, Groundnut, Sunflower, Sesamum, Red gram, Bengal gram, Green gram, Soybean, Black gram, Cotton. Study of megasporogenesis and microsporogenesis. Fertilization and life cycle of an angiosperm plant. Hybridization techniques and precautions to be taken. Selfing, emasculation and crossing techniques. Study of male sterility and incompatibility.

TEACHING SCHEDULE

THEORY (PB-121)

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1-2	History, Aims and Objectives of Plant Breeding. Role of Related Sciences in Plant Breeding	Definition, History of Plant Breeding, Landmarks/ Achievements in Plant Breeding, Eminent Indian Plant Breeders; Aims and General objectives of Plant Breeding with suitable examples; Major achievements and Future prospects; Role of important Sciences/ Disciplines/ Areas in Plant Breeding to develop improved cultivars	6
3	Modes of Reproduction	Sexual reproduction, Asexual reproduction, Apomixis (its types) [Definitions with examples] and their Significance in Plant Breeding	3
4	Modes of Pollination	Types of pollination [Definitions with examples], Mechanisms promoting self-pollination and cross-pollination with suitable examples, Differences between self - and cross-pollinated crops (with their consequences in brief)	3
5	Germplasm Resources and their Utilization	Introduction, Kinds of germplasm, Gene pool system of Classification, Germplasm activities.	3
6-7	Methods of Plant Breeding: Introduction and Acclimatization	Plant Introduction- Definition, Purpose, Types i.e. Primary and Secondary Introduction; Advantages and Disadvantages; Acclimatization- Definition, Concept, Factors affecting acclimatization	5
8-9	Methods of Plant Breeding: Selection	Mass selection- Procedure, Merits, Demerits, Achievements; Pure line selection- Johannsen's pure line theory, Procedure, Merits, Demerits; Achievements	5
10	Hybridization	Definition, Aim and Objectives; Types of hybridization (Definitions and examples); Steps and procedure of hybridization programme	4
11-13	Methods of Handling Segregating Generations: Pedigree method, Bulk method, Back cross method	Detailed Procedure/ Scheme/ Flowchart, Merits, Demerits, Achievements (with Definitions as applicable therein) of ~ Pedigree method, Bulk method, Single seed descent method (SSD), Back cross method- [Procedure for transfer of recessive gene]	10
14-15	Heterosis and Inbreeding Depression	Definitions, Concept, Theories of heterosis, Factors affecting heterosis, Estimation of heterosis. Exploitation of hybrid vigour, Inbreeding depression	5

Continued…

16	Hardy-Weinberg Law	Law Statement, its validity, Factors affecting gene frequency	4
17-18	Selection in Cross-pollinated Crops	List of Plant Breeding methods for Cross-pollinated crops; Mass selection and Progeny selection: Procedure, Merits, Demerits, Achievements	5
19-21	Population Improvement Programme	Recurrent Selection, Disruptive selection, Diallel selective mating and Biparental mating, Procedure, Merits, Demerits, Achievements	6
22-23	Synthetics and Composites	Definition, Steps for development of Synthetics and Composites, Procedure, Merits, Demerits and Achievements	6
24	Methods of Breeding Vegetatively Propagated Crops	List of breeding methods for asexually propagated crops. Clonal selection- Procedure, Merits, Demerits, and Achievements	5
25	Self-Incompatibility	Definitions, Classification, Heteromorphic SI, its features, Distyly, Tristyly, Homomorphic SI, its types i.e. Gametophytic SI and Sporophytic SI, its features, Utilization of SI systems in crop improvement	5
26	Male Sterility	Definitions, Classification / Types with examples, Genetic Male Sterility (GMS), Thermosensitive GMS, Photosensitive GMS, Transgenic MS, Cytoplasmic Male Sterility (CMS), Cytoplasmic Genetic Male Sterility (CGMS); Chemical Hybridizing Agents; Utilization of MS in crop improvement.	5
27-28	Mutation Breeding	Definitions and Types of Mutation and Mutagens; Mutagens and their mode of action; Procedure of Mutation Breeding for seed and vegetatively propagated crops; Applications; its Merits, Demerits and Achievements	6
29	Ploidy Breeding	Definitions and Types of Polyploidy; Induction of polyploidy, its application in crop improvement, Effects of polyploidy and limitations.	5
30-31	Wide Hybridization	Definitions and Types, Main features, Interspecific and Intergeneric hybridization, its examples; Incompatibility barriers for wide hybridization, Techniques for overcoming barriers in wide hybridization; Achievements and its significance in crop improvement	5
32	Procedure for Release of New Varieties	Norms for release of New Variety, Institutions related with release of variety, Variety release procedure.	4
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL (PB-121)

Exercise No.	Exercise Title
1	Classification of plants.
2	Botanical description and Floral biology: Rice and Sorghum.
3	Botanical description and Floral biology: Maize and Wheat.
4	Botanical description and Floral biology: Pearl millet and Sugarcane.
5	Botanical description and Floral biology: Brassicas.
6	Botanical description and Floral biology: Groundnut, Sunflower and Sesame.
7	Botanical description and Floral biology: Red gram and Bengal gram.
8	Botanical description and Floral biology: Green gram and Black gram.
9	Botanical description and Floral biology: Soybean.
10	Botanical description and Floral biology: American cotton and *Desi* cotton.
11	Study of Megasporogenesis and Microsporogenesis.
12	Fertilization and Life Cycle of an Angiosperm plant.
13	Hybridization techniques and precautions to be taken.
14	Plant Breeder's Kit, selfing, emasculation and crossing techniques.
15	Study of Male sterility.
16	Study of Self-incompatibility.

Suggested Readings (PB-121):

1. **Allard R.W. 1960.** Principles of Plant Breeding, John Wiley and Sons.
2. **Chahal G.S and Gosal S.S, 2002.** Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approaches, Narosa Publishers.
3. **Singh P. 2014.** Essentials of Plant Breeding, Kalyani Publishers.
4. **Singh B.D. 2009.** Plant Breeding: Principles and Methods, Kalyani Publishers.

B.Tech. (Biotechnology)

#List/ Bouquet of Skill Enhancement Courses (SECs)
[in continuation of the SECs' Syllabi prescribed under I semester]

Sr. No.	Course No.	Course Title	Credit Hrs.
1.	SEC-111	Practices in Plant Tissue Culture	2(0+2)
2.	SEC-112	Laboratory Management and Instrumentation	2(0+2)
3.	SEC-123	Basic Techniques of Molecular Biology and Biotechnology	2(0+2)
4.	SEC-124	Bioinformatics and Biocomputation	2(0+2)

Note: (i) Skill Enhancement Courses can be added/offered as per the facilities and resources available at the respective universities/colleges based on the relevance to the region and the UG degree subject. However, the SEC courses are already prescribed and mentioned across specific Semesters in the Sixth Deans' Committee Report Deans' Committee Report Syllabus of B.Tech.(Biotech.) degree program.

(ii) Above list/ bouquet of SEC courses is an indicative list and subject to modification as applicable therein.

Semester	**:**	**II**		
Course No.	**:**	**SEC-123**	**Credit Hrs.**	**: 2(0+2)**
Course Title	**:**	**Basic Techniques of Molecular Biology and Biotechnology**		

SYLLABUS

Objectives:

(i) To provide hands-on training on isolation, purification of DNA, measurement of nucleic acid concentration using spectrophotometer and gel electrophoresis, designing of PCR primers, DNA amplification using PCR, elution of PCR products, SDS PAGE, staining and de-staining of proteins and Western blot.

(ii) To study bacteriological media, preparation of media for bacterial culture, preparation of competent cells and transformation, isolation of plasmids from bacteria, and preservation of bacterial clones.

(iii) To study basic computing. Introduction to UNIX, LINUX. Nucleotide information resource: EMBL, GenBank, DDBJ, Unigene, Protein information resource: SwissProt, TrEMBL, Uniprot; Structure databases: PDB, MMDB. Search engines: Entrez, ARSA, SRS. Similarity searching: BLAST and interpreting results. Multiple sequence alignment: ClustalW; structure visualization of DNA and proteins using Rasmol.

PRACTICAL

Overview of molecular biology: DNA, RNA, Proteins. Laboratory safety and basic techniques. Nucleic acid extraction. Principles of DNA and RNA extraction from various sources. Extraction methods: Phenol-chloroform, silica-based columns, quality assessment and quantification of nucleic acids. Polymerase Chain Reaction (PCR), Optimization of PCR conditions and troubleshooting, Gel electrophoresis, Analysis of PCR products, Restriction digests and DNA/RNA samples. Molecular cloning, DNA sequencing. Principles of DNA sequencing: Sanger sequencing, DNA sequencing reaction setup and analysis, Interpretation of sequencing data and sequence alignment. Protein analysis techniques. Gene expression analysis. Practical project: Students to design and conduct a small-scale Molecular Biology Project. They will choose a specific technique or experiment, perform the necessary procedures, analyze data, and present their findings.

TEACHING SCHEDULE

PRACTICAL (SEC-123)

Exercise No.	Exercise Title
1	Introduction to Molecular Biology Laboratory and Safety guidelines.
2-3	Isolation of plant genomic DNA using different methods.
4	Quality and quantity determination of nucleic acid.
5	Isolation of total RNA from various sources.
6	Amplification of genomic DNA by PCR.
7	Agarose gel electrophoresis of PCR product.
8	Restriction digestion of DNA sample.
9-10	Preparation of competent cells and gene cloning.
11	Introduction of DNA sequencing methods.
12	DNA and Protein sequence analysis.
13	Introduction of gene expression analysis techniques.
14	Introduction of protein analysis techniques.
15-16	Practical project: Students to design and conduct a small-scale Molecular Biology Project*.
*** Project Work should be done from start to end of the semester with group of 10-20 students. They will choose a specific technique or experiment, perform the necessary procedures, analyse the data and present their findings.**	

Suggested Readings [SEC-123]:

1. **Green M.R and Sambrook J., 2012.** Molecular Cloning: A Laboratory Manual, 4th Edn, Cold Spring Harbor.
2. **Rapley R. and Whitehouse D. (Eds), 2015.** Molecular Biology and Biotechnology, Royal Society of Chemistry.
3. **Kreuzer H. and Massey A., 2008.** Molecular Biology and Biotechnology: A Guide For Students 3rd Edn, ASM Press.

Semester	**:**	**II**		
Course No.	**:**	**SEC-124**	**Credit Hrs.**	**: 2(0+2)**
Course Title	**:**	**Bioinformatics and Biocomputation**		

SYLLABUS

Objectives:

(i) To expose the students to the construction and use of computers, special algorithms, new complexity theories, computing science and related mathematics.
(ii) To understand the scientific and economic impact of Bioinformatics.
(iii) To have a better understanding of organisms, their metabolism and their evolution.
(iv) To study their applications in healthcare and drug design, new (bio)materials and their engineering, food (engineering) and food production.

TEACHING SCHEDULE

PRACTICAL [SEC-124]

Exercise No.	Exercise Title
1-2	Information search and data retrieval: Introduction to Biological Databases (NCBI, EMBL, DDBJ, UNIPROT).
3	Data retrieval from Biological Databases (Nucleotide, Protein Sequence Data).
4	Genome analysis and gene mapping: Genome Browsers: Exploring genome browsers (UCSC Genome Browser, Ensembl).
5	Gene Mapping: Identifying gene loci on chromosome.
6	Analysing SNPs and their genomic context using dbSNP.
7-8	Alignment of pairs of sequences: Needle and Water, Tools for tools for similarity search and sequence alignment: BLAST, PSI-BLAST.
9-11	Multiple Sequence Alignment using ClustalW or ClustalOmega, Phylogenetic Tree Construction: Constructing trees using neighbour-joining and maximum likelihood methods, Tree Visualization: Visualizing phylogenetic trees using tools like MEGA.
12	ProfileHidden Markov Models: using HMMER for sequence analysis.
13-15	Gene identification and prediction: Gene prediction tools like GENSCAN, ORF Finder, Promoter prediction.
16-18	Gene expression analyses; Microarray data analysis, RNA-Seq Analysis, Pathway Analysis.
19-21	Protein classification, structure analysis and visualization: Protein Structure and Classification databases: CATH and SCOP, Visualization of protein structures: Cn3D, SPDViewer, RasTop etc.

Continued….

22-24	Protein structure prediction: Primary and secondary structure prediction, Tertiary structure prediction using Swiss-Model.
25-27	Computational methods for Pathway and Systems Biology: Pathway Databases exploring pathways using Reactome or KEGG, Network Analysis: Constructing and analyzing biological networks using Cytoscape, Systems Biology Models: Simulating metabolic pathways using tools like CellDesigner.
28-29	Technologies and strategies for drug discovery: Target Identification, Virtual Screening and QSAR Analysis.
30	Biomarkers in drug development.
31-32	Computer-aided drug design; Structure-based drug design (SBDD) & Ligand-based drug design (LBDD), Molecular Docking, Quantitative structure-activity relationship (QSAR).

Suggested Readings [SEC-124]:

1. **Altman R.B, Dunker A.K, Hunter L., Ritchie M.D, Murray T.A. and Klein T.E., 2017.** Biocomputing, https://doi.org/10.1142/10388.
2. **Laplante P.A. (Ed), 2004.** Biocomputing, Ova Biomedical.
3. **Neelakanta P.S. 2024.** A Textbook of Bioinformatics: Information - Theoretic Perspectives of Bioengineering and Biological Complexes.
4. **Jin Xiong. 2006.** Essential Bioinformatics, Texas A and M University, Cambridge University Press.
5. **Rastogi S.C., Mendiratta N., Rastogi P**. **2013.** Bioinformatics Methods and Applications: Genomics, Proteomics and Drug Discovery, Prentice Hall India, ©2013 New Delhi.

