Revised Course Curriculum and Syllabus of

B.Tech. (BIOTECHNOLOGY)
Degree Programme

Submitted to
DICC

Submitted by

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Degree Coordinator &
Associate Dean and Principal
VILASRAO DESHMUKH COLLEGE OF AGRICULTURAL BIOTECHNOLOGY, LATUR 413 512

VASANTRAO NAIK MARATHWADA KRISHI VIDYAPEETH, PARBHANI 431 402 (MS)

Revised Course Curriculum and Syllabus

of

B.Tech. (Biotechnology)

As per Recommendations of Vth Deans' Committee (ICAR), New Delhi

For

State Agricultural Universities of Maharashtra

- **Mahatma Phule Krishi Vidyapeeth, Rahuri.**
- **Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.**
- **Dr. Balasaheb Sawant Kokan Krishi Vidyapeeth, Dapoli.**
- **Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani.**

From

Academic Year, 2017-18

Acknowledgement

The task on preparation of finalization of syllabus and preparation of Teaching schedules of degree course, B.Tech. (Biotechnology) was completed with the support of Discipline Coordinators and Course Coordinators appointed from State Agricultural Universities as well as non Agricultural Universities of Maharashtra, who have provided their expertise which greatly helped to complete Teaching Schedule of B.Tech (Biotechnology) degree. I am very thankful to Dr. Sharad Shetgar, Ex. Associate Dean and Principal, Vilasrao Deshmukh College of Agril. Biotechnology, Latur who has taken the initiatives to fulfill this task Dr. Sharad Shetgar and myself Prof. H.B. Patil, Associate Dean and Principal, Vilasrao Deshmukh College of Agril. Biotechnology, Latur (M.S.) both of us has shouldered this challenging piece of work and endless effort to the fruitfulness of this task.

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(Hemant B. Patil)
Degree Coordinator

List of Degree, Discipline and Course Coordinators

	Degree Coordinator: Prof. H.B. Patil Associate Dean and Principal, Vilasrao Deshmukh College ofAgricultural Biotechnology, Latur (VNMKV, Parbhani)		
	Discipline Coordinators for Biotechnology Core courses:		
	Discipline Coordinators	**Disciplines**	**Designation**
	1. Dr. R.L. Chavhan	Plant Biotechnology	Assistant Professor, VDCOAB, Latur, VNMKV, Parbhani
	2. Dr. A.S. Patil	Animal Biotechnology	Principal, College of Agril. Biotechnology, Baramati
	3. Dr. R.M. Gade	Microbiology & Environmental Biotechnology	Associate Dean, VNCOAB, Yavatmal, Dr. PDKV, Akola
	4. Dr. A.M. Dethe	Bioinformatics	Assistant Professor, VDCOAB, Latur, VNMKV, Parbhani
	Course Coordinators for Deficiency/Remedial courses		
	1. Prof. B.N. Aglave	Basic Botany	Associate Professor, VDCOAB, Latur
		Basic Zoology	
	2. Dr. K.J. Shinde	Basic Mathematics-I Basic Mathematics-II	Asstt. Prof of Mathematics, Dr. PDKV, Akola
	3. Prof. M.M. Bhogaonkar		Asstt. Prof. of Mathematics, College of Agril.,Latur
	Course Coordinators for Common courses:		
	1. Dr. V.D. Surve	Food Science and Processing	Asso. Professor, Food Technology, VDCOAB, Latur
	2. Dr. R. Nandanwar	Environmental Studies and Disaster Management	Head, Dept. of Agril. Botany, Dr. PDKV, Akola.
	3. Dr. Rakesh Ahire	Communication Skills and Personality Development	Head, Dept. of Agril. Extension Education, VNMKV, Parbhani

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	4.	Dr. S. Kareppa	Biostatistics Basic Statistics	Professor, MPKV, Rahuri
	5.	Dr. R.R. Suryawanshi	Economics and Marketing	Prof. Agril. Economics, College of Agril.Kolhapur, MPKV, Rahuri
	6.	Dr. S.S. Suradkar	Human Ethics	Asstt. Professor, Extension.Education,College of Agril. Latur
	7.	Dr. V.N. Tamboli	Information& Communication Technology	Asstt. Professor, Computer Science, VNMKV, Parbhani
			Agricultural Informatics	Asstt. Professor, Computer Science, VNMKV, Parbhani
	Course Coordinators for Elective courses:			
	1.	Dr. S.R. Bhalerao	Elective courses of Biotechnology	Associate Professor, Plant Biotechnology, VDCOAB, Latur
	2.	Prof. R.N. Dhawle		Assistant Professor, Animal Biotechnology, VDCOAB, Latur
	Course Coordinators and Members for READY Programme:			
	1.	Dr. A. S. Jadhav	Student READY Programme	Course coordinator READY programme& Professor, SLBC,MPKV, Rahuri
	2.	Dr. P.N. Jadhav		Member &Asstt. Prof. Biotech Centre, Dr.PDKV, Akola
	3.	Dr. M.P. Moharil		Member &Asstt. Prof. Biotech Centre, Dr.PDKV, Akola
	4.	Dr. S.V. Sawardekar		Member &Associate Prof. Botany, Dr. BSKKV, Dapoli
	5.	Dr. V.D. Surve		Member &Associate Prof. College of Agril. Biotech, Latur
		Dr. A. A. Kale		Co-opted Member & Associate Professor of Biochemistry, State Level Biotechnology

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				Centre, MPKV, Rahuri.
		Dr. M. M. Yadav		Co-opted Member & Assistant Professor, Veterinary Science, RCDP on Cattle, MPKV, Rahuri 413 722
		Dr. R. B. Jagtap		Co-opted Member & Assistant Professor, Dept.Animal Biotech., Vidya Pratishthan's College of Agril. Biotech., Baramati.

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B.Tech (Biotechnology) Degree Course Layout

Deficiency/Remedial Courses   **Total Credit hours= 6**

Course No.	Course Title	Credit
BOT-111	Basic Botany	2+1
ZOO-121	Basic Zoology	2+1
MATH-111	Basic Mathematics – I	3+0
MATH-122	Basic Mathematics - II	3+0

BOT-111 + ZOO-121 or MATH-111 + MATH-122

General Courses   **Total Credit = 18**

Course No.	Course Title	Credit
CSPD-111	Communication Skills and Personality Development	1+1
EDBM -241	Entrepreneurship Development and Business Management	1+1
ECON-231	Economics and Marketing	2+1
ENV-111	Environmental Studies and Disaster Management	2+1
FT-111	Food Science and Processing	1+1
HD-111	Human Ethics	1+0
ICT-231	Information and Communication Technology	1+1
ICT-352	Agricultural Informatics	2+1

Biotechnology Core Courses (23)   **Total Credit =64**

Course No.	Course Title	Credit
BT-111	Cell Biology	2+0
BT-112	Basic Genetics	2+1
BT-113	Introduction to Biotechnology	2+1
BT-124	Plant Tissue Culture	2+1
BT-125	Molecular Biology	2+1
BT-236	Recombinant DNA Technology	2+1
BT-247	Introductory Bioinformatics	2+1
BT-248	Plant Genetic Transformation	2+1
BT/ECE-241	Fundamentals of Electronics and Instrumentation in Biotechnology	1+1
BT-249	Classical and Molecular Cytogenetics	2+1
BT-3510	Immunology	2+1
BT-3511	Molecular Genetics	2+0
BT-3512	Nanobiotechnology	2+0
BT-3513	Animal Biotechnology	3+1
BT-3514	Molecular Marker Technology	2+0
BT-3515	Genomics and Proteomics	3+0
BT-3516	IPR, Biosafety and Bioethics	2+0
BT-3617	Computational Biology	2+1
BIOCHEM- 241	General Biochemistry	3+1
BIOCHEM- 352	Enzymology and Enzyme Technologies	2+1
BOT /ZOO-121	Biodiversity and its Conservation	2+0
MICRO-121	Microbiology	2+1
MICRO-242	Microbial Genetics	2+1

Elective Courses in Biotechnology (one to choose), Each Elective: Total Credit Hours=18

Course No.	Course Title	Credit
Elective I. Plant Biotechnology		
PBTEL-361	Plant Tissue Culture and its Applications	2+1
PBTEL-362	Principles and Applications of Plant Genetic Transformation	2+1
PBTEL-363	Applications of Genomics and Proteomics	2+1
PBTEL-364	Molecular Breeding in Field Crops	2+1
PBTEL-365	Molecular Breeding of Horticultural Crops and Forest Trees	2+1
PBTEL-366	Epigenetics and Gene Regulation	2+1
Elective II. Animal Biotechnology		
ABTEL-361	Principles and Procedures of Animal Cell Culture	2+1
ABTEL-362	Animal Genomics	2+1
ABTEL-363	Embryo Transfer Technologies	2+1
ABTEL-364	Transgenic Animal Production	3+0
ABTEL-365	Molecular Diagnostics	2+1
ABTEL-366	Molecular Virology and Vaccine Production	2+1
Elective III. Microbial and Environmental Biotechnology		
MEBTEL-361	Microbial Biotechnology	2+1
MEBTEL-362	Bio-prospecting of Molecules and Genes	3+0
MEBTEL-363	Molecular Ecology and Evolution	3+0
MEBTEL-364	Fundamentals of Molecular Pharming and Biopharmaceuticals	2+1
MEBTEL-365	Food Biotechnology	2+1
MEBTEL-366	Green Biotechnology	2+1
Elective IV. Bioinformatics		
BIFEL-361	Programming for Bioinformatics	2+2
BIFEL-362	Bioinformatics Tools and Biological Databases	2+1
BIFEL-363	Structural Bioinformatics	2+1
BIFEL-364	Pharmacogenomics	2+1
BIFEL-365	Metabolomics and System Biology	2+1
BIFEL-366	Computational Methods for Data Analysis	1+1