Course Curriculum of Third Semester
as per the ICAR-Sixth Deans' Committee Report for the Academic Programmes in
BIOTECHNOLOGY

- UG-Certificate in Biotechnology
- UG-Diploma in Biotechnology
- UG-Degree: B.Tech. (Biotechnology)

Mahatma Phule Krishi Vidyapeeth, Rahuri

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani

Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli

Maharashtra Agricultural Universities Examination Board, Pune

Compiled & Submitted by

Dr. Anil A. Kale

Incharge, State-level Biotechnology Centre, MPKV, Rahuri.

UG Degree Syllabus State Coordinator

with

UG Degree Syllabus Discipline Coordinators &

DICC - UG Degree Syllabus Core Committee

Submitted to the

Directors of Instruction Coordination Committee

~ w.e.f. AY, 2025-26 ~

Course Layout

B.Tech. (Biotechnology)

Semester: III (New) ***w.e.f.*** **Academic Year: 2025-26**

Sr. No.	Course No.	Course Title	Credit Hrs.	Remark
1.	**AEC-235**	Physical Education, First Aid, Yoga Practices and Meditation	2(0+2)	--
2.	**BT-MATH-232**	Biomathematics	2(2+0)	--
3.	**BT-236**	Recombinant DNA Technology	2(2+0)	--
4.	**BT-237**	Classical and Molecular Cytogenetics	3(2+1)	--
5.	**AHDS-231**	Livestock Production and Management	3(2+1)	--
6.	**PP-231**	Plant Physiology	3(2+1)	--
7.	**CP-231**	Fundamentals of Crop Protection	3(2+1)	--
8.	**SEC-235**	Skill Enhancement Course-V: [#] Methods in Recombinant DNA Technology	2(0+2)	--
9.	**OC-1/ OC-2/ ...**	Online Course(s)/ MOOCs[†]	As opted by student	**NG**
Total Credits Hrs.=			**20(12+8)**	**G**

AEC: Ability Enhancement Course, **SEC**: Skill Enhancement Course, **OC**: Online Course, **G**: Gradial, **NG**: Non-gradial

[†]**Note:** It is mandatory for each Student to complete **total 10 credits** (Non-gradial) of **Online Courses** from available resources across III to VIII semesters under the guidance of assigned Faculty/Advisor.

Course-wise Syllabus with Teaching Schedules

Semester	**:**	**III**			
Course No.	**:**	**AEC-235**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Physical Education, First Aid, Yoga Practices and Meditation**			
Gradial Common Course across all UG Degrees					

SYLLABUS

Objectives : (i) To make the students aware about Physical Education, First Aid and Yoga Practices,

(ii) To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through Yoga.

PRACTICAL

Physical Education; Training and Coaching- Meaning and concept; Aerobic and Aerobic exercises; Calisthenics, Weight Training, Circuit Training, Interval Training, Fartlek Training; Effect of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition- Effect of Diet on Performance; Physiological Changes due to ageing and Role of exercise on ageing process; Personality, its dimensions and types, Role of Sports in Personality Development; Motivation and Achievements in Sports; Learning and Theories of Learning; Adolescent Problems and its Management; Posture; Postural Deformities, Exercises for Good Posture.

Yoga: History of Yoga, Types of Yoga, Introduction to Yoga.

- Asanas (Definitions and Importance)- Padmasan, Gaumukhasan, Bhadrasan, Vajrasan Shashakasan, Pashchimothasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan- left & right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Shawasan.
- Suryanamaskar, Pranayama (Definitions and Importance)- Omkar, Suryabhedan, Chandrabhedan, Anulom, Vilom, Shitali, Shitkari, Bhastrika, Bhramari.
- Meditation (Definitions and Importance)- Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definitions and Importance)- Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Prutvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra.
- Role of Yoga in Sports.
- Teaching of Asanas- Demonstration, Practice, Correction and Practice.

History of Sports and Ancient games, Governance of Sports in India; Important Sporting events- Awards in sports, History, Latest rules, Measurement of playfield, Specifications of equipment, Skill, Technique, Style and Coaching of major games (Cricket, Football, Table tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho and Athletics).

Need and Requirement of First Aid: First Aid techniques, Equipment and Upkeep First Aid techniques; First aid-related with respiratory system; First aid-related with Heart, Blood and Circulation; First Aid-related with wounds and injuries; First Aid-related with Bones, Joints muscles related injuries; First Aid-related with Nervous system and Unconsciousness; First Aid-related with Gastrointestinal Tract, Skin Burns; First Aid-related with Bites and stings, poisoning; First Aid-related with Sense organs; Handling and transport of injured traumatized persons- Sports injuries and their Treatments.

TEACHING SCHEDULE

PRACTICAL [AEC-235]

Exercise No.	Topic	Exercise Title / Sub-topics
1	**Physical Education**	To study the training and coaching- Meaning and concept of Physical Education.
2 - 7	**Methods of Training**	To study the method of training - Aerobic and Aerobic Exercises.
		To study the method of training - Calisthenics
		To study the method of training - Weight Training
		To study the method of training - Circuit Training
		To study the method of training - Interval Training
		To study the method of training - Fartlek Training
8	**Effect of Exercise**	To study the effect of exercise on Muscular, Respiratory, Circulatory and Digestive systems.
9	**Balanced Diet and Nutrition**	To study the Balanced Diet and Nutrition- Effect of diet on performance.
10	**Physiological Changes**	To study the physiological changes due to ageing and role of exercise on ageing process.
11	**Personality Development**	To study the dimensions and types - Role of sports in personality development.

Continued…

12	**Motivation and Achievements in Sports**	To study the Motivation and Achievements in Sports
13	**Learning and Theories of Learning**	To study the Learning and Theories of Learning
14	**Adolescent Problems and its Management**	To study the Adolescent Problems and its Management
15	**Posture**	To study the Postural Deformities, Exercises for Good Posture
16 - 22	**Yoga**	To study the Introduction, History and Types of Yoga
		To study the Asanas: Padmasan, Gaumukhasan, Bhadrasan, Vajrasan Shashakasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan- left leg - right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Shawasan.
		To study the Suryanamaskar, Pranayama, Omkar, Suryabhedan, Chandrabhedan, Anulom, Vilom, Shitali, Shitkari, Bhastrika, Bhramari.
		To study the Meditation, Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
		To study the Mudras: Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Prutvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra.
		To study the Role of Yoga in Sports
		To study the Demonstration, Practice, Correction and Practice of Asanas.
23 - 26	**Sports**	To study the History of Sports and Ancient Games
		To study the Governance of Sports in India
		To study the Awards in Sports, History, Latest rules, Measurement of playfield, Specifications of equipment in important sporting events.
		To study the Skill, Technique, Style and Coaching of major games (Cricket, Football, Table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho and Athletics).

Continued…

27 - 32	**First Aid**	To study the Need and Requirement of First Aid-First Aid techniques, Equipment and Upkeep.
		To study the First aid related with Respiratory system, Heart, Blood and Circulation.
		To study the First aid related with Wounds and Injuries, Bones, Joints muscles related injuries.
		To study the First aid related with Nervous system Unconsciousness, Sense organs.
		To study the First aid related with Gastrointestinal Tract, Skin Burns, Bites and Stings, Poisoning.
		To study the Handling and Transport of Injured Traumatized Persons- Sports Injuries and their Treatments.

Semester	**:**	**III**		
Course No.	**:**	**BT-MATH-232**	**Credit Hrs.** **:**	**2(2+0)**
Course Title	**:**	**Biomathematics**		

SYLLABUS

Objectives:

(i) To study the basic theories of Mathematics,
(ii) To study factor reduction and Eigen values,
(iii) To study the applications of Biomathematics.

THEORY

Differential Calculus: Rolle's Theorem, Lagrange's Theorem, Taylor's and Maclaurin's series.

Partial differentiation: Partial differentiation, Euler's Theorem on homogeneous function, Total Derivative, Change of variable, Maxima and Minima of two variables

Matrix: Eigen values and Eigen vectors of a matrix.

Integral Calculus: Reduction formulae, Definite integrals and its applications.

Ordinary Differential Equation and it's Applications: Solution of ordinary differential equation of first degree and first order and their application for determination of the volume of blood and drug distribution. Epidemic models.

Linear differential equations of higher order and their applications to the simple biological problem.

Simultaneous differential equation of first order and their applications to predator models.

Numerical Methods: Numerical methods for solving algebraic and transcendental equations.

Suggested Readings [BT-MATH-232]:

1. **Grewal B.S.** 2015. Higher Engineering Mathematics. Khanna Publishers Delhi. (43rd Edition).
2. **Rastogi S.K.** 2008. Biomathematics, Krishna Prakashan Media Pvt. Ltd.
3. **Srivastava A.C. and Srivastava P.K.** 2011. Engineering Mathematics, Vol. I, PHI Learning Pvt. Ltd.
4. **Srivastava A.C. and Srivastava P.K.** 2011. Engineering Mathematics, Vol. III, PHI Learning Pvt. Ltd.

TEACHING SCHEDULE

THEORY [BT-MATH-232]

Lecture No.	Topic	Sub-topics / Key Points	Weightage (%)
1 - 10	Differential Calculus	Rolle's Theorem (Without proof)	30
		Lagrange's Theorem (Without proof)	
		Taylor's and Maclaurin's series (Without proof)	
	Partial Differentiation	Partial differentiation	
		Euler's Theorem on homogeneous function (Without proof)	
		Total derivative	
		Change of variable	
		Maxima and Minima of two variables	
11 - 13	Matrix	Eigen values and Eigen vectors of a matrix (Definition, Properties without proof, Examples of eigen values and eigen vectors for non-repeated roots)	10
14 - 18	Integral Calculus	Reduction formulae $\int \sin^n x\,dx$, $\int \cos^n x\,dx$, $\int \tan^n x\,dx$ and $\int \cot^n x\,dx$) Formulae without proof and Basic examples	15
		Definite Integrals (Definition and Properties without proof)	
		Applications of Definite integrals to find area of Cartesian curves and Volumes of Revolution	
19 - 28	Ordinary Differential Equation and it's Applications	Solution of ordinary differential equation of first order and first degree (Variable Separable, Homogenous, Linear and Exact equations)	30
		Applications of ODE for determination of the volume of blood and drug distribution. Epidemic models,	
		Linear differential equations of higher order: Rules for finding complementary function	
		Rules for finding particular integral of the functions of the Type e^{ax}, $Sin(ax+b)$ or $\cos(ax+b)$, x^m	
		Applications of linear differential equations to the simple biological problem.	
		Simultaneous differential equation of first order with constant coefficient and their applications to predator models.	
29 - 32	Numerical Methods	Numerical methods for solving algebraic and transcendental equations:	15
		Bisection method	
		Method of false position	
		Newton-Raphson method	
		Total=	**100**

Semester	**: III**		
Course No.	**: BT-236**	**Credit Hrs.**	**: 2(2+0)**
Course Title	**: Recombinant DNA Technology**		

SYLLABUS

Objectives:

(i) The students will be trained on the Principles of Genetic Engineering,

(ii) To study the components like, vectors, enzymes and host cells,

(iii) To study methods used for confirming cloning and expression.

THEORY

Recombinant DNA technology; Restriction endonucleases: Types and uses; DNA manipulating enzymes, DNA ligases; Vectors: Properties of an ideal vector, Structure of vector, Cloning vectors and Expression vectors; Plasmids, Cosmids, Phagemids, BACs, PACs, YACs, Transposon vectors, Shuttle vectors, Co-integrating vectors. Competent cells; Gene isolation and Cloning; Genetic transformation of *E. coli*; Gel electrophoresis; Preparation of probes; Southern blotting; Northern blotting; Western blotting; PCR and Gene amplification.

TEACHING SCHEDULE

THEORY [BT-236]

Lecture No.	Topic	Sub-topics / Key Points	Weightage (%)
1	Introduction to Recombinant DNA Technology	Definition, Scope, Basic Principles and Historical Perspective	2
2	Milestones and Steps in rDNA Technology	Key breakthroughs, Major steps involved (Isolation, Cutting, Insertion, Ligation, Transformation, Selection)	3
3	Restriction Endonucleases-I	Definition, Discovery, Sources and Nomenclature of Restriction enzymes	4
4 - 5	Restriction Endonucleases-II	Types (I-IV), Cleavage patterns, Examples, Applications, Isoschizomers, Neoschizomers, Isocaudomers	6
6	DNA-Manipulating Enzymes-I	Alkaline phosphatase, T4 polynucleotide kinase, Reverse transcriptase, DNase I, Exonuclease III, Nuclease S1, RNase H - Definitions, Mechanisms	4
7	DNA Ligases	Definition, Classification, Ligation mechanism, Types, Example - *E. coli* DNA ligase	4

Continued…

8 - 9	Vectors-I	Definition, Types, Properties of ideal vectors, General vector structure	6
10 - 11	Plasmids	Definition, Types, Structure and Features of pBR322 and pUC19	4
12 - 13	Lambda Phage, Cosmids, Phagemids	Insertion / Replacement vectors, Definition and Structure of Cosmids and Phagemids, Basic properties	4
14 - 15	YACs, BACs, PACs, and Transposon Vectors	Features, Structure, Classes (Class I and II), Application of transposon vectors	5
16	Expression Vectors	Definition, Essential properties, Suitable examples	2
17 - 18	Shuttle and Binary Plant Vectors	Shuttle vectors: Definition, Properties, Examples; Binary vectors: Mechanism of transfer (Ti plasmid), Co-integrate system, Examples	5
19	Competent Cells	Definition, Preparation methodologies (Chemical / Electroporation), Transformation efficiency	5
20 - 21	Genetic Transformation of *E. coli*	Definition, Types (Heat shock, Electroporation), Methodology, Screening and Selection of recombinants	7
22	Gene Isolation	Definition, Methodologies (Genomic library, cDNA, PCR-based isolation)	5
23	Cloning	Definition, Methodology, Cloning sites, Selection markers	5
24 - 25	Gel Electrophoresis	Definition, Types (Agarose, PAGE), Principles, Methodology, Gel preparation, Visualization	5
26	Probe Preparation	Methodology: End labeling, Nick translation, Primer extension; Radioactive and Non-radioactive labeling methods	3
27 - 28	Southern Blotting	Methodology, Steps, Diagram, Applications and Advantages	6
29	Northern Blotting	Methodology, Steps, Diagram, Comparison with Southern blot	4
30	Western Blotting	Steps involved, Detection of proteins, Advantages, Diagram	3
31 - 32	PCR	Definition, Types (RT-PCR, qPCR), Reaction components, Role of thermostable polymerases, Stages (Denaturation, Annealing, Extension), Applications.	8
		Total =	**100**

Suggested Readings [BT-236]:

1. **Brown T.A.** 1998. Genetics: A Molecular Approach. 3rd Ed. Stanley Thornes.
2. **Singer M. and Berg P.** 1991. Genes and Genome. University Science Books.
3. **Primrose S.B. and Twyman R.M.** 7th Ed. Principles of Gene Manipulation and Genomics. Wiley-Black well. ISBN: 978-1405135443.
4. **Lewin B.** Genes XI. 11th Ed. Jones and Bartlett Learning. ISBN: 978-1449659851.