Basic Science Courses (5)   **Total Credit =14**

Course No.	Course Title	Credit
BOT-232	Plant Physiology	2+1
MATH-233	Biomathematics	2+1
PHY-241	Biophysics	2+1
STAT-121	Basic Statistics	1+1
STAT-362	Biostatistics	2+1

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Agriculture Courses (5)   **Total Credit = 15**

Course No.	Course Title	Credit
AGRO-111	Crop Production Technology	2+1
*HORT-121	Production Technologies for Horticultural Crops	2+1
*PB-121	Principles of Plant Breeding	2+1
*PB-232	Breeding of Field Crops	2+1
*ENT.PL.PATH- 231	Fundamentals of Crop Protection	2+1

Courses marked * are optional to the package of Animal Science courses marked as **

Animal Science Courses (5)   **Total Credit Hours= 15**

Course No.	Course Title	Credit
**AS -121	Anatomy and Physiology of Livestock	3+0
**AS -122	Introduction to Animal Breeding	2+1
AS-233	Livestock Production and Management	2+1
**AS -234	Livestock Product Technology	2+1
**AS-235	Animal Health Care	2+1

Courses marked ** are optional to the package of Agriculture Courses marked as *

Student READY Programme (2 Semesters)   **Total Credit Hours=40**

As per the decision taken during Review Meeting on the Status of Implementation of Recommendations of Fifth Deans' Committee held on 2-3 June, 2017 at Central Agril. Univ., Ranipool Campus, Gangtok, Sikkim, depending upon available facilities, initially module preferably on Plant Biotechnology should be offered to the students in the concerned colleges of Agricultural Universities in Maharashtra.

Course No.	Course Title	Credit
READY-471	In-house Skill Development Modules	20
READY-482	Project Formulation, Execution and Presentation	10
READY-483	Entrepreneurial Development in Biotechnology (on campus /off campus)	10

Non Credit Courses (6)   **Total Credit =6**

Course No.	Course Title	Credit
NCC/NSS-111	National Service Scheme I	0+1 NC
DEG-111	Democracy, Elections and Good Goverence	1+0 NC
NCC/NSS-122	National Service Scheme II	0+1 NC
NCC/NSS-233	National Service Scheme III	0+1 NC
NCC/NSS-244	National Service Scheme IV	0+1 NC
PHYEDN-111	Physical Education and Yoga	0+1 NC

Educational Tours (2)   **Total Credit =2**

ET-351	Educational Tour	0+1
ET-472	Educational Tour	0+1

Course Curriculum Summary

Sr. No.	Type of courses	Total credits
1.	Remedial Courses :	6
2.	General Course :	18
3.	Biotechnology Core Courses:	64
4.	Biotechnology Elective Courses:	18
5.	Ready Programme:	40
6.	Basic Science Course:	14
7.	Agriculture Course:	3+12*=15
8.	Animal Sciences Courses:	3+12**=15
9.	Educational Tour (ET351 and ET472):	2
10.	NSS/NCC/DEG/PHYEDN	6NC
Compulsory Credits:		**178**
Total Credits		**186** **(174+6 NC+ 6 Remedial)**

*12 Credit hours of Agriculture courses exchangeable with **12 Credit hours of   Animal Science courses.

SEMESTERWISE COURSE LAYOUT FOR B.Tech. (BIOTECHNOLOGY)

Semester I		
Course No.	**Course Title**	**Credit**
BOT-111/ MATH-111	Basic Botany/ Basic Mathematics – I	2+1/3+0
AGRO-111	Crop Production Technology	2+1
BT-111	Cell Biology	2+0
BT-112	Basic Genetics	2+1
BT-113	Introduction to Biotechnology	2+1
CSPD-111	Communication Skills and Personality development	1+1
ENV-111	Environmental Studies and Disaster Management	2+1
FT-111	Food Science and Processing	1+1
HD-111	Human Ethics	1+0
DEG-111	Democracy, Elections and Good Goverence	1+0 NC
NCC-111/ NSS-111	NCC/NSS	0+1 NC
	Total	**15+7 (22) +2 NC=24**

Semester II		
Course No.	**Course Title**	**Credit**
ZOO-121/ MATH-122	Basic Zoology/ Basic Mathematics-II	2+1/3+0
BT-124	Plant Tissue Culture	2+1
BT-125	Molecular Biology	2+1
BOT/ZOO-121	Biodiversity and its Conservation	2+0
MICRO-121	Microbiology	2+1
*HORT-121/ **AS-121	Production technologies for Horticultural Crops/ Anatomy and Physiology of Livestock	2+1/ 3+0
*PB -121/**AS-122	Principles of Plant Breeding/ Introduction to Animal Breeding	2+1/ 2+1
STAT-121	Basic Statistics	1+1
PHYEDN-111	Physical Education and Yoga	0+1 NC
NCC-122/ NSS-122	NCC/NSS	0+1 NC
Total		**15+7(22)+2 NC=24**

Semester III		
Course No.	Course Title	Credit
AS -233	Livestock Production and Management	2+1
BT-236	Recombinant DNA Technology	2+1
BOT-232	Plant Physiology	2+1
MATH-233	Biomathematics	2+1
ICT-231	Information and Communication Technology	1+1
ECON-231	Economics and Marketing	2+1
*ENT./Pl.PATH- 231/ **AS-234	Fundamentals of Crop Protection/ Livestock Product Technology	2+1/ 2+1
*PB-232/ **AS 235	Breeding of Field Crops/ Animal Health Care	2+1
NCC-233/NSS-233	NCC/NSS	0+1 NC
Total		**15+8(23) +1 NC =24**

Semester IV		
Course No.	Course Title	Credit
EDBM -241	Entrepreneurship Development and Business Management	1+1
BIOCHEM- 241	General Biochemistry	3+1
BT-247	Introductory Bioinformatics	2+1
BT-248	Plant Genetic Transformation	2+1
BT/ECE-241	Fundamentals of Electronics and Instrumentation in Biotechnology	1+1
BT-249	Classical and Molecular Cytogenetics	2+1
MICRO-242	Microbial Genetics	2+1
PHY-241	Biophysics	2+1
NCC-244/NSS-244	NCC/NSS	0+1 NC
Total		**15+8 (23)+1NC =24**

Semester V		
Course No.	Course Title	Credit
BIOCHEM-352	Enzymology and Enzyme Technologies	2+1
BT-3510	Immunology	2+1
BT-3511	Molecular Genetics	2+0
BT-3512	Nanobiotechnology	2+0
BT-3513	Animal Biotechnology	3+1
BT-3514	Molecular Marker Technology	2+0
BT-3515	Genomics and Proteomics	3+0
BT-3516	IPR, Biosafety and Bioethics	2+0
ICT-352	Agricultural Informatics	2+1
EDNT-351	Educational Tour	0+1
Total		**20+5=25**

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As per the decision taken during Review Meeting on the Status of Implementation of Recommendations of Fifth Deans' Committee held on 2-3 June, 2017 at Central Agril. Univ., Ranipool Campus, Gangtok, Sikkim, initially elective courses preferably on Plant Biotechnology should be offered to the students in the concerned colleges of Agricultural Universities in Maharashtra.

Semester VI		
Course No.	**Course Title**	**Credit**
BT-3617	Computational Biology	2+1
STAT-362	Biostatistics	2+1
Optional/ Elective Courses (6) PBTEL-361 to 366 ABTEL-361 to 366 MEBTEL-361 to 366 BIFEL-361 to 366	Electives (4): Only one to be chosen (each with six courses)	18
	1. Plant Biotechnology	12+6
	2. Animal Biotechnology	13+5
	3. Microbial and Environmental Biotechnology	14+4
	4. Bioinformatics	11+7
Total		**24**

Elective Courses in Biotechnology (one to choose), Each Elective: Total Credit Hours=18

Elective I. Plant Biotechnology		
Course No.	**Course Title**	**Credit**
PBTEL-361	Plant Tissue Culture and its Applications	2+1
PBTEL-362	Principles and Applications of Plant Genetic Transformation	2+1
PBTEL-363	Applications of Genomics and Proteomics	2+1
PBTEL-364	Molecular Breeding in Field Crops	2+1
PBTEL-365	Molecular Breeding of Horticultural Crops and Forest Trees	2+1
PBTEL-366	Epigenetics and Gene Regulation	2+1
Elective II. Animal Biotechnology		
ABTEL-361	Principles and Procedures of Animal Cell Culture	2+1
ABTEL-362	Animal Genomics	2+1
ABTEL-363	Embryo Transfer Technologies	2+1
ABTEL-364	Transgenic Animal Production	3+0
ABTEL-365	Molecular Diagnostics	2+1
ABTEL-366	Molecular Virology and Vaccine Production	2+1
Elective III. Microbial and Environmental Biotechnology		
MEBTEL-361	Microbial Biotechnology	2+1

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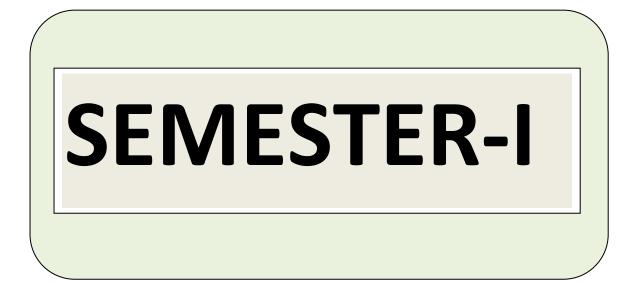| MEBTEL-362	Bio-prospecting of Molecules and Genes	3+0
MEBTEL-363	Molecular Ecology and Evolution	3+0
MEBTEL-364	Fundamentals of Molecular Pharming and Biopharmaceuticals	2+1
MEBTEL-365	Food Biotechnology	2+1
MEBTEL-366	Green Biotechnology	2+1
Elective IV. Bioinformatics		
BIFEL-361	Programming for Bioinformatics	2+2
BIFEL-362	Bioinformatics Tools and Biological Databases	2+1
BIFEL-363	Structural Bioinformatics	2+1
BIFEL-364	Pharmacogenomics	2+1
BIFEL-365	Metabolomics and System Biology	2+1
BIFEL-366	Computational Methods for Data Analysis	1+1

As per the decision taken during Review Meeting on the Status of Implementation of Recommendations of Fifth Deans' Committee held on 2-3 June, 2017 at Central Agril. Univ., Ranipool Campus, Gangtok, Sikkim, module preferably on Plant Biotechnology should be offered initially to the students in the concerned colleges of Agricultural Universities in Maharashtra.

Semester VII		
Course No.	**Course Title**	**Credit**
ET-472	Educational Tour	0+1
Plant Biotechnology*		
READY-PB-471	Micro-propagation of field, horticultural and Medicinal plants	0+20
	or	
READY-PB-472	DNA Fingerprinting and hybridity testing	0+20
Animal Biotechnology		
READY-AB-471	Dissemination of *Elite* germplasm of any species by frozenSemen technology	0+20
READY-AB-472	Molecular diagnostics for diseased/disordered animals	0+20
Microbial and Environmental Biotechnology		
READY-MEB-471	Production of Probiotics/ Fermented Milk Products	0+20
READY-MEB-472	Mushroom Production and Processing Technology	0+20
READY-MEB-473	Liquid Biofertilizer Production Technology	0+20
Bioinformatics		
READY-BIF-471	Biological database creation and its management	0+20
READY-BIF-472	Bioinformatics: Gene to genome	0+20

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READY-BIF-473	Drug designing and pharmacogenomics	0+20
READY-BIF-474	AgriSciences utility tool designing	0+20
Total		**0+21=21**

*To opt only one module as per the chosen elective.

Semester VIII		
Course No.	**Course Title**	**Credit**
READY-482	Student READY- Project Formulation, Execution and Presentation	0+10
READY-483	Student READY- Entrepreneurial Development in Biotechnology (On-campus/Off Campus)	0+10
Total		**0+20 =20**

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SEMESTER-I

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Course No : BOT-111   Course Title : **Basic Botany**

Credits : 3(2+1)   Semester : **I**

Syllabus: Theory

UNIT I

Plant kingdom and features of each group; Morphology, modifications and functions of root, stem, leaf, flower and inflorescence; Pollination and fertilization; Fruit types; Structure of dicot and monocot seed, seed germination.

UNIT II

Cell structure; DNA, chromosome and genes; Cell and tissue types; Internal structure of root, stem and leaf.

UNIT III

Plant taxonomy, systems of classification; Characteristics and economic importance of Poaceae, Brassicaceae, Fabaceae, Malvaceae, Rutaceae, Rosaceae, Asteraceae and Solanaceae families.

Practical

Description of one plant species from each group of plant kingdom; Study of morphology and modifications of root, stem, leaf, flower; Types of inflorescence; Structure of various types of seeds and fruits; Demonstration of cell structure, tissue types; Structure of monocot and dicot root, stem and leaf; One flower from each family.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightage (%)
	UNIT I	
1	Plant kingdom : Introduction, Classification with examples-	2
2	Algae, Bryophytes, Pteriophytes	3
3	Angiosperm and Gynosperm	3
4	Morphology, modifications and functions of root	3
5	Morphology, modifications and functions of stem	3
6	Morphology, modifications and functions of leaf	2
7	Morphology, modifications and functions of flower	3
8	Morphology, modifications and functions of inflorescence	2
10	Pollination: Modes; Differences;	9
11	Mechanisms promoting self/ cross pollination ,	
12	Floral biology related terminology	
13	Modes of reproduction and fertilization	
14	Fruit types: Structure of dicot seed	3
15	Fruit types: Structure monocot seed	3
16	Seed germination: Types	6
	UNIT II	
17	Cell structure: -	3
18	Cell and tissue types: -	3

19	DNA, chromosome and genes:-	6
20	Internal structure (Anatomy) of root	2
21	Internal structure (Anatomy) of stem	3
22	Internal structure (Anatomy) of leaf	3
UNIT III		
23-24	Plant taxonomy: Systems of classification	8
25	Characteristics and economic importance of Poaceae	6
26	Characteristics and economic importance of Fabaceae	6
27	Characteristics and economic importance of Malvaceae	3
28	Characteristics and economic importance of Rutaceae	3
29	Characteristics and economic importance of Rosaceae	3
30	Characteristics and economic importance of Asteraceae	3
31-32	Characteristics and economic importance of Solanaceae	6
	Total:	**100**

Practical Exercises

Exercise No.	Title
1-2	Description of one plant species from each group of plant kingdom
3	Study of morphology and modifications of root
4	Study of morphology and modifications of stem
5	Study of morphology and modifications of leaf
6	Study of morphology and modifications of flower
7-8	Types of inflorescence
9-10	Structure of various types of seeds and fruits
11-12	Demonstration of cell structure & tissue types
13	Structure of monocot and dicot root each family
14	Structure of monocot and dicot stem from each family
15	Structure of monocot and dicot leaf from each family& flower
16	Structure of monocot and dicot flower from each family& flower

Text Books:

1. Bendre A& Kumar A. 1999.*Textbook of Practical Botany.*Vol. 2, 7th Ed., Rastogi Publications.
2. Bendre AM & Pande PC. 2009. *Introduction to Botany*. Rastogi Publications.
3. Dutta A.C. 2016. *Botany for Degree Students*. Oxford University Press.

Reference books

4. Bendre A & Kumar A. 1999.*Textbook of Practical Botany.*Vol. 2, 7th Ed., Rastogi Publications.
5. Bendre AM & Pande PC. 2009. *Introduction to Botany*. Rastogi Publications.

Course No   : **MATH-111**   Course Title   : **Basic Mathematics-I**

Credits   : **3(3+0)**   Semester   : **I**

Syllabus- Theory

UNIT I

Complex numbers: Properties of real numbers, complex numbers, their addition, multiplication and division, square root of complex numbers, cube roots of unity and their properties, De-Moiré's theorem; Theory of equations: Solution of quadratic equation, equation reducible to quadratic equation, relation between roots and coefficients, nature of roots and formation of quadratic equation with given roots.

UNIT II

Geometric series: nth term of G.P. series, sum of G.P. series, geometric mean; Harmonic series, harmonic mean; Arithmetic geometric series and special series $\sum n$, $\sum n^2$, $\sum n^3$. Partial fractions; Logarithms; Binomial theorem for any index: Expansion, middle term, general term, terms independent of x.

Unit III

Trigonometry: Trigonometric ratios, allied angles, graphs of trigonometric functions; Addition and subtraction formulae; Product and sum formulae; Multiple and sub-multiple angles, sine, cosine and projection formulae; Area of a triangle.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightage (%)
Complex numbers		
1	Properties of real numbers.	20
2	Introduction to Complex numbers	
3	Addition of Complex number	
4	Multiplication of complex number	
5	Division of Complex number	
6- 7	Square root of Complex numbers	
8- 9	Cube roots of unity and their properties,	
10	De-Moivres theorem (Without proof)	
Theory of equations		
11	Definition of quadratic equation,	20
12 & 13	Solution of quadratic equation and its examples	
14	Equations reducible to quadratic equation,	
15	Relation between roots and coefficients	
16	Nature of roots	
17 & 18	Formation of quadratic equation with given roots.	
Geometric series		
19	Definition of G.P. and nth term of G.P. series	30
20	Sum of G.P. series	
21	Geometric mean	

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22	Harmonic series		
23	Harmonic mean		
24	Arithmetic geometric series		
25 & 26	Special series $\sum n$, $\sum n^2$, $\sum n^3$		
27 & 28	Partial fractions		
29	Logarithm series		
30	Binomial theorem for any index		
31 & 32	Expanding a given expression using Binomial theorem		
33	Finding the Middle term using Binomial Expansion		
34	Finding the General term using Binomial Expansion		
35	Terms independent of Variable (x).		
Trigonometry			
36	Introduction Trigonometric ratios, Trigonometric identities		
37 & 38	Trigonometric ratios of allied angles		
39	Graphs of trigonometric functions		
40 & 41	Addition and subtraction formulae		
42	Product and sum formulae	30	
43 & 44	Trigonometric ratios of Multiple and sub-multiple angles		
45 & 46	Sine and Cosine formulae		
47	Projection formulae		
48	Area of a triangle		
Total:		**100**	

Text Books
1) A Text Book of Mathematics, 11th Part-I and Part II, Maharashtra State Board of Secondary and Higher secondary Education-Pune
2) NCERT 2012. *Mathematics of Class XI.* NCERT India.
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Reference Books:
1) Sharma RD. 2014. *Mathematics of Class XI.* Dhanpat Rai Publisher.
2) Hall HS and Knight SR. 2016. Higher Algebra. Arihant Publication.

Course No   : **AGRO-111**   Course Title   : **Crop Production Technology**

Credits   : **3(2+1)**   Semester   : **I**

Theory

UNIT I

Soil and its components; Soil morphological, physical, chemical and biological properties; Acidic, saline and alkali soils and their reclamation; Essential plant nutrients: Functions and deficiency symptoms; Soil micro-organisms; Rhizosphere and its domain in soil; Organic manures and inorganic fertilizers.

UNIT II

Agriculture; Agronomy and its relation with other sciences; Classification of crops; Tillage and tillage practices, concepts of tillage and objectives; Seed, its characteristics and different sowing methods; Weed management: definition of weed, losses and benefits of weeds, different weed control methods and their suitability under different conditions; Irrigation: Soil water classification, methods of irrigation, approaches for scheduling irrigation.