Reference Books [BT-236]:

1. **Watson J.D. and Zoller M.** Recombinant DNA. 3rd Ed. Panima Publishers.
2. **Winnacker E.L.** 2003. From Genes to Clones: Introduction to Gene Technology. 4th Ed. Panima Publishers.

Semester	**:**	**III**		
Course No.	**:**	**BT-237**	**Credit Hrs.** **:**	**3(2+1)**
Course Title	**:**	**Classical and Molecular Cytogenetics**		

SYLLABUS

Objectives:

(i) To learn the basic aspects of Classical and Molecular Cytogenetics,
(ii) To study the chromatin, chromosome banding and chromosome variations,
(iii) To be able to perform genome analysis through chromosomal variations.

THEORY

Introduction and History. Structure of chromatin. Chromosome structure and chromosome landmarks. Specialized chromosomes. Differential staining of the chromosomes: Q-banding, G-banding, C-banding, R-banding. *In situ* hybridization- FISH, GISH. Changes in chromosome number: Aneuploidy - Monosomy, Trisomy and Tetrasomy, Haploidy and Polyploidy- Autopolyploidy and Allopolyploidy. Methods of doubled haploid production. Structural aberrations of chromosomes: Deletions, Duplications, Inversions and Translocations. Locating genes on chromosomes. Genome analysis.

PRACTICAL

Lymphocyte culture from blood for karyotyping. Fibroblast cultures from eggs for karyotyping. Preparation of metaphase chromosome spread. Staining techniques of chromosome spreads. Karyotyping and ideogram preparation, Chromosome banding techniques: Q-banding, G-banding, C-banding, R-banding.

Suggested Readings [BT-237]:

1. **Becker K. and Hardin.** 2004. The World of Cell, 5th Edn., Pearson Edu.
2. **Carroll M.** 1989. Organelles, The Guilford Press.
3. **Charles B.** 199. Discussions in Cytogenetics, Prentice Hall.
4. **Fan Y.S.** 2002. Molecular Cytogenetics: Protocols and Applications. Humana Press.
5. **Gupta P.K.** 2007. Cytogenetics, Rastogi Publications.
6. **Mahabal R.** 2010, Fundamentals of Cytogenetics and Genetics, PHI Learning Pvt. Ltd.
7. **Popescu P., Hayes H. and Dutrillaux B.** 2000. Techniques in Animal Cytogenetics, Springer Science and Business Media.

TEACHING SCHEDULE

THEORY [BT-237]

Lecture No.	Topic	Sub-topics / Key Points	Weightage (%)
1 - 2	Introduction and History	Definition, Scope, Importance/ Applications in Agriculture (Focusing on their applications in Diagnosis, Research and Crop Improvement); Historical milestones in Cytogenetics	3
3 - 6	Structure of Chromatin	Introduction to Chromatin; Chromatin structure and Hierarchy, Nucleosomes structure and Organization	4
		Chromatin structure and Hierarchy	4
		Nucleosome: Introduction	3
		Nucleosome: Structure and Hierarchy	3
7 - 9	Chromosome Structure	History of Discovery	4
		Chromosome in Prokaryotes and Eukaryotes, Structure in sequences, DNA packaging, Chromosome number in various organisms: Eukaryotes, Prokaryotes	6
10 - 12	Chromosome Landmarks	Karyotype: Historical notes, Chromosome landmarks; Visible chromosomal landmarks: Chromosome size, Centromere position, Position of nucleolar organizers	5
		Chromomere patterns, Heterochromatin patterns, Banding patterns	4
13 - 14	Specialized Chromosomes	Lampbrush chromosomes, Polytene chromosomes, Accessory chromosome	4
15 - 17	Differential Staining of the Chromosomes	Q-banding, G-banding: History, Introduction, Procedure and Applications	4
		C-banding, R-banding: History, Introduction, Procedure and Applications	4
18 - 20	*In situ* Hybridization	Definitions/ Meanings; FISH and GISH: Probes – RNA and DNA, Introduction, Principle, Procedure and Application	8
21 - 22	Changes in Chromosome Number	Aneuploidy - Monosomy: Definitions, Types, Causes with Examples and Significance	4
		Trisomy and Tetrasomy; Haploidy and Polyploidy: Definitions, Types and Causes with Examples; Significance	4

Continued…

23	Polyploidy	Autopolyploidy and Allopolyploidy: Definitions, Types, Causes with Examples; Significance	4
24 - 26	Methods of Doubled Haploid Production	Anther culture (Androgenesis), Microspore Culture, Ovary / Ovule Culture (Gynogenesis), Wide Hybridization (Chromosome Elimination), *In vivo* Haploid induction, Parthenogenesis / Apomixis and Applications	8
27 - 28	Structural Aberrations of Chromosomes	Deletions and Duplications: Definitions, Types, Consequences and Examples	4
		Inversions and Translocations: Definitions, Types, Consequences and Examples	4
29 - 30	Locating Genes on Chromosomes	Gene Mapping, Types of Gene mapping (Linkage, Physical and Cytogenetic mapping) and Applications	8
31 - 32	Genome Analysis	Steps in Genome analysis, Techniques involved in Genome analysis and their Applications	8
		Total=	**100**

TEACHING SCHEDULE

PRACTICAL [BT-237]

Exercise No.	Exercise Title
1 - 2	Establishment and Harvesting of blood Lymphocyte Cultures for Karyotyping.
3 - 4	Fibroblast cultures from eggs for karyotyping.
5 - 7	Preparation of metaphase chromosome spread.
8 - 11	Staining techniques of chromosome spreads (Giemsa staining, FISH, Trypsin staining etc.).
12 - 13	Karyotyping and Ideogram preparations.
14 - 16	Chromosome banding techniques: Q-banding, G-banding, C-banding, R-banding.

Semester : III		
Course No. : AHDS-231	**Credit Hrs. : 3(2+1)**	
Course Title : Livestock Production and Management		

SYLLABUS

Objectives:

(i) To study the history of Livestock in India, Animal Husbandry and breeds of livestock,

(ii) To study the management of livestock in terms of the housing system, health and diseases,

(iii) To study the economic importance of livestock.

THEORY

Livestock history in India: Vedic, Medieval and Modern era. Demographic distribution of livestock and Role in economy. Introductory Animal Husbandry. Breeds of livestock, Cattle, Buffalo, Sheep, Goat and Pig. Important traits of livestock. General management and feeding practices of animals. Handling and restraining of animals. Housing systems. Importance of grasslands and fodders in livestock production. Common farm management practices including Disinfection, Isolation, Quarantine and Disposal of carcass. Common vices of animals and their prevention. Diseases, Parasite control and Hygiene care.

History and Economic importance of poultry. Poultry breeds. Reproductive system of male and female birds. Formation and structure of eggs. Important economic traits of poultry. Egg production, Egg weight, Egg quality. Fertility and Hatchability, Plumage characteristics and Comb types. Care and management of chicks, grower and layers / broiler. Brooding management. Hatchery practices. Poultry Diseases, Control and Hygiene care.

PRACTICAL

Visit to livestock farms/demonstration centres. Breeds of Cattle, Buffalo, Sheep, Goat and Pigs. Familiarization with body parts of animals. Handling and restraining of cattle, buffalo, sheep, goat and swine. Male and Female reproductive system and artificial Insemination. Feeding of livestock. Methods of identification: Marking, Tattooing, Branding, Tagging. Milking methods. Record keeping. Visit to the poultry farm, poultry breeds, body parts of chicken, duck, quail and turkey. Housing, Equipment, Nesting and Brooding requirements. Male and Female reproductive system. Methods of identification and sexing. Hatchery layout and equipment. Identification of diseases and control of parasites. Vaccination and Maintenance of farm records.

TEACHING SCHEDULE

THEORY [AHDS-231]

Lecture No.	Topic	Sub-topics / Key Points	Weightage (%)
1 - 2	History	Livestock history in India: Vedic, Medieval and Modern era	4
3	Role of Livestock	Demographic distribution of livestock and Role in economy	4
4	Introduction	Introductory Animal Husbandry	4
5 - 8	Breeds	Breeds of Livestock, Cattle, Buffalo, Sheep, Goat and Pig	6
9	Important Traits	Important traits of livestock	4
10 - 11	Management Practices	General management and Feeding practices of animals	6
12	Handling and Restraining	Handling and Restraining of animals	4
13	Housing systems	Types, Design (in brief)	4
14 - 15	Grassland and Fodder Production	Importance of grasslands and fodders in livestock production	6
16 - 17	Common Farm Management	Common farm management practices including Disinfection, Isolation, Quarantine and Disposal of carcass	4
18	Common Vices of Animals	Common vices of animals and their Prevention	4
19	Diseases	Diseases and Parasite control and Hygiene care	4
20	History and Importance of Poultry	History and Economic importance of poultry	4
21	Poultry Breeds	Poultry breeds	4
22 - 23	Reproductive Systems	Reproductive systems of male and female birds	4
24	Structure of Eggs	Formation and Structure of eggs	4
25	Important Economic Traits	Important economic traits of poultry	4
26	Egg Production	Egg production, Egg weight, Egg quality	4
27	Fertility and Hatchability	Fertility and Hatchability, Plumage Characteristics and Comb types	4
28 - 29	Care and Management	Care and Management of Chicks, Grower and Layers/Broiler	6
30	Brooding Management	Brooding management	4
31	Hatchery Practices	Hatchery practices	4
32	Poultry Diseases	Poultry diseases, Control and Hygiene care	4
		Total=	**100**

TEACHING SCHEDULE

PRACTICAL [AHDS-231]

Exercise No.	Exercise Title
1	Visit to Livestock Farms/ Demonstration Centers.
2	Breeds of cattle, buffalo, sheep, goat and pigs.
3	Familiarization with body parts of animals.
4	Handling and restraining of cattle, buffalo, sheep, goat and swine.
5	Male and female reproductive system and artificial Insemination.
6	Feeding of livestock.
7	Methods of identification: Marking, tattooing, branding, tagging.
8	Milking methods; Record Keeping.
9	Visit to the poultry farm.
10	Poultry breeds, body parts of chicken, duck, quail and turkey.
11	Housing, equipment, nesting and brooding requirements.
12	Male and female reproductive system.
13	Methods of identification and sexing.
14	Hatchery layout and equipment.
15	Identification of diseases and control of parasites vaccination.
16	Maintenance of farm records.

Suggested Readings [AHDS-231]:

1. **Banerjee G.C. 2020.** A Textbook of Animal Husbandry, Oxford and IBH Publication.
2. **Thomas C.K. and Sastry NSR**. 2020. Livestock Production Management, Kalyani Publishers.
3. **Sastry NSR. and Thomas C.K.** 2020. Dairy Bovine Production, Kalyani Publishers.

Semester : III		
Course No. : PP-231	**Credit Hrs. : 3(2+1)**	
Course Title : Plant Physiology		

SYLLABUS

Objectives:

(i) To introduce the concepts/principles of Plant Physiology and their importance and application in Agriculture,

(ii) To study the plant growth and metabolism,

(iii) To study plant response to stresses.

THEORY

Plant Physiology: its Scope in Agriculture. Osmosis, Imbibition, Water absorption, Water translocation and Transpiration. Stomatal mechanisms. Physiological role and Deficiency symptoms of major and minor elements. Absorption and translocation of minerals. Concepts of photosynthesis, Photorespiration, Respiration and Translocation of photoassimilates. Dynamics of growth. Photoperiodism, Stress Physiology. Nitrogen and Sulphur metabolism. Plant growth regulators; Their biosynthesis and physiological roles, Seed germination and seed dormancy, Senescence, Vernalization. Circadian rhythms in plants.

PRACTICAL

Demonstration of processes of diffusion, osmosis, imbibition and plasmolysis. Ascent of sap, Transpiration. Deficiency symptoms of nutrients in crop plants. Plant growth analysis. Quantitative and qualitative estimation of plant pigments. Experiments on photosynthesis and respiration. Effects of plant growth regulators on plant growth and seed germination. Experiments on seed dormancy. Relative water content and plant water potential. Proline estimation.

TEACHING SCHEDULE

THEORY [PP-231]

Lecture No.	Topic	Sub-topics / Key Points	Weightage (%)
1	Introduction to Plant Physiology	Definition; Introduction to Plant Physiology and its Scope and Importance/ Application/ Role in Agriculture	2
2	Plant Cell	Plant cell: Cell organelles and their Role (*in brief*)	2
3 - 4	Water Relations and Ascent of Sap	Definitions; Osmosis, Imbibition, Water Potential, Absorption of water and Path of water; Water translocation; Ascent of Sap and Theories of Ascent of Sap	10
5 - 6	Transpiration	Transpiration- Definition, Types; Structure of stomata, Physiology of stomata, Factors affecting transpiration, Stomatal mechanisms	5
7 - 9	Mineral Nutrition of Plants	Mineral nutrition of plants: Classification of mineral elements; Criteria of essentiality; Physiological role and Deficiency symptoms of major and minor elements; Mechanism of mineral element uptake	10
		Absorption and Translocation of minerals	
10 - 12	Photosynthesis	Photosynthesis: Definition, Pigments involved, Structure of chloroplast <u>Light reaction</u>- Photolysis of water, Emerson effect, Cyclic and Non-cyclic electron transfer, Significance of light reaction	10
13 - 14		<u>Dark reaction</u>- C_3, C_4 and CAM plants, Factors affecting photosynthesis, Photorespiration	5
15 - 17	Respiration	Respiration: Definitions, Types, Glycolysis, TCA/Krebs cycle and Electron Transport Chain	8

Continued…

18	Translocation	Translocation of Photo-assimilates (*in brief*)	2
19	Plant Growth	Dynamics of plant growth, Definitions; Integrating morphology, Physiology and Development	5
20	Photoperiodism	Photoperiodism - Definitions, Induction of flowering and Florigen concept	5
21 - 22	Stress Physiology	Stress Physiology: Definition and Types of stress, Physiological Responses to stress; Molecular mechanisms of stress tolerance- (HSPs, Signaling, Antioxidant Defence); Impact on growth, development and metabolism	5
23 - 24	Nitrogen and Sulphur Metabolism	Importance and Overview of Nitrogen and Sulphur cycles; Pathways; Enzyme regulation	5
25 - 27	Plant Growth Regulators	Plant Growth Regulators: Definition, Types, their Biosynthesis, Physiological role and Agricultural uses of PGRs	10
28 - 29	Seed Germination	Seed germination: Definitions; Physiological, Biochemical and other changes accompanying seed germination, Seed vigour, Seed viability, Orthodox and Recalcitrant seeds	5
30	Seed Dormancy	Seed Dormancy: Definition and Significance; Types; Methods to break dormancy	5
31	Senescence and Vernalization	Senescence: Definition, Types and Phases; Physiological mechanism. Vernalization : Definition; Mechanism and Importance in Agriculture	4
32	Circadian Rhythms	Circadian rhythms- Definition and Significance in plants, Clock genes (*in brief*)	2
		Total=	**100**

TEACHING SCHEDULE

PRACTICAL [PP-231]

Exercise No.	Exercise Title
1	Study of a typical plant cell.
2	Study of imbibition, diffusion and osmosis.
3	Study of plasmolysis.
4	Study of root pressure and ascent of sap.
5	Measurement of rate of transpiration.
6	Study of structure and distribution of stomata.
7	Estimation of relative water content of tissue.
8	Study of separation of photosynthetic pigment through paper chromatography.
9	Measurement of rate of photosynthesis by different methods.
10	Study of respiration and respiratory quotients.
11	Rapid tissue tests for macro-elements.
12	Rapid tissue tests for micro-elements.
13	Study of use of PGR in fruit ripening.
14	Study the effect of osmotic pressure on seed germination; Measurement of plant growth.
15	Estimation of proline content.
16	Experiments on breaking the seed dormancy.

Suggested Readings [PP-231]:

1. **Bhatia K.N. and Prashar A.N.,** 1990. Plant Physiology, Trueman Book Company.
2. **Salisbury F.B. and Ross C.W.**, 1992. Plant Physiology, Wordsworth Publishing Company.
3. **Srivastava H.N.,** 2000, Plant Physiology, Pradeep Publications.
4. **Taiz L. and Zeiger E.,** 2002. Plant Physiology, Sinauer Associates; 3rd Edition.
5. **Jain V.K., 2021.** Fundamental of Plant Physiology, 19th Edition, Rastogi Publications.

Semester	**:**	**III**		
Course No.	**:**	**CP-231**	**Credit Hrs.**	**: 3(2+1)**
Course Title	**:**	**Fundamentals of Crop Protection**		

SYLLABUS

Objectives:

(i) To study insects, their classification, structure and incidences,

(ii) To study pathogens, their classification, pathogenesis and disease development,

(iii) To study the best practices of insect and disease management.

THEORY

Insects- their general body structure. Importance of insects in agriculture. Life cycle of insects. Insects diversity. Feeding stages of insects and kinds (modifications) of mouthparts. Concepts in population build-up of insects – GEP, DB, EIL, ETH and pest status. Causes of insect-pests outbreak. General symptoms of insect attack. Principles and methods of insect-pests management. Integrated Pest Management concept.

Importance and scope of plant pathology. Concept of disease in plants. Nature and classification of plant diseases. Importance and general characters of fungi, bacteria, fastidious bacteria, nematodes, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa and phanerogamic parasites. Pathogenesis due to obligate and facultative parasites. Variability in plant pathogens. Conditions necessary for the development of disease epidemics. Survival and dispersal of plant pathogens. Management of key diseases and nematodes of major crops.

PRACTICAL

Familiarization with generalized insect's body structure and appendages. Life stages. Acquaintance with insect diversity. Identification of important insect pests of cereals, cotton, oilseeds, pulses, sugarcane, fruit and vegetables crops and stored-grains, and their symptoms of damage. Acquaintance with useful insects: predators, parasitoids, pollinators, honey bees and silkworms. Acquaintance with various pesticidal formulations. Principles and working of common plant protection appliances. Calculation for preparing spray material.

Acquaintance with plant pathology laboratory equipment. Preparation of culture media for fungi and bacteria. Demonstration of Koch's postulates. Study of different groups of fungicides and antibiotics and methods of their evaluation. Diagnosis and identification of important diseases of cereals, cotton, oilseeds, pulses, sugarcane, fruit and vegetable crops and their characteristic symptoms.

TEACHING SCHEDULE

THEORY [CP-231]

Lecture No.	Topic	Sub-topics / Key Points	Weightage (%)
1 - 4	Insects- their General Body Structure	Body segmentation of insect, Head: Insect head capsule: Important sclerites and sutures, Positions of head; Structure and Modifications of insect antennae, Thorax: Structure of typical insect leg and its Modifications., Structure of Wing and its Modifications with Examples, Abdomen: Abdominal appendages	10
5	Importance of Insects in Agriculture	Beneficial and Harmful insects in Agriculture with examples	10
6	Life Cycle of Insects	Different stages of life cycle; Types of eggs, larvae and pupae; Definition and Types of Metamorphosis / Life cycle: with examples	
7	Insects Diversity	Distribution and Abundance of insects; Reasons for diversity of insects / Dominance of insects	10
8 - 9	Feeding Stages of Insects and Kinds (Modifications) of Mouthparts	Different feeding stages of insects; Insect Mouthparts and its modifications with feeding mechanisms. (Cockroach, Honeybee, Red cotton bug, Thrips, House fly and Butterfly)	
10 - 11	Concepts in Population Build-up of Insects – GEP, DB, EIL, ETL and Pest Status	Concepts in population build-up of insects: Biotic potential, Environmental resistance, Carrying capacity, Reproductive rate, Generation time, Density-dependent factors, Density-independent factors, Migration/ dispersal, Dormancy; Concept of GEP, DB, EIL, ETL and Pest status and Different types of pests	5
12	Causes of Insect-Pests Outbreak	Reasons or Causes for outbreak of insect-pests with example	10
13	General Symptoms of Insect Attack	Yellowing or Drying of leaves, Stunted growth and Wilting, Holes or Damage on leaves, Stems, or Fruits, Presence of insects, their Droppings, or Frass, Sooty mold, Distorted growth or Deformed parts, Gall formation, Bark ripping, Branch dieback, etc.	
14 - 15	Principles and Methods of Insect-Pests Management	Principles of insect-pests management: Consideration of Ecosystem, Pest Surveillance, Utilization of Economic Threshold Levels (ETL), Application of minimum selective hazards, etc; Methods of insect-pests management: Cultural, Mechanical, Physical, Biological, Host Plant Resistance, Genetic, Legal, Chemical and Recent Advances in Pest Management	10

Continued…

16	Integrated Pest Management Concept	Concepts of insect-pests management: Understanding agroecosystems, Planning of agroecosystems, Cost-Benefit ratio, Tolerance of pest damage, Leaving pest residue, Timing of treatment, Public understanding and Acceptance; Importance of IPM	
17 - 18	Importance and Scope of PLANT Pathology, Terms and Concepts in Plant Pathology	Importance of Plant diseases (Crop losses, Food security, Environmental impact, Health hazards, Environmental sustainability). Terms and Concepts in Plant Pathology	4
19 - 20	Nature and Classification of Plant Diseases and Causes of Plant Disease with Examples	Classification of Plant diseases: A. On the basis of major causal agent B. Group of host affected C. Plant part affected D. Pathological effect of host E. Gross effect produced on host F. Occurrence of the disease G. Extent of Infection H. Pathogen generation Causes of Plant Disease with examples: i) Biotic – Eukaryotic- Fungi, Protozoa, Algae, Nematode and Flowering parasites - Prokaryotic - Bacteria, Fastidious vesicular bacteria, Phytoplasmas, Spiroplasmas, Actinomycetes) ii) Mesobiotic- Viruses, Viroids iii) Abiotic causes of diseases - Deficiencies or excess of nutrients, Light, Moisture, Aeration, Abnormalities in soil conditions and atm. impurities	6
21 - 24	Important and General Characters of Fungi, Bacteria, Fastidious Vesicular Bacteria, Nematodes, Phytoplasmas, Spiroplasmas, Viruses, Viroids, Algae, Protozoa and Phanerogamic Parasites	Fungi: General characters, Somatic structures, Bacteria: General morphological characters. Reproduction in bacteria (Broad outline of Binary fission, Conjugation, Transduction and Transformation). Important genera of phytopathogenic bacteria and their characters Introduction to other plant Pathogens: Flagellant protozoa, FVB, Green algae and Parasitic higher plants (Cuscuta, Striga, Orobanchy and Loranthus) Viruses and Viroid: General characters, Nature, Multiplication and Infection. Mode of transmission (Mechanical, Vegetative Propagative materials, Grafting, Seed and Pollen, Cuscuta, Insects)	10

Continued…

25 - 27	Pathogenesis, Avenues of Infection and Defence Mechanism	Pathogenesis- (Mechanism of infection by various plant pathogens- Active infection (Fungi and Flowering plant parasites) and Passive Infection (Bacteria and Viruses) Avenues of penetration: A) Direct- i. Cutinised surface- Epidermal layer, ii. Non-cutinised surface- Root hairs, Seedlings, Nectaries, Buds, Anthers, Stigma Ends, Needles B) Indirect- i. Natural openings- Stomata, Lenticels, Hydathodes ii. Artificial openings- Injuries, Wound, Cut ends Defence mechanism associated with host- Morphological or Structural defence (Pre-existing defence structure, Post-infection defence structures) Biochemical defence mechanism (Pre-existing defence biochemicals, Post-infection defence biochemical)	5
28	Variability in Plant Pathogens	Variability in plant pathogens- Emergence of new strains or races that can overcome host resistance. Variability is driven by: various mechanisms *viz.*, Mutation, Hybridization and Recombination.	5
29 - 30	Conditions Necessary for the Development of Disease Epidemic	Introduction to Plant Disease Epidemiology: Spread of the disease in a population; Van der Plank (1963)- Threshold Theorem; Compound interest diseases, Simple Interest Diseases; Factors governing epidemic: Host factors, Pathogen factors, Environmental factors, Human intervention, Space, Time and Chance Essential conditions for an epiphytotic- Distance of susceptible plants from the source of primary inoculums; Abundance and Distribution of susceptible host; Disease proneness; Presence of suitable collateral and alternate host; Presence of aggressive pathogen; High birth rate of pathogen; Low death rate Easy and rapid dispersal of the pathogen; Adaptability of pathogen; Optimum weather	5
31	Survival and Perpetuation of Plant Pathogens	Survival and Perpetuation of plant pathogens: Facultatism, Persistent mycelium; Dormant mycelium, Propagative part Sclerotia; Collateral and Alternate host resistant spores; Polymorphism physiologic specialization	5
32	Dissemination of Plant Pathogens	Dissemination of plant pathogens: Direct- autonomous, Wind, Water, Rain, Soil, Compost, Animals, Birds, Insects, Seed/ Propagative parts, Indirect- Human.	5
		Total=	**100**

TEACHING SCHEDULE

PRACTICAL [CP-231]

Exercise No.	Exercise Title
1	To study generalized insect's body structure and appendages
2	To study different life stages of insects
3	To study insect diversity
4 - 5	To identify important insect pests of cereals, cotton, oilseeds, pulses, sugarcane, fruit and vegetables crops and stored-grains and their symptoms of damage
6	To study useful insects: predators, parasitoids, pollinators, honey bees and silkworms.
7	To study various pesticidal formulations.
8	To study principles and working of common plant protection appliances. Calculation for preparing spray material.
9	Acquaintance with various Plant Pathology Laboratory equipments.
10 - 11	Preparation of culture media for fungi and bacteria.
12	Demonstrations of Koch's postulates
13 - 14	Study of different groups of fungicides and antibiotics and method of their evaluation
15 -16	Diagnosis and identification of important diseases and their characteristic symptoms: cereals, cotton, sugarcane, oilseeds, pulses, fruit and vegetable crops.

Suggested Readings [CP-231]:

1. **Atwal A.S. and Dhaliwal G.S.** 2002. Agricultural Pests of South-Asia and their Management, Kalyani Publishers.
2. **Dhaliwal G.S. and Arora R.** 1996, Principles of Insect Pest Management, National Agriculture Technology Information Centre.
3. **Dhaliwal G.S., Singh R. and Chhillar B.S.** 2006. Essentials of Agricultural Entomology, Kalyani Publishers.
4. **Singh H.** 1984. Household and Kitchen Garden Pests – Principles and Practices, Kalyani Publishers.
5. **Sehgal P.K.** 2017. Fundamentals of Agricultural Entomology Unknown Binding, Kalyani Publishers.
6. **Agrios, G.N.** 2010. Plant Pathology. Acad. Press.
7. **Mehrotra R.S. and Aggarwal A.** 2007. Plant Pathology.7th Ed. Tata McGraw Hill Publ. Co. Ltd.
8. **Singh R.S.** 2008. Plant Diseases.8th Ed. Oxford and IBH. Pub. Co.
9. **Singh R.S.** 2013. Introduction to Principles of Plant Pathology. Oxford and IBH Pub. Co.
10. **Stakman E.C. and Harrar J.G.** 1957. Principles of Plant Pathology, Oxford and IBH Pub. Co.
11. **Tar SAJ.** 1964. The Principles of Plant Pathology, McMillon, London.
12. **Kumar S.** 2021. Fundamentals of Plant Pathology, SBN9789390591206, NIPA.