UNIT III

Soil fertility and productivity; Concept of essentiality of plant nutrients; Fertilizers, manures and their types, methods of fertilizer application; Concepts of crop rotation, multiple cropping and intercropping - their principles, advantages and limitations; Cropping intensity; Production technology of major crops: Rice, maize, cotton, soybean, mung bean, mash, wheat, rapeseed and mustard, gram and Egyptian clover.

Practical

Study of soil profile and its characteristics; Determination of soil particle size distribution, particle density and bulk density; Determination of soil pH, electrical conductivity and organic carbon; Isolation of soil micro-flora (bacteria, fungus and actinomycetes).

Land measurement; Practice in seed bed preparation and seeding methods; Identification of crop seeds, crops, weeds and fertilizers; Identification and use of hand tools and implements; Computation of fertilizer doses and their method of application.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightage (%)
	UNIT I	
1	Soil and its components.	**3**
2	Morphological and physical properties of soil.	**2**
3	Chemical and biological properties of soil.	**3**
4	Acidic, saline and alkali soils and their reclamation	**3**
5	Essential plant nutrients: Major, minor, primary and secondary plant nutrients	**4**
6	Functions of essential plant nutrients.	**3**

7	Deficiency symptoms of essential plant nutrients	2
8	Soil micro-organisms in Rhizosphere	3
9	Domain of Soil micro-organisms in soil	2
10	Organic manures: Meaning and their types, advantages and disadvantages of organic manures.	3
11	Inorganic fertilizers: Classification of inorganic fertilizers and methods of fertilizer application.	4
	UNIT II	
12	Agriculture; Agronomy and its relation with other sciences;	3
13	Classification of crops	3
14	Agroclimatic zones of Maharashtra	2
15	Tillage: definition and types of tillage, tilth, implements used for tillage.	4
16	Concepts of tillage and its objectives	3
17	Seed: classification of seed and its characteristics	3
18	Different methods of sowing	2
19	Weed management: definition of weed, losses caused by weeds and benefits of weeds	3
20	Different methods of weed control and their suitability under different conditions	4
21	Irrigation: Soil water classification, methods of irrigation.	4
22	Approaches for scheduling irrigation	2
	UNIT III	
23	Soil fertility and productivity.	3
24	Concepts of crop rotation: Types of cropping systems, multiple cropping and intercropping.	3
25	Principles, advantages and limitations of cropping system, cropping intensity	3
26	Production technology of major field crops (cereals): Jowar, maize, bajra.	4
27	Production technology of major field crops (cereals): Rice and wheat.	4
28	Production technology of major field crops (pulses): Red gram, green gram, black gram.	4
29	Production technology of major field crops (pulses): Bengal gram, pea, lentil.	4
30	Production technology of major field crops (oilseeds): Soybean, groundnut, sesame.	4
31	Production technology of major field crops (oilseeds): Sunflower, safflower, rapeseed and mustard.	4
32	Production technology of major cash crops: cotton and sugarcane.	2
	Total	**100%**

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Practical Exercise

Exercise No.	Title
1	To study the soil profile.
2	Study of soil characteristics
3	Determination of soil particle size distribution: particle density
4	Determination of soil particle size distribution: bulk density.
5	Determination of soil pH.
6	Determination of electrical conductivity
7	Determination of organic carbon.
8	Isolation of soil micro-flora (bacteria)
9	Isolation of soil micro-flora (fungus)
10	Isolation of soil micro-flora (actinomycetes)
11	Land measurement; Practice in seedbed preparation
12	To study the methods of sowing
13	Identification of crop seeds and crops.
14	Identification of weeds and fertilizers.
15	Identification and use of hand tools and implements.
16	Computation of fertilizer doses and their method of application

Text Books:
1. Balasubrananiyan P & Palaniappan SP. 2010. *Principles and Practices of Agronomy.* Agrobios.
2. Chandrasekaran B, Annadural K & Samasundaram E. 2010. *A Text Book of Agronomy.* New Age International (P) Limited Publishers.
3. Acquaah G. 2005. *Principles of Crop Production: Theory, Techniques and Technology.* Prenice Hall.
4. Reddy SR. 2011. *Principles of Agronomy.* Kalyani Publishers.
5. Vaidya VG and Sahastrabuddhe KR.1979. .Introduction to Agronomy-Soil and Water Management. Continental Publication.

Reference Books:
i. Alexander M. 1977. *Introduction to Soil Microbiology*, 2nd Edition. John Wiley & Sons.
ii. Brady NC & Well RR. 2002. *The Nature and Properties of Soils,* Thirteenth Edition. Pearson Prentice Hall.
iii. Das DK. 2011. *Introductory Soil Science.* Third Revised Edition, Kalyani Publishers.

Course No   : **BT-111**   Course Title   : **Cell Biology**

Credits   : **2(2+0)**   Semester   : **I**

Theory

UNIT I

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, vacuoles.

UNIT II

Structure and function of cytoskeleton and its role in motility; Cell membrane transport; Introduction to cell signalling; Cell growth, cell cycle and its control; Cell death and cell renewal.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightages (%)
	UNIT I	
1 -2	Origin and evolution of cell: a. Evolution of molecules & first cell	1
	b Evolution from Prokaryotes to Eukaryotes c.Evolution of single cells to multicellular organisms	2

3-5	Introduction to microscopy:
	    a. Light microscopy principles and applications
	    b. Compound microscopy
	    c. Phase contrast microscopy
		4

	d. Dark-field microscopy
	    e. Fluorescence Microscopy
	    f. Differential interference microscopy
		4

	g. Confocal laser scanning microscopy h. Electron Microscopy	2
6	a. Sub-cellular structure of prokaryotic and eukaryotic cells b. Difference between prokaryotic and eukaryotic cells	2
7- 8	Membrane structure and function a. Lipid bilayer	2
	b. Membrane proteins c. Membrane functions	3

9 -10	Plasma membrane
	    a. Origin of plasma membrane
	    b. Different models of plasma membrane structure
	    c. Functions of plasma membrane
		5

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11-12	Cell wall and extracellular matrix a. Cell wall composition & structure	2
	b. Functions of cell wall c. Cell-cell junctions, cell adhesion & extracellular matrix.	3
13	Structural organization and function of intracellular organelles and organelle biogenesis	2
14	Structure & Functions of Nucleus	3
15	Structure & Functions of plastids	3
16	Structure & Functions of mitochondria	3
17	Structure & Functions of endoplasmic reticulum	3
18	Structure & Functions of Golgi apparatus	3
19	Structure & Functions of lysosomes, peroxisomes, vacuoles.	3
UNIT II		

20 -21	Cytoskeleton:
	   a. Origin & functions of cytoskeleton
	   b. Actin & actin binding proteins
	   c. Myosin & actin
		4

	d. Microtubules, Microfilaments & Intermediate filaments
	   e. Cilia & centrioles
	   f. Role of cytoskeleton in mobility
		4

22 - 24	Cell membrane transport: a. Principles of membrane transport	2
	b. Active & Passive transport	4
	c. Transporters & their functions d. Ion-channels	4

25 - 27	Introduction to cell signaling:
	   a. General principles of signaling
	   b. Signaling molecules & their receptors
		4

	c. Functions of cell surface receptors d. G-protein coupled receptors	4
	e. Enzyme coupled receptors f. Pathways of intracellular signal transduction	4
28 - 30	Cell growth, cell cycle and its control: a. Overview of cell cycle	4
	b. Phase of cell cycle: G1, S phase, M phase, Mitosis & cytokinesis c. Meiosis	6
	d. Components of cell cycle control system e. Regulation of cell cycle	2
31 - 32	Cell death &cell renewal a. Programmed cell death/Apoptosis	3

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	b. Cell renewal: stem cells & maintenance of adult tissues c. Embryonic stem cells	5
Total:		**100**

Text Books:
1. Alberts B, Johnson A, Lewis J, Raff M, Roberts K &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.

Course No   : **BT-112**   Course Title   : **Basic Genetics**

Credits   : **3(2+1)**   Semester   : **I**

Theory

UNIT I

History of Genetics; Mendel's principles and rediscovery; Cell division; Chromosomes structure and function; Chromosome theory of inheritance; Sex-linked, sex-limited and sex-influenced inheritance; Sex determination and sex differentiation.

UNIT II

Multiple allelism; Linkage and crossing-over; Gene-gene interaction; Genetic analysis in prokaryotes and eukaryotes; Extra chromosomal inheritance; Mutations; Hardy-Weinberg law; Quantitative inheritance; Introduction to Human genetics; Genetic basis of evolution.