B.Tech. (Biotechnology)

#List/ Bouquet of Skill Enhancement Courses (SECs)

[in continuation of the SECs' Syllabi prescribed under I and II semesters]

Sr. No.	Course No.	Course Title	Credit Hrs.
1.	**SEC-111**	Practices in Plant Tissue Culture	2(0+2)
2.	**SEC-112**	Laboratory Management and Instrumentation	2(0+2)
3.	**SEC-123**	Basic Techniques of Molecular Biology and Biotechnology	2(0+2)
4.	**SEC-124**	Bioinformatics and Biocomputation	2(0+2)
5.	**SEC-235**	Methods in Recombinant DNA Technology	2(0+2)
6.	**SEC-246**	Practices in Molecular Marker Technology	2(0+2)

Note: (i) Skill Enhancement Courses can be added/ offered as per the facilities and resources available at the respective universities/colleges based on the relevance to the region and the UG degree subject. However, the SEC courses are already prescribed and mentioned across specific Semesters in the ICAR-Sixth Deans' Committee Report Deans' Committee Report Syllabus of B.Tech.(Biotech.) degree program.

(ii) Above list/ bouquet of SEC courses is an indicative list and subject to modification as applicable therein.

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Semester	**:**	**III**		
Course No.	**:**	**SEC-235**	**Credit Hrs.**	**: 2(0+2)**
Course Title	**:**	**Methods in Recombinant DNA Technology**		

SYLLABUS

Objectives:

(i) To train the students on Good Laboratory Practices, media and stock preparation,

(ii) To enable skill development by providing hands-on training on methods in recombinant DNA technology.

PRACTICAL

Preparation of growth media, Stock solutions and buffers. Plasmid DNA isolation. Quality and Quantity assessment of DNA. Restriction digestion of DNA. Agarose gel electrophoresis. Preparation of competent cells and genetic transformation of *E. coli*. Screening of recombinant DNA clones in *E. coli*. Confirmation of recombinant clones.

TEACHING SCHEDULE

PRACTICAL [SEC-235]*

Exercise No.	Exercise Title
1 - 2	Orientation to recombinant DNA laboratory and laboratory rules.
3 - 4	Introduction to various instruments used in rDNA laboratory and their working principle.
5 - 6	Preparation of solutions of different molarities, normalities, percentages.
7	Preparation of solid and liquid nutrient media for *E. coli*.
8	Culturing of *E. coli* on solid and liquid nutrient media and maintenance of *E. coli culture*.
9 - 10	Isolation of Genomic DNA from Bacterial source.
11 - 12	Isolation of Plasmid DNA from Bacterial source.
13	Quality and Quantity determination of DNA.
14 - 15	Agarose gel electrophoresis of plasmid DNA, Bacterial genomic DNA and DNA ladder.
16 - 17	Set up of restriction digestion reaction for Genomic and Plasmid DNA.
18	Visualization of restriction digestion of DNA bands on an agarose gel electrophoresis.

Continued…

19 - 20	Mapping of restriction sites on Plasmid DNA for restriction map.
21	Ligation of DNA molecules.
22 - 23	Preparation of *E. coli* competent cells using $CaCl_2$.
24	Storage of competent cells to ensure the Viability and Transformation efficiency.
25	Transformation of *E. coli* competent cells with a plasmid by heat shock method.
26	Screening of transformed *E. coli* cells using selectable markers.
27	Screening of recombinant *E. coli* cells by blue-white screening.
28 - 29	Recombinant plasmid DNA isolation from transformed bacterial cells.
30	Set up of PCR reaction for plasmid DNA with gene specific primers.
31	Programming of PCR machine for the amplification of gene of interest.
32	Visualization of PCR amplified bands of gene of interest on gel electrophoresis.

***Project work should be done from start to end of the semester with group of 10 - 20 students.**

Suggested Readings [SEC-235]:

1. **Green M.R. and Sambrook J**., 2012, Molecular Cloning: A Laboratory Manual, 4th Ed, Cold Spring Harbor.
2. **Glick B.R. and Patten C.L**., 2022, Molecular Biotechnology: Principles and Applications of Recombinant DNA, John Wiley and Sons.
3. **Carson S. and Robertson D**., 2005, Manipulation and Expression of Recombinant DNA, Elsevier.

Course Curriculum of Fourth Semester as per the ICAR-Sixth Deans' Committee Report for the Academic Programmes in BIOTECHNOLOGY

- UG-Certificate in Biotechnology
- UG-Diploma in Biotechnology
- UG-Degree: B.Tech. (Biotechnology)

Mahatma Phule Krishi Vidyapeeth, Rahuri

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani

Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli

Maharashtra Agricultural Universities Examination Board, Pune

Compiled &Submitted by

Dr. V.P. Chimote

Incharge, State-level Biotechnology Centre, MPKV, Rahuri.

UG Degree Syllabus State Coordinator

with

UG Degree Syllabus Discipline Coordinators &

DICC - UG Degree Syllabus Core Committee

Submitted to the

Directors of Instruction Coordination Committee

~ w.e.f. AY, 2025-26 ~

Course Curriculum of Fourth Semester as per the
ICAR-Sixth Deans' Committee Report for Academic Programmes in
BIOTECHNOLOGY

Course Layout

B.Tech. (Biotechnology)

Semester: IV (New) ***w.e.f.*** **Academic Year: 2025-26**

Sr. No.	Course No.	Course Title	Credit Hrs.	Remark
1.	**MDC-243**	Agriculture Marketing and Trade	3(2+1)	--
2.	**VAC-242**	Agricultural Informatics and Artificial Intelligence	3(2+1)	--
3.	**BT-248**	Introductory Bioinformatics	4(3+1)	--
4.	**BT-249**	Molecular Marker Technology	2(2+0)	--
5.	**BT-2410**	Biodiversity and its Conservation	2(2+0)	--
6.	**BIOCHEM-241**	Basic Biochemistry	4(3+1)	--
7.	**EXTN-241**	Human Ethics	1(1+0)	--
8.	**SEC-246**	Skill Enhancement Course VI: Practices in Molecular Marker Technology	2(0+2)	--
9.	**OC-1/ OC-2/…**	Online Courses/ MOOCs †	As opted by student	NG
		Total Credits Hrs.	**21(15+6)**	**G**
MDC: Multidisciplinary Course, **VAC**: Value-added Course, **OC**: Online Course, **G**: Gradial, **NG**: Non-gradial				
Post-IV Semester (Only for Exit option for award of UG-Diploma)				
10.	**INT-242**	Internship (10-week)	10(0+10)	NG

† **Note:** It is mandatory for each Student to complete **total 10 credits** (Non-gradial) of **Online Courses** from available resources across III to VIII semesters under the guidance of assigned Faculty/Advisor.

Course-wise Syllabus with Teaching Schedules

Semester	**:**	**IV**			
Course No.	**:**	**MDC-243**	**Credit Hrs.**	**:**	**3(2+1)**
Course Title	**:**	**Agricultural Marketing and Trade**			
Gradial Common Course among 4 UG Degrees viz., **B.Tech. (Biotech.)/ B.Sc. (Hons.) Forestry/ B.F.Sc. (Hons.)/ B.Sc. (Hons.) Community Sci.**					

SYLLABUS

Objectives:

i) To understand the fundamentals of Agricultural Marketing and Trade,

ii) To analyse the factors influencing supply and demand in agricultural markets,

iii) To explore different marketing channels and strategies in Agriculture,

iv) To examine the role of Government Policies and Regulations in agricultural markets.

THEORY

Agricultural Marketing: Concepts and Definitions of Market, Marketing, Agricultural Marketing, Market structure, Marketing mix and Market segmentation, Classification and Characteristics of Agricultural markets; Demand, Supply and Producer's surplus of agri-commodities: Nature and Determinants of demand and supply of farm products, Producer's surplus – Meaning and its types, Marketable and Marketed surplus, Factors affecting marketable surplus of agri-commodities; Pricing and promotion strategies: Pricing considerations and approaches – Cost-based and Competition-based pricing; Market promotion – advertising, Personal selling, Sales promotion and Publicity– their meaning and merits and demerits; Marketing process and Functions: Marketing process concentration, dispersion and equalization; Exchange functions – buying and selling; physical functions – storage, transport and processing; Facilitating functions – packaging, branding, grading, quality control and labeling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and Definition of Marketing Channel; Number of channel levels; Marketing channels for different farm products; Integration, Efficiency, Costs and Price spread: Meaning, Definitions and Types of market integration; Marketing efficiency; Marketing costs, margins and price spread; Factors affecting cost of marketing; Reasons for higher marketing costs of farm commodities; Ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP, DMI, NAFED, TRIFED, NCDC, APEDA– their objectives and functions; Cooperative marketing in India; Risk in marketing: Types of risk in marketing; Speculation and hedging; An overview of futures trading; Agricultural prices and policy: Meaning and functions of price; Administered prices; Need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, Theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian Agriculture; IPR. Role of Government in Agricultural marketing. Role of APMC and its relevance in the present-day context.

PRACTICAL [MDC-243]

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, Identification of marketing channels for selected commodity; Collection of data regarding marketing costs, margins and price spread and Presentation of report in the class; Visit to market institutions - NAFED, SWC, CWC, Cooperative Marketing Society etc. To study their organization and functioning. Application of principles of comparative advantage of International Trade.

TEACHING SCHEDULE

THEORY [MDC-243]

Lecture No.	Topic	Sub-topics / Key Points	Weightage (%)
1	Market and Marketing	Meaning – Definitions – Components of market – Market structure – Meaning – Components – Market conduct – Market performance	4
2	Agricultural Marketing	Meaning – Definition – Scope – Subject matter – Importance of Agricultural Marketing in economic development	6
3		Market structure, Marketing mix and Market segmentation	
4	Classification and Characteristics of Agricultural Market	Classification of Markets – On the basis of Location, Area of coverage, Time span, Volume of transaction, Nature of transaction, Number of commodities, Degree of competition, Nature of commodities, Stage of marketing, Extent of public intervention, Type of population served, Accrual of marketing margins	4
5	Demand and Supply	Demand, Supply and Producer's Surplus of agri-commodities; Nature and Determinants of Demand and Supply of farm products	4
6	Producer's Surplus	Meaning- Marketable surplus- Marketed surplus- Importance- Factors influencing Marketable surplus of agri-commodities	4
7 - 8	Pricing and promotion strategies	Pricing and Promotion Strategies; Pricing considerations and Approaches – Cost-based and Competition-based pricing	6
9	Market Promotion	Advertising, Personal selling, Sales promotion and Publicity – their Meaning, Merits and Demerits	4
10	Marketing Process and Functions	Marketing process concentration, Dispersion and Equalization	12
11		Marketing functions – Meaning – Exchange functions – Buying and Selling	
12		Physical Functions – Storage, Transport and Processing	
13		Facilitating Functions – Packaging, Branding, Grading, Quality control and Labeling (AGMARK)	
14	Market Functionaries and Marketing Channels	Types and Importance of agencies involved in Agricultural Marketing	8
15 - 16		Meaning and Definition of Marketing Channel; Number of channel levels; Marketing channels for different farm products;	

Continued…

17	Market Integration	Definition-Types of Market integration - Horizontal, Vertical and Conglomeration	4
18	Marketing Efficiency	Meaning- Definitions- Technical or Physical or Operational efficiency, Pricing or Allocative efficiency	4
19	Marketing Cost	Marketing Cost- Margins- Price spread- Factors affecting the costs of marketing- Reasons for higher marketing costs of agricultural commodities, Ways of reducing marketing costs for farm products	4
20	Role of Govt. in Agricultural Marketing	Govt. in Agricultural Marketing- Remedial measures, Regulated markets – Definition -Important features of Regulated markets, Functions, Progress and Defects	4
21 - 22	Public Sector Institutions	Objectives and Functions of: • National Agricultural Cooperative Marketing Federation (NAFED) • Tribal Cooperative Marketing Development Federation (TRIFED) • National Cooperative Development Corporation (NCDC) • Agricultural and Processed Food Products Export Development Authority (APEDA) • Central Warehousing Corporation (CWC) • State Warehousing Corporations (SWC) • Food Corporation of India (FCI) • Commission for Agricultural Cost and Prices (CACP) • Directorate of Marketing and Inspection (DMI)	6
23	Cooperative Marketing	Meaning- Structure- Functions of Cooperative Marketing Societies	2
24	Risk in Marketing	Types of Risk in Marketing	6
25		Speculation and Hedging- An Overview of Futures trading	
26	Agricultural Prices & Policy	Meaning and Functions of Price; Administered prices; Need for Agricultural Price Policy	4
27 - 28	International Trade	Concept of International Trade and its Need, International trade- Definition, International vs. Interregional trade, Free trade vs. Protection.	10
29		Theories of Absolute and Comparative Advantage	
30		Present status and Prospects of International trade in Agri-commodities; GATT and WTO	
31		Agreement on Agriculture (AoA) and its implications on Indian Agriculture, Intellectual Property Rights (IPR)	
32	APMC	Role of APMC and its relevance in the present-day context	4
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [MDC-243]

Exercise No.	Exercise Title
1	Plotting and Study of demand and supply curves.
2	Calculation of price and income elasticity of demand.
3	Study of the relationship between market arrivals and prices of selected commodities.
4	Computation of marketable and marketed surplus of important commodities.
5	Study of price behaviour (seasonal indices) over time for selected commodities.
6	Construction of simple and weighted price index numbers.
7	Visit to the local market to study different marketing functions performed by different Agencies.
8	Study and Identification of marketing channels for selected commodities.
9	Collection of data and estimation of marketing cost, marketing margin and price spread of selected commodities.
10	Introduction to different Public Agricultural Marketing Web Portals - (AgMarkNet, MSAMB).
11	Visit to NAFED – Organisational and Functional Study.
12	Visit to SWC/CWC- Study of Warehousing Operations.
13	Visit to Co-operative Marketing Society – Functional analysis.
14	Visit to Local Processing Unit.
15	Application of Absolute Advantage Theory in International Trade.
16	Application of Comparative Advantage Theory in International Trade.