Practical

Life cycle in model plants and animals; microscopy; Mitosis and meiosis; Monohybrid crosses (segregation); Dihybrid crosses (independent assortment); Probability and use of Chi-square; Sex-linked inheritance; Multiple allelism; Detection and estimation of linkage.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightage (marks)
	UNIT I	
1- 2	**History of Genetics** PreMendelian concept (500 BC – 1850 AD) Mendelian Era (1850-1900) Post Mendelian concept (1900 onwards)	4
3	**Mendel's principles and rediscovery** Mendel's laws of inheritance, reasons of Mendel's success. Mendelian deviation or exception	4
4- 5	**Cell Division** Mitosis, importance of mitosis, stages of mitosis, , significance of meiosis, stages of meiosis	4
6	**Chromosome** morphology and chemical composition	4
7	**Chromosome** : Structure and function, recent models of chromosomes structure, special chromosomes, functions of chromosomes	4
8	**Chromosomal theory of inheritance:** Inheritance of quantitative and qualitative traits, characters of quantitative and qualitative traits	4
9	Sex linked, sex limited and sex influenced inheritance	4
10	Sex determination and sex differentiation	4
	Unit II	
11	**Multiple alleles,** Some classical examples of multiple allele, characters of multiple allele	4
12	**Cytoplasmic inheritance:** Definition and character of cytoplasmic inheritance	4
13	Maternal effects, inheritance of structure and patterns, Role of cytoplasmic inheritance in parasites, symbionts and kappa particles in	4

	paramoecium	
14	**Mutation,** history, classification of mutation , spontaneous mutation, induced mutation	4
15-16	**Mutation**, molecular basis of mutation , mutator and anti mutator genes, mutable genes, suppressor mutation, mechanism of suppressor mutation	4
17	**Mutation** (induction and detection), physical mutagens, chemical mutagens, detection of mutation, applications of mutation	4
18-19	**Linkage** History, Types of linkage, detection of linkage, detection in test cross generation, detection in F_2 generation	4
20	**Crossing over**: Definition. factors affecting recombination frequency, cytological basis of crossing over	4
21	**Crossing over** : Crossing over in the four strand stage, relationship between chiasma and crossing over, molecular mechanisms of crossing over, linkage maps and linkage groups	4
22-23	**Gene interaction:** types of gene interaction, typical dihybrid ratio and its modifications	5
24	**Gene interaction** modification of gene interaction F_2 ratios partial dominance at an inhibitory locus (7:6:3), additive gene action (1:4:6:4:1), dominance modification of duplicate genes (11:5)	5
25	**Gene interaction** modifying genes, dominance modification, major and minor gene affecting character, suppression of mutant allele, molecular basis for gene interaction	4
26	**Hardy-Weinberg law** : Gene frequency genotype frequency, gene pool, random union of gametes, random mating among genotypes	4
27	**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
28-29	**Quantative inheritance**: Multiple factor hypothesis, transgressive segregation, effects of environment on qualitative traits	4
30	**Genetic basis of evolution and origin of species:** Theories of evolution: Lamarckism, Darwinism, Mutation theory, neo. darwinism.	3
31-32	**Introduction to human genetics:** Human the organism, Cytogenetics of man: chromosome banding, chromosome aberration. Genetics studies , genetics diseases , blood groups , Disputed Parentages	3
Total:		100

Practical Exercise

Exercise No.	Title
1	Study of life cycle in model plant and animals
2	Study of microscopes
3	Preparation of microscopic slides of mitosis in onion roots tips
4	Preparation of microscopic slides of meiosis in Tradescancia / onion /wheat inflorescence
5	Method of finding gametes
6	Problems on monohybrid ratio and its modification-I
7	Problems on monohybrid ratio and its modification-II
8	Problems on dihybrid ration and its modifications-I

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9	Problems on dihybrid ration and its modifications-II
10	Problems on probability
11	Problems on chi-square test
12	Problems on multiple allele
13-14	Problems on linkage of genes
15	Problems on sex linked inheritance
16	Problems

Suggested Readings:

Text Book and Reference Books:

1. Gupta PK. 2014. Genetics 4th ed. Rastogi Publications.
2. Inbasekar P. 2009. Cell Biology and Genetics. Panima Publications.
3. Miglani GS. 2000. Basic Genetics. Narosa Publishing house, New Delhi.
4. Russell PJ. 2013. Genetics: Pearson New International Edition: A Molecular Approach. Pearson.
5. Watson JD, Bakee TA, Bell SP, Gann A, Levine M & Losick R. 2008. Molecular Biology of the Gene. 6th Ed. Pearson Education International.
6. Gardner EJ, Simmons MJ, Snustad DP. 2006. Principles of Genetics. 8th Ed. John Wiley & Sons.
7. Singh BD. 2004. Fundamentals of Genetics, Kalyani Publication New Delhi.
8. Strickberger MW. 1985. Genetics, Pearson education, Inc.
9. Singh P., 2015. Elements of Genetics, Kalyani Publication New Delhi.
10. Elrod S. and Stansfield W. 2008. Genetics, Mc Graw Hill Publishing Company   Limited , New Delhi.

B.Tech. (Biotechnology)

Course No   : **BT-113**   Course Title   : **Introduction to Biotechnology**

Credits   : **3(2+1)**   Semester   : **I**

Theory

UNIT I

History, definitions, concepts, scope and importance of Biotechnology: Plant, microbial, animal, medical, environmental, industrial, Marine, Agricultural and food Biotechnology; Nanobiotechnology.

UNIT II

Introduction to recombinant DNA technology and its applications: Vectors, DNA restriction and modifying enzymes, gene cloning; Introduction to genomics and proteomics: Molecular markers, DNA sequencing; Genetic transformation and transgenic organisms; Bioinformatics. Biosafety guidelines.

Practical

Orientation to the laboratories: glass houses, screen houses, transgenic facilities and field area; General guidelines for working in Biotechnology laboratories; Familiarization with basic equipment's used in biotechnology; Selection of chemicals (different grade), buffer preparation, calculations and scientific notations used in laboratories.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightages (%)
	UNIT I	
1-2	**History and branches of biotechnology**: definitions and concepts	3
3	**Scope and importance of biotechnology**	3
4	**Plant and Agricultural biotechnology**: tissue culture, concept of totipotency and micro-propagation, applications	5
5	**Microbial biotechnology:** basic concepts, various techniques and industrial applications	3
6	**Medical and Animal biotechnology:** basic concepts, various techniques and industrial applications	3
7	**Environmental , Industrial and Marine biotechnology:** basic concepts, various techniques and industrial applications	3
8	**Agricultural and Food biotechnology:** basic concepts, various techniques and industrial applications	3
9	**Nanobiotechnology:** Nano-particles, nano-fertilizers and applications and future aspects of nano-biotechnology	5
	UNIT II	
10	**Recombinant DNA :** Introduction, Definition, requirements and evolution	3
11	**Gene clonining:** concept, importance and steps involved in gene cloning, transformation, transduction and Transfection	5
12-15	**Vectors:** Definition, properties of good vector, plasmid-	8

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	pBR322, pUC18, pUC19: properties and physical maps. **Types of vectors:** Phage vector (lambda phage, M13), artificial chromosome vectors: BAC, YAC, MAC	
16-18	**Restriction endonuclease:** Types, nomenclature and characteristics of restriction enzymes, restriction site, unit of restriction enzyme, cleavage pattern and mapping	8
19	**The range of manipulative enzymes:** nucleases, ligases, polymerases, topoisomerase, alkaline phosphatase	5
20-21	**Introduction to genomics:** basics of genomics, methods to study genome using bioinformatics tools.	5
22	**Proteomics:** Basics of proteomics, methods of protein analysis using bioinformatics tools, concepts in protein structure prediction.	5
23	**Molecular markers:** Introduction and types- biochemical, morphological and molecular	5
24	**Types of markers:** RFLP, RAPD, AFLP, VNTR, SSR, STR, EST, micro-satellite marker and QTL (methods and applications)	5
25-26	**DNA sequencing:** Introduction, Maxam-Gilbert method, Sanger's method and automated sequencing.	5
27	Genetic transformation and transgenic organisms: methods and applications	5
28-29	**Bioinformatics:** Introduction, scope and importance, Biological databases, introductory programming, introduction to gene expression and microarrays.	5
30	**Biosafety guidelines:** Definition, Biosafety concerns,	2
31	Levels of biosafety, Guidelines in biotechnology,	3
32	Biosafety regulatory framework, Agencies and their role	3
	Total	**100**

Practical Exercise

Exercise No.	Title
1-2	Biotechnology laboratory specifications, organization of instruments and their use , general guidelines
3	Study of glass house and screen house
4	Study of basic equipments used in biotechnology laboratory
5	Different techniques in biotechnology: sterilization and aseptic manipulations.
6	Study of general guidelines and safety measures for working in biotechnology laboratory.
7	Calculation and preparation of molar solution, normal solution, percent solution.
8	Introduction to scientific notations in laboratory
9	Preparation of different buffers in laboratory with different pH
10	Isolation of genomic DNA from bacteria, animal and plant source.
11	Quantification of DNA
12	Gel electrophoresis technique
13-14	Study of gene transfer methods: direct methods

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| 14-15 | Gene transfer methods: indirect methods |
| 16 | Confirmation of genetic transformation by PCR method |

Text Book:
1. Singh BD. 2003.Introduction to Biotechnology.
2. Chawla HS.2002.: Introduction to Plant Biotechnology. Science Pub. Inc.
3. Brown TA. 2017.*Genome4.*. New York: Wiley-Liss.

Reference Books:
1. Prave P, Faust U, Sittig W & Sukatsch DA. 1987. Basic Biotechnology: A Student's Guide. VCH Verlagsgesellschaft.
2. Prave P, Faust U & Sittig W. 1987 Fundamentals of Biotechnology.VCH Verlagsgesellschaft.
3. Renneberg R. 2008. Biotechnology for Beginners. Academic Press Publishers.

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Course No: **CSPD-111**   CourseTitle : **Communication Skills and Personality Development**

Credits : **2(1+1)**   Semester   : **I**

Theory

Definition and Basics of Personality; Analyzing Strength and Weakness; Theories on Personality Development; Body Language; Preparation of Self-Introduction; Communication Skills: Listening Skills; Communication Skills: Communication Barriers; Overcoming these barriers; Building Self-Esteem and Self- Confidence; Attitudes: Assertive, Aggressive and Submissive; Introduction to Leadership; Leadership Styles; Group Dynamics;Team Building; Interpersonal Communication and Relationship;Conflict Management: Introduction, Levels of Conflict and Managing Conflict. Time Management: a. Concept b. Importance and Need.c. Steps towards better Time Management. Public Speaking: a. Introduction b. Increasing Vocabulary c. Voice Modulation d. Social Graces and Email and Telephone Etiquettes.

Practicals

One-on-One Sessions for Individual Personality Traits; Role Play and Impromptu Conversation/Public Speaking Practice focusing on Body Language; Vocabulary Practices: Developing a repertoire of words in various fields like Agriculture, Politics, Economics, Family, Personal Grooming etc. Role Play for Self Introduction in the class; Listening to recorded Short Speeches, Lectures and Conversations Practicing Dialogues, Speeches and Conversations by Students in the Class to illustrate that Communication Barriers can be overcome; Lecture and Questionnaires for Building Self-Esteem and Self Confidence; Case Studies based on Development of Attitudes; Case Studies on Leadership Development; Case Studies on Leadership Development; Group Games, Ice breakers, Warm-ups and Energizers Team Building Activities and Exercises and Trust Building Activities; Psychological Self awareness Exercises; Practice of Non-Verbal Communication Skills: Dumb Charades and Dubsmash Practice; Mutually Acceptable Proximity; and Eye Contact; Time Management Games to Practice and Experience the Importance of Planning/ Delegating Work among them to properly manage time and complete the task in the shortest time possible; Public Speaking Games: (Introducing a friend with his/her life style; Describing a funny image provided by the teacher; Continuing a Story starting with one student and others try to continue with it and try to complete it. Take any object available and try to make a commercial for it; Practice of Emails].

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightages (%)
	Communication Skills	
1	Meaning and Process of Communication	5
2, 3	Verbal and Nonverbal Communication	8
4	Public Speaking, Impromptu Presentation	5
5	Individual Presentation, Group Discussion, Seminars and Conferences	10
6	Science of body language	5
	Writing Skills	
7	Precise Writing, Summarizing, Abstracting	7
8, 9	Listening and Note Taking, Field Diary and Lab Record	8
10	Indexing, Footnote and Bibliographic Procedures	5
	Personality Development	
11	Meaning and definition of Personality	3
12	Factors effecting Personality, Personality Traits	10
13	Voice modulation basics & their usage for meaningful impact on people	7
14	Attributes of an effective leader	5
15	Stress and conflict management,Time management	12
16	Prioritizing and balancing, Cosmopolitan culture, Role of team work	10
	Total:	**100**

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Practical Exercise

1. Oral Presentation Skill
2. Individual and Group Presentation
3. Writing Skill
4. Field Diary and Lab Record
5. Indexing and Footnote and
6. Bibliographic Procedures
7. Precise Writing
8. Summarizing, Abstracting
9. Video recorded mock group discussions & interviews
10. Video recorded practical to evaluate change in confidence level
11. Attitude management
12. Setting & achieving a short term goal
13. Creating a personal vision statement of life
14. Voice modulation
15. Practicing conscious body postures & movements
16. Rapport building

Text Books:

1. Balasubramanian T. 1989. A Textbook of Phonetics for Indian Students. Orient Longman, New Delhi.
2. Balasubrmanyam M. 1985. Business Communication. Vani Educational Books, New Delhi.
3. Naterop JB and Rod R. 1997. Telephoning in English. Cambridge University Press, Cambridge.
4. Mohan Krishna and Banerjee M. 1990. Developing Communication Skills. Macmillan India Ltd. New Delhi.
5. Krishnaswamy N. and Sriraman T. 1995. Current English for Colleges. Macmillan India Ltd. Madras.
6. Narayanaswamy VR. 1979. Strengthen your writing. Orient Longman, New Delhi.
7. Sharma RC and Krishna Mohan. 1978. Business Correspondence. Tata Mc Graw Hill Publishing Company, New Delhi.
8. Dale C. 2012. How to Win Friends and Influence People in the Digital Age. Simon & Schuster.
9. Covey SR. 1989. The Seven Habits of Highly Successful People. Free Press.
10. Spitzberg B, Barge K & Morreale, Sherwyn P. 2006. Human Communication: Motivation, Knowledge & Skills. Wadsworth.
11. Verma KC. 2013. The Art of Communication. Kalpaz.
12. Bhatnagar M and Bhatnagar N. 2011. Effective Communication and Soft Skills. Person Education.
13. Meenakshi R and Sharma S. 2015. Technical Communication: Principles and Practice. Oxford Univ. Press, India.
14. Wallace HR and Masters LA. 2010. Personality Development for Life and Work. Cengage Learning.

15. Rutherford AJ. 2001. Basic Communication Skills for Technology. Pearson Education Inc. New Delhi
16. Carroll BJ. 1986. English for College, Macmillan India Ltd. New Delhi
17. Hahn H. 1996. "The Internet complete reference, Tata McGraw-Hill Edu. Pvt. Ltd.
18. Hornby AS. 1975. Guide to patterns and usage in English. Oxford University, NewDelhi.
19. Qurik R and GreenbaumS. 2002. A University Grammar of English. Longman Pub.

B.Tech. (Biotechnology)

Course No   : **ENV-111**   Course Title   : **Environmental Studies &Disaster Management**
Credits   : **3(2+1)**   Semester   **: I**
Theory

ENVIRONMENTAL STUDIES

<u>UNIT I</u>

Multidisciplinary nature of environmental studies; Definition, scope and importance.

<u>UNIT II</u>

Natural Resources: Renewable and non-renewable resources; Natural resources and associated problems.

a) Forest resources: Use and over-exploitation; Deforestation; Case studies. Timber extraction, mining; Dams and their effects on forest and tribal people.

b) Water resources: Use and over-utilization of surface and ground water; Floods; Drought; Conflicts over water; Dams-benefits and problems.

c) Mineral resources: Use and exploitation; Environmental effects of extracting and using mineral resources; Case studies.

d) Food resources: World food problems; Changes caused by agriculture and overgrazing; Effects of modern agriculture; Fertilizer-pesticide problems; Water logging; Salinity; Case studies.

e) Energy resources: Growing energy needs; Renewable and non-renewable energy sources; Use of alternate energy sources; Case studies.

f) Land resources: Land as a resource; Land degradation; Man induced landslides; Soil erosion and desertification.

Role of an individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles.

<u>UNIT III</u>

Ecosystems; Concept of an ecosystem; Structure and function of ecosystem; Producers, consumers and decomposers; Energy flow in ecosystem; Ecological succession; Food chains, food webs and ecological pyramids; Introduction, types, characteristic features, structure and function of forest ecosystem, grassland ecosystem, desert ecosystem and aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

<u>UNIT IV</u>

Biodiversity and its conservation; Introduction, definition, genetic, species and ecosystem diversity and biogeographical classification of India; Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values; Biodiversity at global, national and local levels; India as a mega-diversity nation; Hot-sports of biodiversity; Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; Endangered and endemic species of India; Conservation of biodiversity: *In-situ* and *Ex-situ* conservation of biodiversity.

<u>UNIT V</u>

Environmental Pollution: definition, cause, effects and control measures air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear

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hazards; Solid waste management: causes, effects and control measures of urban and industrial wastes; Role of an individual in prevention of pollution; Pollution case studies.

UNIT VI

Social issues and the environment; From unsustainable to sustainable development; 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; Wasteland reclamation; Consumerism and waste products; Environment Protection Act; Air (Prevention and Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; Issues involved in enforcement of environmental legislation; Public awareness.

UNIT VII

Human population and environment: population growth, variation among nations, population explosion, Family Welfare Programme; Environment and human health: human rights, value education, HIV/AIDS; Women and child welfare; Role of information technology in environment and human health; Case studies.

DISASTER MANAGEMENT

UNIT I

Natural disasters - Meaning and nature of natural disasters; their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves; Climatic change: global warming, sea level rise, ozone depletion.

UNIT II

Man-made disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III

Disaster management - Effect to migrate natural disaster at national and global levels; International strategy for disaster reduction; Concept of disaster management; National disaster management framework; Financial arrangements; Role of NGOs, community-based organizations and media; Role of central, state, district and local administration; Armed forces, police and other organizations in disaster response.

Practical

Visit to a local area to document environmental assets: river/ forest/ grassland/ hill/ mountain; Visit to a local polluted site - urban/ rural/ industrial/ agricultural; Study of common plants, insects, birds and study of simple ecosystems - pond, river, hill slopes, etc.; Visit to disaster management organizations; Collection of statistics of national disasters occurred since 20th century.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
1.	Environmental studies:- Nature, Definition, scope and importance	3
2.	Natural Resources:-Renewable and non-renewable resources, Natural resources and associated problems.	2
3.	a) Forest resources: Use and over-exploitation, deforestation. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.	3
4.	c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources.	2
5.	d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.	3
6.	e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of non-conventional energy sources. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.	4
7.	Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.	2
8.	Ecosystems: -Concept of an ecosystem,Structure and function.	3
9.	Study of Producers, Consumers and Decomposers,Energy flow in the ecosystem. Ecological succession, Food chains, food webs and ecological pyramids.	5
10.	Types of Ecosystem Introduction, characteristic features, structure and function of Forest,Grassland, Desert and Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	6
11-12.	Biodiversity: - Introduction, definition, genetic, species & ecosystem diversity and bio-geographical classification of India, Value of biodiversity.	6
13-14.	Biodiversity at global, national and local levels, india as a mega-diversity nation. Hot-spots of biodiversity, threats to biodiversity: Endangered and endemic species of Iindia., conservation of biodiversity:	6
15-17.	Environmental pollution:- types of pollution, definition, cause, effects and control measures ofair, water, soil, marine, noise, thermal pollutions and nuclear hazards.	7
18.	Solid waste management: causes, effects and control measures of urban and industrial wastes.Role of an individual in prevention of pollution.	7
19-20.	Carbon credit: concept, exchange of carbon credits. Carbon sequestration, importance, meaning and ways.	3
21-22.	Environmental ethics: climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products.	5

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23-24.	Environment (Protection) Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act and Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness.	08
25.	Human Population and the Environment: Population growth, variation among nations, population explosion. Environment and human health: Human Rights, Value Education.	04
26-27.	Natural disasters- meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves.	7
28.	Climatic change: global warming, Sea level rise, ozone depletion.	3
29-30.	Man made disasters:- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents.	08
31-32.	Disaster management:-concept, effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. National disaster management framework; financial arrangements. Role of ngos, community –based organizations and media.central, state, district and local administration; armed forces in disaster response; police and other organizations.	03
Total:		**100**

Practical Exercise

Exercise No.	Title
1	Study of collection, processing and storage of effluent samples.
2	Estimation of solids in water samples.
3	Measurement the dissolved O_2 content in pond water by Winkler's method.
4	Estimation of respirable and non respirable dust in the air by using portable dust sampler.
5	Determination of sound level by using sound level meter.
6	Study of community structure.
7	Study of ponds / river/ hill slopes ecosystem-abiotic and biotic components.
8	Study of grass land and agro-ecosystem and measurement of their productivity.
9	Crop adaptation to different ecosystems. A. Hydrophytes
10	Crop adaptation to different ecosystems. B. Mesophytes
11	Crop adaptation to different ecosystems. C. Xerophytes
12	Crop adaptation to different ecosystems. D. Halophytes
13	Study and Visit of flora and Fauna.
14	Visit to local polluted site - urban / rural: observations and remedial control measures.
15	Visit to local polluted site - Industrial: observations and remedial control measures.
16	Collection, identification, herbarium, maintenance and study of plants grown in various ecosystems.