Suggested Readings [MDC-243]:

1. **Acharya, S.S. and Agarwal, N.L.** 2006. Agricultural Marketing in India, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. **Chinna, S.S.** 2005. Agricultural Economics and Indian Agriculture. Kalyani Pub, New Delhi.
3. **Dominic Salvatore**, Micro Economic Theory.
4. **Kohls Richard, L. and Uhl Josheph, N.** 2002. Marketing of Agricultural Products, Prentice-Hall of India Private Ltd., New Delhi.
5. **Kotler and Armstrong.** 2005. Principles of Marketing, Pearson Prentice-Hall.
6. **Lekhi, R. K. and Joginder Singh.** 2006. Agricultural Economics. Kalyani Publishers, Delhi.
7. **Memoria, C.B., Joshi, R.L. and Mulla, N.I.** 2003. Principles and Practice of Marketing in India, Kitab Mahal, New Delhi.
8. **Pandey Mukesh and Tewari Deepali.** 2004. Rural and Agricultural Marketing, International Book Distributing Co. Ltd, New Delhi.
9. **Sharma, R.** 2005. Export Management, Laxmi Narain Agarwal, Agra.

Semester	**:**	**IV**
Course No.	**:**	**VAC-242**	**Credit Hrs. : 3(2+1)**
Course Title	**:**	**Agricultural Informatics and Artificial Intelligence**
Gradial Common Course across 8 UG degrees viz., B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Horticulture, B.Tech. (Biotechnology), B.Tech. (Food Technology), B.Sc. (Hons.) Agri. Business Management, B.Sc. (Hons.) Forestry, B.F.Sc. (Hons.) and B.Sc. (Hons.) Community Science		

SYLLABUS

Objectives :

(i) To acquaint students with the basics of computer applications in Agriculture, multimedia, database management, application of mobile app and decision-making processes etc.,

(ii) To provide basic knowledge of computer with applications in Agriculture,

(iii) To make the students familiar with Agricultural-Informatics, its components and applications in Agriculture and Artificial Intelligence.

THEORY

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office® for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database- concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (WWW): Concepts and components. Computer programming: General concepts, Introduction to general programming concepts and standard input/output operations. e-Agriculture, concepts, design and development; Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, input-output files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in Agriculture for farm advice: Market price, post-harvest management etc. Geospatial technology: Techniques, components and uses for generating valuable agri-information, Decision support systems: Concepts, components and applications in Agriculture. Agriculture Expert System: Soil Information Systems etc. for supporting farm decisions. Preparation of contingent crop planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Introduction to Artificial Intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A*algorithm, IoT and Big Data; Use of AI in Agriculture for autonomous crop management and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce and other food processing applications; Concepts of Smart Agriculture, Use of AI in Food and Nutrition Science etc.

PRACTICAL

Study of computer components, accessories, practice of important DOS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. Use of MS-WORD and MS-PowerPoint for creating, editing and presenting a scientific document, MS-EXCEL - Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri-information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as- Visual Basic, Java, Fortran, C, C++, Hands-on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/Wofost, Preparation of inputs file for CSM and study of model outputs, Computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, AR/VR demonstration, India Digital Ecosystem of Agriculture (IDEA).

TEACHING SCHEDULE

THEORY [VAC-242]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1- 3	**Introduction to Computers, Anatomy of Computers** **Memory Concepts:** **Operating System:**	Definitions; Characteristics of Computer; Components of Computer; CPU: CU, ALU, MU; Input Devices; Output Devices; Units of Memory: bit to TB, Types: Primary, Secondary; Definitions and Types: Single user, Multi-user and features. OS Special Types (Brief Overview): Batch, Real-Time, Time Sharing, Distributed, Network OS. Functions of operating system	7
4 - 6	**Applications of MS Office®**	MS Word: Creating a New Document, Formatting option features; Insertion of Table; MS Excel: Creating worksheet and graph, Functions for Data Analysis: AVERAGE, COUNT, SUM, MIN, MAX, MEDIAN, MODE, STDEV, STDEVP, VAR, VARP, CORREL, PERCENTILE; Mathematical functions in MS-Excel: SUM, AVERAGE, AVERAGEIF, COUNT, COUNTIF, MOD, ROUND	7
7 - 9	**Database and DBMS**	Database: Definitions, Concepts and Types; Uses of DBMS in Agriculture; Characteristics of Database; Structure of Database Management System, Tables: Concept of view, Primary key, Foreign key; Creating Database: SQL query: Create, Insert, Select, Delete, Update. Form: Steps for Creating Forms, Entering Data in forms, Report using MS-ACCESS: Steps for Creating Reports, Printing reports.	7

Continued…

10	**Internet and World Wide Web (www)**	Concepts and components; Internet: Introduction; Definition of LAN, WAN, MAN and Internet Internet Service Provider (ISP); World Wide Web; Hypertext; Web Browser; Web Page and Websites; E-Mail: Creating Email, Email Addresses, Using Email, Sending the message, CC and BCC; Search Engine	7
11 - 12	**Introduction to Computer Programming**	Computer Programming: Introduction, General concepts, Standard input/output operations.	7
13 - 14	**e-Agriculture**	Concepts, Application & Importance of IT in e-Agriculture; AGRINET: Introduction, Objectives; Advantages and Challenges in Agriculture.	7
15 - 16	**Computer Models in Agriculture**	Statistical, Weather Analysis and Crop Simulation Models; Concepts, Input-output files, Limitation, Advantages and Application of models for understanding plant processes, Sensitivity, Verification, Calibration and Validation	7
17 - 19	**IT and IoT Applications in Agriculture**	IT Applications & their role in Agriculture with emphasis on Computation of Water and Nutrient Requirement of Crop; IoT - Definition, Benefits/ Applications/ Uses in Agriculture: Precision Farming, Agricultural Drones, Smart Greenhouses, Drones; Challenges.	7

Continued…

20 - 21	**Computer-controlled Devices; Smartphone Apps and Geospatial Technology**	Computer-controlled Devices (Automated systems) for Agri-input management- Examples of Automation Devices: Robotics Application in Planting, Drones for Irrigation, Harvest Automation Tools, Automated Tractors etc., AWS - Automatic Weather Station, AIS - Automatic Irrigation System. Smartphone Mobile Apps in Agriculture- Introduction- Irrigation Systems, Fertilizer Application, Pest and Disease Management; Seeding and Planting, Harvesting Systems; Weather Forecasting, Soil Testing and Analysis, Crop Management, Market Prices; Farm Management, Financial & Insurance Services. Geospatial Technology (*in brief*) – Introduction, Techniques, Components and Uses for generating valuable agri-information.	7
22 - 23	**Decision Support System (DSS)**	DSS: Introduction, Concepts, Components, Types and Applications in Agriculture.	7
24 - 25	**Agriculture Expert System (AES)**	AES: Introduction, Concepts, Components and Applications in Agriculture- Soil Information Systems for supporting farm decisions.	7
26 - 27	**Contingent Crop Planning using IT Tools**	Preparation of Contingent Crop Planning and Crop Calendars: Introduction, Definition, Benefits, Steps to prepare Contingent Crop Planning & Calendars using IT Tools.	7
28 - 30	**Digital India and Schemes to promote Digitalization of Agriculture in India**	Digital India and Schemes to Promote, Digitalization of Agriculture in India; Digital Agriculture in India: Status, Challenge, Digital India and Initiatives in Agriculture Sector. Digital Agriculture or NeGP-A 2.0	8
31- 32	**Introduction to and Uses of Artificial Intelligence (Overview)**	Introduction to Artificial Intelligence, Background and Applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A*algorithm, IoT and Big Data; Use of AI in Agriculture for autonomous crop management and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce and other food processing applications; Concepts of Smart Agriculture, Use of AI in Food and Nutrition Science etc.	8
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [VAC-242]

Exercise No.	Exercise Title
1 - 2	Study of computer components, accessories, practice of important DOS command; Introduction to different Operating systems- such as Windows, Unix/ Linux; Creating files and folders, Files Management.
3 - 4	Use of ~ MS-WORD: Creating files and folders; Files management and MS-POWERPOINT: Presentation for creating, editing and presenting scientific documents. MS-EXCEL: Mathematical calculations; Preparation of Spread sheets; Use of statistical tools; Writing expressions; Creating graphs; Analysis of scientific data.
5	MS-ACCESS: Creating Database; Preparing queries and reports.
6	Demonstration of Agri-information system(s)
7 - 8	Introduction of Programming Languages & Program in C-Language: a) Program to enter name and print name b) Program to calculate sum and subtraction of numbers c) Program to calculate Area of Circle d) Program to calculate Area of Triangle e) Program to calculate Area of Rectangle
9	Introduction to Internet, World Wide Web (WWW) and its components.
10 - 11	Hands-on Practice on Crop Simulation Models (CSM): CROPWAT 8.0/ DSSAT/ Crop-Info/ CropSyst/ Wofost/ etc. Computation of water and nutrient requirements of crop using CSM and IT tools.
12	Use of Smartphone Apps (developed by SAUs) and other devices in agro-advisory and dissemination of market information
13	Introduction to Geospatial Technology (Use of Open-source GIS Tools)
14	Study/ Demonstration of general AR/VR tools (as available)
15	Hands-on Practice on Decision Support System (DSS);
16	Introduction to India Digital Ecosystem of Agriculture (IDEA)

Suggested Readings [VAC-242]:

1. Fundamentals of Computer by V. Rajaraman, PHI Learning.
2. Introduction to Information Technology by Pearson.
3. Introduction to Database Management System by C.J. Date, Pearson Education, N. Delhi.
4. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India.
5. Introductory Agri Informatics by Mahapatra, Subrat K. *et al.*, Jain Brothers Publication.
6. Russell, Stuart, Artificial Intelligence: A Modern Approach, Pearson Edition 2013.
7. Nilson N.J. 2001. Principles of Artificial Intelligence. Narosa Publ.
8. Agricultural Informatics and Artificial Intelligence for B.Tech.(Agril Technology) by Prashant Publ.

➢ ***Online Resources: (VAC-242)***

- https://en.wikipedia.org/wiki/Computer
- https://www.javatpoint.com/computer
- https://iasri.icar.gov.in/
- https://www.nrsc.gov.in/EO_Agr_Objective?language_content_entity=en
- https://www.agrimoon.com
- https://www.agriinfo.in
- https://eagri.org
- https://www.agriglance.com
- https://agritech.tnau.ac.in
- https://loksabhadocs.nic.in/Refinput/New_Reference_Notes/English/Agriculture_and_Digital_India.pdf
- https://www.investindia.gov.in/team-india-blogs/digitalisation-agriculture-india
- http://courseware.cutm.ac.in/wp-content/uploads/2020/06/Session-11-Preparation-of-Contingent-Crop-Planning-and-Crop-Calendars-Using-IT-Tools.pdf
- https://optimizeias.com/indias-digital-ecosystem-for-agriculture/
- https://www.igi-global.com/chapter/introduction-to-agricultural-information-systems/266572#:~:text=Agricultural%20Information%20Systems%3A%20Information%20system,knowledge%20utilization%20by%20agricultural%20producers.
- https://cropcalendar.apps.fao.org/#/home
- http://www.irdindia.in/journal_ijrdmr/pdf/vol4_iss1/7.pdf
- https://learn.microsoft.com/en-us/office365/servicedescriptions/office-applications-service-description/office-applications
- https://ebooks.inflibnet.ac.in/hsp16/chapter/application-of-software-in-statisticalanalysis-i-microsoft-excel/
- http://eagri.org/eagri50/STAM102/index.html
- https://edu.gcfglobal.org/en/internetbasics/using-a-web-browser/1/
- https://www.javatpoint.com/what-is-world-wide-web
- https://www.mdpi.com/journal/agriculture/special_issues/Decision_Support_Systems_Application
- https://apps.gov.in/ministry/ministry-agriculture
- http://courseware.cutm.ac.in/wp-content/uploads/2020/06/Session-11-Preparation-of-Contingent-Crop-Planning-and-Crop-Calendars-Using-IT-Tools.pdf
- https://apps.mgov.gov.in/apps_by_category;jsessionid=8206D0DAE69F48FB50962462A8922C23?name=Agriculture

➢ ***Tools available for Student for Academic Purpose only: (VAC-242)***

1. DSSAT (Decision Support System for Agrotechnology Transfer)
   - Purpose: A comprehensive crop modeling tool.
   - Use: Simulates plant growth, development, and yield for various crops under different management and environmental conditions.
   - Download: https://dssat.net/
2. APSIM (Agricultural Production Systems Simulator)
   - Purpose: A powerful plant simulation tool.
   - Use: Models the effects of environmental variables like soil, climate, and management strategies on plant growth and crop yield.
   - Download: https://www.apsim.info/
3. Open Sim Root
   - Purpose: A root growth modeling software.
   - Use: Helps understand plant root growth processes, interactions with soil, and how they respond to environmental conditions.
   - Download: Available as open-source software via research platforms like Git Hub. https://gitlab.com/rootmodels/OpenSimRoot
4. Virtual Plant
   - Purpose: A tool for visualizing and modeling plant metabolic and regulatory networks.
   - Use: Helps in understanding complex plant processes such as gene regulation, metabolic pathways, and how they respond to environmental conditions.