Text Book:

1 Bharucha E. 2004. Text book of Environmental Studies for undergraduate courses. University Grants Commission, New Delhi.
2 Sharma PD. 2009. Ecology and Environment. Rastogi Publication, Meerut.
3 Purohit SS, Shammi QJ and Agrawal AK. 2004. Environmental Sciences: A new approach. Student Edition, Agrobios, Jodhpur.
4 Prasanthrajan M and Mahendran PP. 2013. A Text Book on Ecology and Environmental Science. Agrotech Publishing Academy, Udaipur
5 The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad.
6 Singh S. 2010. Disaster Management Oxford Book Company.
7 Khannna. BK. and Khanna N.. 2015. Disasters: Strengthening Community Mitigation and Preparedness. New India Publication Agency.
8 Kaur A. 2015. Laboratory Manual of Ecology and Environmental Studies. Goel Pub. House.

Course No   : **FT-111**   Course Title   : **Food Science and Processing**

Credits   : **2(1+1)**   Semester   : **I**

Theory

UNIT I

Definition: Food and nutrition; Food production and consumption trends in India; Major deficiencies of calories, proteins, vitamins and micronutrients; Food groups and concept of balanced diet; RDA.

UNIT II

Causes of food spoilage; Principles of processing and preservation of food by heat, low temperature, drying and dehydration, chemicals and fermentation; Preservation through ultraviolet and ionizing radiations.

UNIT III

Post-harvest handling and technology of fruits, vegetables, cereals, oilseeds, milk, meat and poultry; Food safety, adulteration and food laws; Status of food industry in India.

Practical

Physical and chemical quality assessment of cereals, fruits, vegetables, egg, meat and poultry; Value added products from cereals, millets, fruits, vegetables, milk, egg and meat; Visit to local processing units.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
1	Definition: Food and Nutrition	4
2	Food production and consumption trends in India	4
3	Major deficiencies of calories, proteins, vitamins and micronutrients	10
4	Food groups	4
5	Concept of balanced diet and recommended dietary allowance	8
6	Causes of food spoilage	4
7	Principles of processing and preservation of food by heat	8
8	Preservation of food by low temperature, drying and dehydration, chemicals and fermentation	12
9	Preservation through ultraviolet and ionizing radiations	4
10	Post-harvest handling and technology of fruits, vegetables and oilseeds	10
11	Post-harvest handling and technology of cereals	4
12	Post-harvest handling and technology of milk	4
13	Post-harvest handling and technology of meat and poultry	8
14	Food safety	4
15	Food adulteration and food laws	8
16	Status of food industry in India	4
Total		**100**

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Practical Exercise

Exercise No.	Title
1	Determination of physico-chemical composition of cereals and meat.
2	Quantative determination of proteins by Micro-kjeldhal method
3	Quantative determination of proteins by Lowry's method
4	Quantative determination of carbohydrates by Anthorne reagent
5	Quantative determination of cellulose of fruits and vegetables.
6	Determination of physiological loss in weight (PLW),
7	Determination of total soluble solids and acidity of fruits and vegetables
8	Microbial examination of cereal flour
9	Microbial examination of canned foods.
10	Estimation of microbial count of milk
11	Estimation of microbial count of meat and poultry
12	Preparation of value added products from milk
13	Preparation of value added products from fruits and vegetables
14	Production of vinegar from fruit juices by fermention
15	Production of wine from fruit juices.
16	Visit to local processing units.

Text Books
1. Potter NN & Hotchkiss JH. 1995. *Food Science.*Chapman and Hall Publishers.
2. Swaminathan M. 2005. *Handbook of Foods and Nutrition.* Ganesh and Co. Pvt. Ltd.
3. Swaminathan M. 1990. *Food Science, Chemistry and Experimental Foods.*BAPPCO.

Reference Books
1. Vaclavik VA & Christian EW. 2003. Essentials of Food Science, 2[nd]Ed.   Kluwer Academic/ Plenum Publishers, New York.
2. Marwaha K. ed. 2015.Food Process Engineering: Theory and Laboratory Experiments. ISBN: 9788189729943
3. Battcock M. and Ali SA, 2016. Fermented Fruits and Vegetables: A global   Perspective. ISBN: 9788170352488

Course No : **HD-111**   Course Title : **Human Ethics**

Credits : **1(1+0)**   Semester : **I**

Theory

UNIT I

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.

UNIT II

Spirituality, positive attitude and scientific temper; Team work and voluntering; 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

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
1	**Universal human aspirations:** Happiness and prosperity	6
2	**Human values and ethics:** Concept, definition	6
3	**Human values and ethics:** Significance and sources	6
4	**Fundamental values:** Right conduct, peace, truth, love and non-violence	8
5	**Ethics:** professional, environmental	6
6	**Ethics:** ICT	8
7	**Sensitization** towards others particularly senior citizens, developmentally challenged and gender	8
8-9	**Spirituality**, positive attitude and scientific temper	8
10-11	**Team work** and volunteering, Rights and responsibilities	8
12	**Road safety**; Human relations and family harmony	8
13	**Modern challenges** and value conflict,Sensitizationagainst drug abuse and other social evils	6
14	Developing personal code of conduct **(SWOT Analysis)**	8
15	**Management** of anger	6
16	**Stress Management**	8
Total:		**100**

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Text Books:

Gaur RR, Sangal R &Bagaria GP. 2011. A *Foundation Course in Human Values and Professional Ethics.* Excel Books.

Nagrajan R. S. 2006. *Professional Ethics and Human Values.*Text book.New Age International (P) Ltd Publishers.

Sharma RA. 2011. *Human Values and Education -Axiology, Inculcation and Research.*R. Lall Book Depot.

Sharma RP & Sharma M. 2011.*Value Education and Professional Ethics.*Kanishka Publishers.

Srivastava S. 2011. *Human Values and Professional Ethics.*S K Kataria& Sons.

Srivastava S. 2011. *Environmental Science.*S K Kataria& Sons.

Tripathi A.N. 2009.*Human Values.*New Age International (P) Ltd Publishers.

Reference Books:

Mathur SS. 2010. *Education for Values, Environment and Human Rights.*RSA International.

Encyclopedia of Ethics, 2nd ed. D. H. Hill Ref. BJ63 .E45 2001 3 vols.

Course No   : **DEG-111**   Course Title   : **Democracy, Elections and Good Goverence**

Credits   : **1(1+0)**   Semester   : **I**

Theory

Unit No. 1

Democracy – Introduction meaning, classification, Principles of Democracy, Dimensions of democracy, Democracy and Diversity Decentralization : concept, features,Fundamental Rights in the Indian Constitution, Outcomes of Democracy and Challenges of Democracy

Unit No. 2

Independent Election Commission in India powers of election commission in India,Elections to local self Government Bodies, National level, State level,Institutions at the local level Municipal Cooperation, Municipal Council Nagar Panchayat, ZillaParishad, PanchayatSamiti, Gram Panchayat : powers duties, Constitutional Provision of 73 & 74 constitutional Amendment Act and Important features of 73 & 74 Constitutional Amendment Act

Unit No. 3

Good Governance : Concept, meaning,Government & Good Governance, , Good Governance and India, Nature of G.G. in India,Attributes of Poor Goverance1 and Steps taken for Good Governance in India.