   Download: https://sourceforge.net/projects/virtualplant/
5. R Studio (with Bioconductor and Plant Modeling Libraries)
   - Purpose: A programming environment for statistical computing.
   - Use: Using plant modeling libraries like plant and photosynthesis, researchers can model plant growth, carbon assimilation, and nutrient cycling.
   - Download: https://posit.co/downloads/
6. WOFOST (World Food Studies)
   - Purpose: A plant process and crop growth simulation model developed by the FAO.
   - Use: Helps in understanding crop development, photosynthesis, and biomass accumulation under different environmental and management conditions.
   - Download: https://www.wur.nl/en/research-results/research-institutes/environmental-research/facilities-tools/software-models-and-databases/wofost/downloads-wofost.htm
7. Green Lab
   - Purpose: A plant growth model focused on plant architecture and functional growth processes.
   - Use: Simulates plant organ development and growth processes, integrating functional and structural aspects of plant behavior.
   - Download: https://greenlab.cirad.fr/GLUVED/html/P3_Tools/Tool_simul_003.html

Semester	**:**	**IV**			
Course No.	**:**	**BT-248**	**Credit Hrs.**	**:**	**4(3+1)**
Course Title	**:**	**Introductory Bioinformatics**			

SYLLABUS

Objectives:

i) To train the students on applications of computers on analyzing the biomolecules (DNA, RNA and Protein),
ii) To study various types of databases,
iii) To study various operations and algorithms in Bioinformatics.

THEORY

Introduction to Bioinformatics. Development and scope of Bioinformatics. Applications of Computers in Bioinformatics. Operating systems, Hardware, Software, Internet, WWW resources, FTP, Application of Bioinformatics in Agriculture.

Primary databases: Nucleotide sequence databases (GenBank, EMBL), Protein sequence databases; Secondary databases: SwissProt/TrEMBL, Conserved domain database, Pfam; Structure databases: Protein Data Bank (PDB), MMDB, SCOP, CATH; File formats: GenBank, EMBL, FASTA, PDB, Flat file, ASN.1, XML.

Introduction to Sequence alignment and its applications. Pairwise and Multiple sequence alignment, the Concept of Local and Global alignment; Algorithms. Dot Matrix method, Dynamic programming methods (Needleman–Wunsch and Smith–Waterman). Tools of MSA: ClustalW, TCoffee. Phylogeny. Introduction to BLAST and FASTA; MSA and Phylogeny. Assembly and Annotation.

PRACTICAL

Hands-on-Training on Databases,

Database Construction and Management,

Algorithms and Analysis of DNA, RNA and proteins.

TEACHING SCHEDULE

THEORY [BT-248]

Lecture No.	Topic	Sub-topics / Key Points	Weightage (%)
1 - 4	Introduction to Bioinformatics	Definition, Introduction, History, Development and Scope of Bioinformatics, Applications of Computers in Bioinformatics, Future prospects	6
5 - 9	Computers in Bioinformatics	Operating systems and Computer hardware, Software applications, Bioinformatics workstations; Internet and web resources, FTP, Role of Bioinformatics in Agriculture	8
10 - 11	Biological Databases and their Classification	Definition and Biological Database Classification	8
12 - 15	Primary Databases	Nucleotide sequence databases (GenBank, EMBL, data submission and retrieval; annotation basics), Protein sequence databases; their features and uses	10
16 - 18	Secondary Databases	SwissProt/ TrEMBL, Conserved domain database (CDD), Pfam	8
19 - 22	Structure Databases	Protein Data Bank (PDB), MMDB, SCOP, CATH classifications	8
23 - 24	File Formats	GenBank, EMBL, FASTA, PDB, Flat files, ASN.1, XML; data exchange and interoperability	8
25 - 28	Introduction to Sequence Alignment and its Applications	Definition and Types; Pairwise and Multiple sequence alignment, The Concept of Local and Global alignment, Application of these algorithms in different biological problems	8
29 - 33	Algorithms of Sequence Algorithm	Dot Matrix method, Dynamic programming methods: (Needleman–Wunsch algorithm; Smith–Waterman algorithm)	6
34 - 38	Introduction to BLAST and FASTA	Different BLAST Programmes: their application in terms of Nucleic acid and Protein sequence. Significance of E Value. FASTA Tool	10
39 - 42	MSA (Multiple Sequence Alignment)	Tools of MSA: ClustalW, TCoffee; Use of these tools for MSA of DNA and Protein sequences. Save output file in Phylip format.	8
43 - 45	Phylogeny	Terminologies in Phylogeny, Applications and Methods of phylogenetic analysis	6
46 - 48	Assembly and Annotation	Genome Assembly and Genome Annotation: Principles and Approaches; Structural and functional annotation	6
		Total=	**100**

TEACHING SCHEDULE

PRACTICAL [BT-248]

Exercise No.	Exercise Topic
1	DNA sequence retrieval from biological databases: EMBL/ GenBank/ DDBJ.
2	To study the protein database: Protein information resource and UniProtKB.
3	To study the protein secondary databases: CDD and Pfam.
4	To study the protein structural databases: PDB, MMDB.
5	To study the protein secondary databases: CATH, SCOP.
6	To create small custom databases for DNA and protein sequences using tools like, SQLite/MySQL.
7	To organize, updating, and querying biological databases using SQLite/MySQL.
8	To convert sequence data between FASTA, GenBank, EMBL, and PDB formats using EMBOSS SEQRET tool.
9	BLAST analysis of unknown protein sequence and unknown nucleotide sequence.
10	Sequence similarity searching using FASTA Tool.
11	Multiple sequence alignment of DNA using Clustal Omega.
12	Phylogenetic Tree Construction: Constructing trees using neighbour-joining and maximum likelihood methods.
13	Prediction of primary structure of protein: Translation and prediction of amino-acid and atomic compositions, pI, extinction coefficient, etc.
14	Secondary structure prediction of protein sequence using APSSP and Ramachandran Plot.
15	Tertiary structure prediction of protein sequence using Swiss Model/ Modeller.
16	Molecular visualization of protein structures using Cn3D, SPD Viewer, Ras Top etc.

Suggested Readings [BT-248]:

1. **Baxevanis, A.D., Ouellette, B.F.F.** 2011. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, John Wiley and Sons.
2. **Mount, D.W.** 2001. Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor.
3. **Xiong, J.** 2012. Essential Bioinformatics, Cambridge University Press.
4. **Atwood, T.K. and Parry-Smith, D.J.** 1999. Introduction to Bioinformatics, Harlow, Essex, England: Longman.
5. **Cynthia Gibas and Per Jambeck.** 2001. Developing Bioinformatics Computer Skills, O'Reilly.
6. **Rastogi, S.C. Mendiratta, and Rastogi, P.** 2023. Bioinformatics Methods and Applications Genomics, Proteomics and Drug Discovery. 5th Edition, PHI learning.

Semester	**:**	**IV**		
Course No.	**:**	**BT-249**	**Credit Hrs.**	**: 2(2+0)**
Course Title	**:**	**Molecular Marker Technology**		

SYLLABUS

Objectives:

i) To study the importance and types of molecular markers,

ii) To study the mapping populations, development and analysis,

iii) To study the applications of molecular markers in Mapping and Breeding.

THEORY

Introduction; Types of molecular markers - RFLP; PCR-based markers like RAPD, SCAR, SSR, STS, CAPS, AFLP, SNP and their variants. Uses of molecular markers. Application as a genetic tool for genotyping and gene mapping. Mapping populations: F_2, DH, RILs, NILs. Bulked segregant analysis, linkage maps, physical maps. Application of molecular markers. Assessing genetic diversity, variety protection. Introduction to genomic selection, marker-assisted breeding for accelerated introgression of trait/transgene and quantitative traits. Human and Animal health. Association with genetic-based diseases. Paternity determinations. Parentage using SNP data. Forensic studies. DNA Fingerprinting.

Suggested Readings [BT-249]:

1. **Srivastava, P.S.** 2005, Plant Biotechnology and Molecular Markers, New India Publishing Agency, Springer and Academic Press.
2. **Gupta P.K.** 2015, Molecular Biology and Genetic Engineering, Rastogi Publication.
3. **Manikanda Boopathi N.** 2013, Genetic Mapping and Marker-Assisted Selection, Springer.
4. **Manikanda Boopathi N.** 2020, Genetic Mapping and Marker-Assisted Selection: Basics, Practice and Benefits, Springer.
5. **Schook L.B.** (Ed), 2020, Gene-Mapping Techniques and Applications, CRC Press.
6. **Verma P.S.** 2018, Cell Biology Genetics Molecular Biology Evolution and Ecology, Chaukhamba Auriyantaliya Publishers.
7. **Watson J.D., Levine M., Baker T.A., Gann A., Bell S.P. and Losick, R.** 2014, Molecular Biology of the Gene, Pearson.

TEACHING SCHEDULE

THEORY [BT-249]

Lecture No.	Topic	Sub-topics / Key Points	Weightage (%)
1	Introduction & Types of Markers	Definitions; Morphological markers, Biochemical Markers and Genetic markers	2
2 - 3	Types of Molecular Markers	Dominant and Co-dominant nature of markers with their specific applications	2
4 - 5	Types of Molecular Markers	Study of different marker-systems with their limitations and strengths viz., RFLP; PCR-based markers like, RAPD, SCAR, SSR, STS, CAPS, AFLP, SNP and their variants	12
6	Uses of Molecular Markers	Applications of molecular markers in various fields with special reference to crop improvement	10
7 - 8	Application as a Genetic Tool	Application as a genetic tool for genotyping and gene mapping	6
9 - 12	Mapping Populations	Different types of mapping populations viz., F_2, DH, RILs, NILs	4
		Methods of development and segregation pattern in each type of population. Merits and Demerits of each population	4
		Evaluation criteria for each type of population. Application of mapping population in molecular marker studies	2
13 - 14	Bulked Segregant Analysis	Analysis technique used for Bulked segregant analysis. Applications of BSA.	10
15 - 16	Linkage Maps; Physical Maps	Construction of linkage map and Physical map. Application of Linkage maps and Physical maps	10
17	Genomic Selection	Introduction to Genomic Selection (*in brief*)	2
18 - 19	Application of Molecular Markers	Assessing genetic diversity, Variety protection	8
20 - 21		Marker-Assisted Breeding for accelerated introgression of Trait/ Transgene	4
22 - 23		Marker-Assisted Breeding for quantitative traits	4
24 - 28	Application of Molecular Markers: Human and Animal Health	Association with genetic-based diseases: Genetic variations in the human genome, Genetic testing for genetic-based diseases, Parentage using SNP data	4
29 - 30	DNA Fingerprinting	Paternity determination: Determinations of paternity by molecular genetic "fingerprinting". Advantages of DNA fingerprints for determination of correct paternity, for genetic linkage and pedigree studies	8
31 - 32	Forensic Studies	Applications, Implications, Limitations of Molecular Forensics	8
		Total =	**100**

Semester	**:**	**IV**			
Course No.	**:**	**BT-2410**	**Credit Hrs.**	**:**	**2(2+0)**
Course Title	**:**	**Biodiversity and its Conservation**			

SYLLABUS

Objectives:

i) To study the concepts of biodiversity,

ii) To study the methods of protecting biodiversity,

iii) To study the regulations on biodiversity conservation.

THEORY

Concepts of Biodiversity, Bioresource and Wildlife management, Conservation strategies: In-situ and Ex-situ conservation. Wildlife conservation projects in India. Protection of biodiversity for its suitable utilization. Threats to Biodiversity. WCU Red data book; Biodiversity hotspots in India. National Bureaus of Genetic Resources. Biodiversity Mapping. Biogeographical regions. Sustainable development. Diversification of cropping system. Diversity of indigenous livestock. Threats to biodiversity; WCU Red data book. Vulnerability and Extinction of flora and fauna. Endangered species in various ecosystems. Germplasm banks. Environmental impact assessment. Bioremediation and Biosafety. Introduction to regulatory agencies and legislation.

TEACHING SCHEDULE

THEORY [BT-2410]

Lecture No.	Topic	Sub-topics / Key Points	Weightage (%)
1	Concepts of Biodiversity	Meaning, Definitions, Examples, Importance	3
2	Bioresources	Meaning, Expression, Importance of Bioresources; Genetic Resources	10
3		Plant and Animal Biotechnology, GMOs, Agriculture applications	
4		Water technology, Waste treatment, Ecosystem services	
5	Wildlife Management	Definition, Scope, Types of wildlife management	6
6		Tools, Strategies, Community participation	
7	Conservation Strategies	In-situ conservation: Concept, Examples, Importance	8
8		Ex-situ conservation: Concept, Examples, Importance	
9	Wildlife Conservation Projects in India	Project Tiger, Elephant, Rhino etc.	5
10		Wildlife Conservation Organizations: WCS, BNHS, WWF, IUCN – Roles and Contributions	
11	Protection and Restoration Techniques -I	Ecological restoration principles; Species protection	3
12	Protected Areas	National parks, Wildlife sanctuaries	8
13		Forest reserves, Forest conservation steps	
14		Zoological parks, Botanical gardens	
15	Threats to Biodiversity	Habitat loss, Fragmentation, Sustainability issues	10
16		Overharvesting, Invasive exotic species	
17		Climate change and Biodiversity	
18	Red Data Book and Species Categories	Purpose; 8 Categories (IUCN)	4
19	Biodiversity Mapping	Methods and Applications	3
20	Biogeographical Regions of India	Definitions, 10 Biogeographic zones	4

Continued…

21	Biodiversity Hotspots in India	Concepts and Examples: Western Ghats, Eastern Himalayas	4
22	National Bureaus of Genetic Resources	Establishment, Network, NBPGR activities	4
23	Sustainable Development	Meaning, Principles, Objectives	6
24		Economic growth, Social progress, Environmental protection	
25 - 26	Diversification of Cropping Systems	Meaning, Concept, Need and Importance	4
27 - 28	Diversity of Indigenous Livestock	Livestock Husbandry importance; Livestock biodiversity	4
29 - 30	Vulnerability and Extinction	Meaning/ Definitions, Concept, Examples	6
		Importance of Vulnerability; Extinction drivers	
31	Endangered Species	Meaning; Examples from various ecosystems	4
32	Germplasm Banks, EIA, Bioremediation and Biosafety	Germplasm banks; EIA Concept and Principles; Basics of Bioremediation and Biosafety; Regulatory agencies.	4
		Total=	**100**

Suggested Readings [BT-2410]:

1. **Das, M.K. and Choudhury, B.P.** 2008, A Textbook on Plant Nomenclature and Biodiversity Conservation, Kalyani Publishers.
2. **Gaston, K.J. and Spicer, J.I.** 2004, Biodiversity an Introduction, Blackwell Publishers.
3. **Hopsetti, B.B. and Venketashwarlu, M.** 2001, Trends in Wild Life Conservation and Management, Vol. 2, Daya Publishing House.
4. **Singh, M.P. and Singh, B.S.** 2002, Plant Biodiversity and Taxonomy, Daya Publishing House.

Semester	**:**	**IV**			
Course No.	**:**	**BIOCHEM-241**	**Credit Hrs.**	**:**	**4(3+1)**
Course Title	**:**	**Basic Biochemistry**			

SYLLABUS

Objectives:

i) To study the structure and functions of biomolecules of living organisms,

ii) To study metabolism and bioenergetics,

iii) To study secondary metabolites and their applications.

THEORY

Introduction and Importance. Acids, Bases and Buffers of living systems. The pK of biomolecules. Biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids – Structure, Functions and Properties. Vitamins and Hormones.

Bioenergetics. Metabolism – Basic concept: Glycolysis, Citric acid cycle, Glycogenesis, Glycogenolysis, Oxidative phosphorylation, Fatty acid oxidation; Ketone bodies' metabolism.

Secondary metabolites: Alkaloids, Phenolics and their Applications in Food and Pharmaceutical industries.

PRACTICAL

Qualitative tests for Carbohydrates, Amino acids, Proteins and Lipids. Extraction and characterization of lipids by TLC. Determination of Acid, Iodine and Saponification values of oil. Extraction, Quantitative estimation and Separation of sugars by paper chromatography.

Suggested Readings [BIOCHEM-241]:

1. **Nelson, D.L. and Cox, M.M.** 2017. Lehninger Principles of Biochemistry. 7th Ed. W.H. Freeman.
2. **Satyanarayana, U. and Chakrapani, U.** 2021. Essentials of Biochemistry. Elsevier.
3. **Berg J.M., Tymoczko J.L. and Gatto G.** Stryer's Biochemistry. W.H. Freeman.
4. **Voet D. and Voet J.** Biochemistry. Wiley.
5. **Garrett and Grisham.** Biochemistry. Cengage Learning.

TEACHING SCHEDULE

THEORY [BIOCHEM-241]

Lecture No.	Topic	Sub-topics / Key Points	Weightage (%)
1	Introduction to Biochemistry	Definition; Scope and Importance of Biochemistry, Applications	3
2	Water: Properties	Structure, Hydrogen bonding, Biological significance	3
3 - 4	Acids, Bases and pH	Acid-Base concept, pH scale, Henderson–Hasselbalch equation	4
	Buffers in Biological Systems	Types, Roles, Bicarbonate and Phosphate buffers	2
5 - 7	Chemical Bonding in Biomolecules	Covalent, Ionic, Hydrogen, Hydrophobic, Electrostatic, Van der Waals forces	3
8	Intermolecular Forces in Macromolecules	Stability of Proteins, Nucleic acids	2
9	Biomolecules: Overview	Classification of Biomolecules-(Macromolecules and Micromolecules), Examples, Macromolecules *vs.* Micromolecules	2
10 -13	Carbohydrates	Structure, Classification, Functions, Properties, Stereochemistry, Biological roles	6
14 -17	Lipids	Classification, Structure, Complex lipids, Functions, Properties	6
18 - 21	Amino Acids	Classification, Structures, Functions, Properties, Essential AAs, Special AAs	8
22 - 24	Proteins	Classification, Levels of structure-Primary, Secondary, Tertiary, Folding, Domains, Functions, Different types and roles of Proteins-Enzymes, Receptors, Structural proteins, Antibodies, Receptor, Globular *vs*. Fibrous proteins, Functions	8
25 - 27	Nucleic Acids	DNA/RNA structures, Types, Properties, Functions	6
28 - 29	Vitamins	Classification, Biochemical roles/ Biological Functions, Deficiencies structure	3
30	Hormones	Plant, Animal and Insect hormones, Important pathways and Mechanisms, Structure and Functions	3
31 - 32	Bioenergetics	Thermodynamics, Free energy, Redox reactions, Thermodynamic Principles in Biological processes, Energy transformations	6
33	Metabolism: Introduction	Basic concepts: Catabolism, Anabolism, Metabolic regulation	3

Continued…

34	Glycolysis	Pathway, Enzymes, Regulation, ATP yield	2
35	Citric Acid Cycle	Steps, Key intermediates, Energy production, Intermediates, Energetics	2
36	Electron Transport Chain	EC Complexes I-IV, Proton pump, Proton flux	2
37	Oxidative Phosphorylation	Mechanism, Chemiosmotic hypothesis, ATP synthase	3
38 - 40	Glycogenesis, Glycogenolysis and Gluconeogenesis	Pathways, Regulation, Physiological role	5
41 - 42	β-Oxidation and Ketone Body Metabolism	β-oxidation, Ketogenesis, Physiological significance, Steps, Regulation,	4
43	Integration of Metabolism	CHO - Lipid - Protein metabolic interlinking	2
44 - 45	Amino Acid and Nucleotide Metabolism	Transamination, Deamination, Nucleotide synthesis basics	3
46	Secondary Metabolism: Introduction	Role and Classification of Secondary Metabolites	3
47	Terpenoids, Alkaloids, Phenolics	Structure, Functions, Classification	3
48	Applications of Secondary Metabolites	Uses in Agriculture, Food, Pharmaceutical and Other industries	3
		Total=	**100**

TEACHING SCHEDULE

PRACTICAL [BIOCHEM-241]

Exercise No.	Exercise Topic
1 - 2	Preparation of standard and buffer solutions.
3	Qualitative tests for carbohydrates.
4 - 5	Qualitative tests for amino acids and proteins.
6 - 7	Extraction of oil from oil seeds by standard method.
8	Determination of acid and saponification value of oil.
9	Determination of iodine value of oil.
10 - 11	Estimation of protein by Folin- Lowry method.
12 - 13	Quantitative estimation of total and reducing sugars by Nelson-Somogyi method.
14	Separation of amino acids and sugars by paper chromatography.
15 - 16	Separation of Lipids by TLC Method.

Semester	**:**	**IV**		
Course No.	**:**	**EXTN-241**	**Credit Hrs.**	**: 1(1+0)**
Course Title	**:**	**Human Ethics**		

SYLLABUS

Objectives:

i) To study the meaning and concepts of human behaviour,
ii) To study human ethical values,
iii) To study spirituality and attitude,
iv) To study the methods of stress management.

THEORY

Universal human aspirations. Happiness and Prosperity. Human values and Ethics. Concept, Definition, Significance and Sources. Fundamental values. Right conduct, Peace, Truth, Love and Non-violence. Ethics: Professional, Environmental, ICT. Sensitization towards others particularly senior citizens, developmentally challenged and gender.

Spirituality, Positive attitude and Scientific temper. Teamwork and Volunteering. Rights and Responsibilities. Road safety. Human relations and Family harmony. Modern challenges and Value conflict. Sensitization against drug abuse and other social evils. Developing personal code of conduct (SWOT Analysis). Management of anger and stress.

Suggested Readings [EXTN-241]:

1. **Gaur R.R., Sangal, R. and Bagaria, G.P.** 2011. A Foundation Course in Human Values and Professional Ethics, Excel Books.
2. **Mathur, S.S.** 2010. Education for Values, Environment and Human Rights, RSA International.
3. **Sharma, R.A.** 2011. Human Values and Education -Axiology, Inculcation and Research, R. Lall Book Depot.
4. **Sharma, R.P. and Sharma, M.** 2011. Value Education and Professional Ethics, Kanishka Publishers.
5. **Punia, M.S.** Manual on international Research and Research Ethics. CCS, Hayana Agricultural University, Hisar.

TEACHING SCHEDULE

THEORY [EXTN-241]

Lecture No.	Topic	Sub-topics / Key Points	Weightage (%)
1	**Universal Human Aspirations**	Happiness and Prosperity	5
2	**Human Values**	Concept, Definition, Types, Value Education, Evolution of human values	10
3	**Ethics**	Concept, Definition, Types, Work Ethics	10
4	**Human Values and Ethics**	Meaning, Process, Principles and Steps in Programme development	5
5	**Fundamental Values**	Right conduct, Peace, Truth, Love and Non-violence	5
6	**Ethics**	Professional, Environmental	5
7		Information and Communication Technology (ICT)	10
8	**Sensitization**	Meaning, Sensitization towards Senior Citizens, Developmentally challenged and Gender equity	5
9	**Spirituality, Positive Attitude and Scientific Temper**	Meaning, Definitions and Characteristics Spirituality, Positive attitude and Scientific temper	5
10	**Team Work and Volunteering**	Meaning of Team work and Volunteering, Role, Rights and Responsibilities of Volunteer	5
11	**Road Safety**	Human relations and Family harmony	5
12	**Drug Abuse**	Meaning, Signs and Symptoms of drug use, Modern challenges and Value conflict, Sensitization against drug abuse	5
13	**Social Evils**	Meaning, Reasons and Measures to overcome Social Evils	5
14	**SWOT Analysis**	Developing Personal Code of Conduct (SWOT Analysis)	10
15	**Anger**	Meaning of Anger, Management of Anger	5
16	**Stress**	Meaning of Stress, Management of Stress	5
		Total=	**100**

Semester	**:**	**IV**			
Course No.	**:**	**SEC-246**	**Credit Hrs.**	**:**	**2(0+2)**
Course Title	**:**	**Practices in Molecular Marker Technology**			

SYLLABUS

Objectives:

i) This course aims at imparting skills through hands-on training in the area of molecular markers and their applications,

ii) To study the development of markers and marker systems, genotyping with various types of markers, mapping, diversity analysis, marker-assisted selection, DNA fingerprinting, diversity and cluster analysis, phylogenetic analysis.

PRACTICAL

Overview of Molecular markers: Types, Applications, Significance. Principles of genetic variation and Inheritance, DNA Extraction and Quantification, PCR-Based molecular markers, RFLP (Restriction Fragment Length Polymorphism) analysis, AFLP (Amplified Fragment Length Polymorphism) analysis, SSR (Simple Sequence Repeat) analysis, SNP (Single Nucleotide Polymorphism) analysis. Principles of SNP detection, PCR-based SNP genotyping assays, SNP array and Sequencing-based approaches. DNA sequencing and Sequence analysis, Interpretation of sequencing data and Sequence alignment, Marker-Assisted Selection (MAS), Genomic selection and Marker discovery. Practical Project: Students design and Conduct a small-scale molecular marker project. They will choose a specific technique or experiment, Perform the necessary procedures, Analyze data and Present their findings.

Suggested Readings [SEC-246]:

1. **Gupta, P.K.** 2015. Molecular Biology and Genetic Engineering, Rastogi Publication.
2. **Manikanda Boopathi N.** 2013. Genetic Mapping and Marker-Assisted Selection, Springer.
3. **Manikanda Boopathi N.** 2020. Genetic Mapping and Marker-Assisted Selection: Basics, Practice and Benefits, Springer.
4. **Schook, L.B.** (Ed), 2020. Gene-mapping Techniques and Applications, CRC Press.
5. **Verma, P.S.** 2018. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Chaukhamba Auriyantaliya Publishers.
6. **Watson, J.D., Levine, M., Baker, T.A., Gann, A., Bell, S.P. and Losick, R.** 2014. Molecular Biology of the Gene, Pearson.

TEACHING SCHEDULE

PRACTICAL [SEC-246]

Exercise No.	Exercise Topic
1 - 2	Introduction to Molecular Markers: Overview, Types, Applications and Significance. Principles of genetic variation and inheritance.
3 - 4	Preparation of Stock Solutions and Buffers: Formulation, Calculations and Laboratory Safety Measures.
5 - 6	Isolation of Genomic DNA from Plant Samples: Standard protocols and Troubleshooting.
7 - 8	Agarose Gel Electrophoresis: Gel preparation, Sample loading and Visualization of DNA bands.
9	Qualitative and Quantitative Analysis of DNA: Using Spectrophotometry and Gel documentation systems.
10 - 11	PCR Technology: Preparation of PCR reaction mixture, Optimization and Execution of PCR using programmed thermo-cycling.
12	Restriction Fragment Length Polymorphism (RFLP) Analysis: Principles, Digestion reactions and Gel resolution.
13	Amplified Fragment Length Polymorphism (AFLP) Analysis: DNA digestion, Adaptor ligation, Amplification and Profiling.
14 - 15	Principles of SNP Detection: Concept, Biological relevance and Detection strategies.
16 - 17	PCR-based SNP Genotyping Assays: Allele-specific PCR, CAPS, dCAPS, and Other methods
18 - 19	SNP Array and Sequencing-Based Approaches: High-throughput SNP discovery and Genotyping platforms.
20 - 21	DNA Sequencing: Sanger and NGS methodologies, Workflow and Applications.
22 - 23	Sequence Data Interpretation and Alignment: Use of software tools for alignment, Scoring and Variant identification.
24 - 25	Marker-Assisted Selection (MAS): Workflow, Case studies and Relevance in crop improvement.
26 - 27	Genomic Selection and Marker Discovery: Principles, Statistical models and Breeding applications.
28 - 29	Mini Project – Part I: Students Design a small-scale molecular marker experiment (Topic selection, Objectives and Methodology).
30 - 32	Mini Project – Part II: Students Perform the experiment, Analyze results, Prepare a scientific report and Present findings.