Teaching Schedule (Theory)

Lecture	Topic	Weightage (%)
1	Democracy – Introduction meaning, classification	4
2	Principles of Democracy, Dimensions of democracy	6
3	Democracy and Diversity Decentralization : concept, features,	6
4	Fundamental Rights in the Indian Constitution	10
5	Outcomes of Democracy, Challenges of Democracy	5
6	Independent Election Commission in India powers of election commission in India	8
7	Elections to local self-Government Bodies, National level, State level	8
8	Institutions at the local level Municipal Cooperation, Municipal Council Nagar Panchayat	8
9 & 10	ZillaParishad, PanchayatSamiti, Gram Panchayat : powers duties	10
11	Constitutional Provision of 73 & 74 constitutional Amendment Act	5

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Lecture	Topic	Weightage (%)
12	Important features of 73 & 74 Constitutional Amendment Act	5
13	Good Governance : Concept, meaning	5
14	Government & Good Governance, , Good Governance and India, Nature of G.G. in India	5
15	Attributes of Poor Goverance1	5
16	Steps taken for Good Governance in India	10
	Total	**100**

Suggested Readings:

1) Development and Democrasy in India by Shailendra D Dharma, Publication : Publisher: Lynne Rienner, Boulder. Year: 2002

2) The Constitution of India, by P. M. Bakshi. Publication:Universal Law Publishing. Edn.: 14th, Year :2017

Course No : **NSS-111**   Course Title : **National Service Scheme I**

Credits : **1(0+1)**   Semester : **I**

Syllabus:

Introduction and basic components of NSS:

Orientation: history, objectives, principles, symbol, badge; regular programmes under NSS, organizational structure of NSS, code of conduct for NSS volunteers, points to be considered by NSS volunteers awareness about health

NSS programmes and activities
Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analysing guiding financial patterns of scheme, youth programme/ schemes of GOI, coordination with different agencies and maintenance of diary

Understanding youth
Definition, profile, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change

Community mobilisation
Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilisation 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 shramdan
Indian tradition of volunteerism, its need, importance, motivation and constraints; shramdan 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 rights to information
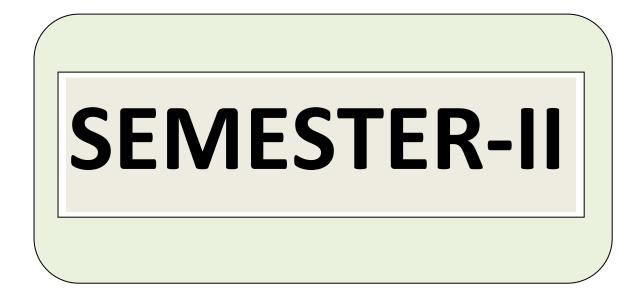
Family and society
Concept of family, community (PRIs and other community based organisations) and society

Practical Exercise

Exercise No.	Topic	Weightages (%)
1.	Introduction and basic components of NSS: Orientation: history, objectives, principles, symbol, badge; regular programmes under NSS, organizational structure of NSS,	7
2.	Code of conduct for NSS volunteers, points to be considered by NSS volunteers awareness about health	7
3.	NSS programmes and activities Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey,	7
4.	Analysing guiding financial patterns of scheme, youth programme/ schemes of GOI,	7
5.	Coordination with different agencies and maintenance of diary	6
6.	Understanding youth Definition, profile, profile, categories, issues and challenges of youth;	6

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7.	Opportunities for youth who is agent of the social change	6
8.	Community mobilisation Mapping of community stakeholders, designing the message as per problems and their culture;	6
9.	Identifying methods of mobilisation involving youth-adult partnership	6
10.	Social harmony and national integration Indian history and culture,	6
11.	Role of youth in nation building, conflict resolution and peace-building	6
12.	Volunteerism and shramdan Indian tradition of volunteerism, its need, importance, motivation and constraints;	6
13.	Shramdan as part of volunteerism	6
14.	Citizenship, constitution and human rights Basic features of constitution of India, fundamental rights and duties,	6
15.	Human rights, consumer awareness and rights and rights to information	6
16.	Family and society Concept of family, community (PRIs and other community based organisations) and society	6
Total:		**100**

SEMESTER-II

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Course No: **ZOO-121**   Course Title: **Basic Zoology**

Credits: **3(2+1)**   Semester   : **II**

Theory

UNIT I

Introduction to Zoology; Structure and functions of cell and cell organelles; Difference between prokaryotic and eukaryotic cell; Cell division – mitosis and meiosis; Structure and function of biomolecules; Types of simple and compound tissues.

UNIT II

Binomial Nomenclature; Classification and general survey of animal kingdom; Functional organization of various systems of a mammal: digestive, circulatory, respiratory, excretory, nervous and reproductive; Laws of inheritance; Multipleallelism - blood groups; Genetic disorders in human and their inheritance.

Practical

Study of animal cell structure and cell division; Histological preparation of simple and compound tissues; General survey of animal kingdom up to phyla in invertebrates and up to classes in vertebrates; Demonstration of mammalian anatomy; Blood grouping.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
	UNIT I	
1	Introduction to zoology	4
2-3	Animal cell: Structure and functions of Cell wall, plasma membrane, mitochondria, golgi apparatus, nucleus, lysosomes, ribosomes, endoplamic reticulum	8
4-5	Prokarotic Cell: Structure and functions of Cell wall, flagella, fimbriae, nucleoid, capsule, slime, mesosomes; Difference between prokaryotic and eukaryotic cell	8
6-7	Cell division-mitosis	8
8-9	Study of Meiosis-	8
10-11	Structure and function of proteins, carbohydrates, lipids, nucleic acid.	8
12-14	Study of simple epithelial tissue, connective tissue, muscular tissue and nervous tissue	8
	UNIT II	
15-16	Binomial Nomenclature	4
17-18	Kingdom Animalia- Invertebrate, protozoa, porifera	4
19	Kingdom Annelida, Arthropoda, mollusca, echinodermata	4
20	Vertebrate-pisces, amphibian	3
21	Vertebrates- Reptiles, Aves, mammals	4
22-23	Functional organization of various systems of a mammal: digestive and circulatory system	5

24	Functional organization of various systems of a mammal: respiratory and excretory system	5
25-26	Functional organization of various systems of a mammal: nervous and reproductive system.	5
27-29	Laws of inheritance; Multiple allelism - blood groups; Study of Rh factor	8
30-32	Genetic disorders in human and their inheritance-Klinefelter syndrome, Downs syndrome etc.	6
Total		**100**

Practical Exercise

Exercise No.	Title
1-2	Study of animal cell structure
3-4	Study of animal cell division
5-6	Histological preparation of simple tissues
7-8	Histological preparation ofcompound tissues
9-10	General survey of animal kingdom up to phyla in invertebrates
11-12	General survey of animal kingdom up to classes in vertebrates
13-14	Demonstration of mammalian anatomy
15-16	Study of Blood grouping

Text Books:

1. Bhatia KN & Tyagi MP. 2012. *Trueman's Elementary Biology*. 24th ed. Trueman Book Company.
2. Dhami PS & Mahindru RC. 1996. *A Text Book of Biology for 10+2.*Pradeep Publications.

Course No : **MATH-122** Course Title **: Basic Mathematics**
Credits : **3(3+0)** Semester **: II**

Theory:

UNIT I

Functions, Types of functions, Limit: Introduction, left handed and right handed limits, general rules for calculation of limits Standard limits(Without proof) $\underset{x \to a}{Lt} \dfrac{x^n - a^n}{x - a}$, $\underset{x \to 0}{Lt} \dfrac{\sin x}{x}$, $\underset{x \to 0}{Lt} (1 + x)^{\frac{1}{x}}$, $\underset{x \to 0}{Lt} \dfrac{a^x - 1}{x}$, $\underset{x \to 0}{Lt} \dfrac{\log(1 + x)}{x}$. Continuity: Definition of continuity, continuity of algebraic functions, Continuity of trigonometric and exponential functions.

UNIT II

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

UNIT III

Integration: Integration by substitution, integration by partial fractions, integration by parts.

UNIT IV

Matrices and Determinants: Definition of matrix, types of matrices, addition, subtraction and multiplication, inverse of matrix; Solution of linear equations: By Crammer's rule.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
Functions; Limit &Continuity:		
1	Definition of Functions, Types of functions, Limit Introduction	
2	Left handed and right handed limits, General rules for calculation of limits	
3	**Standard limits of following types (Without proof) with examples**	
4& 5	$\underset{x \to a}{\mathbf{Lt}} \dfrac{x^n - a^n}{x - a}$	
6	$\underset{x \to 0}{\mathbf{Lt}} \dfrac{\sin x}{x}$	30
7 & 8	$\underset{x \to 0}{\mathbf{Lt}} (1 + x)^{\frac{1}{x}}$	
9 & 10	$\underset{x \to 0}{Lt} \dfrac{a^x - 1}{x}$	
11& 12	$\underset{x \to 0}{Lt} \dfrac{\log(1 + x)}{x}$	
13	Definition of continuity, continuity of algebraic functions	
14	Continuity of trigonometricfunctions	
15	Continuity of exponential functions	
Differentiation:		
16 & 17	Definition of Differentiation, Differentiation by first principle	30

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18	Differentiation using sum and difference formulae		
19 &20	Differentiation using product formula		
21	Differentiation using quotient formula		
22 &23	Differentiation using chain rule		
24	Differentiation of functions in parametric form		
25	Differentiation of functions in implicit form		
26 & 27	Logarithmic differentiation		
28	Successive differentiation		
29	Introduction to Maximum and Minimum values of a function on its domain, Local Maxima and minima		
30 & 31	Examples on maximum and minimum values of the function by first derivative and second derivative test		
32 & 33	Applied problems on Maxima and Minima		
Integration:			
34, 35	Definition of Integration of a function, fundamental Integral formulae, theorems on integration (without proof)	20	
36, 37	Integration by substitution method		
38, 39	Integration by partial fractions		
40, 41	Integration by parts		
Matrices and Determinants;			
42	Definition of matrix, Types of Matrices	20	
43	Addition and Subtraction of Matrices		
44, 45	Multiplication of Matrices		
46, 47	Inverse of matrix by Adjoint method		
48	Solution of linear equation by crammer's rule		
	Total:	**100**	

Text Books
1) NCERT 2012. *Mathematics of Class XII.* NCERT India
2) A Text Book of Mathematics, 12th Part-I and Part-II-Maharashtra State Board of Secondary and Higher secondary Education-Pune.

Reference Book
1) Sharma RD. 2014. *Mathematics of Class XII.* Dhanpat Rai Publisher

Course No   : **BT-124**   Course Title   : **Plant Tissue Culture**

Credits   : **3(2+1)**   Semester   : **II**

Theory

<u>UNIT I</u>

History of plant tissue culture; concept of totipotency; Concept of aseptic culture practices; Components of *in vitro* culture media and role of different macro and micro nutrients, vitamins, plant growth regulators and growth supplements; Sterilization techniques.

<u>UNIT II</u>

Various plant cell, tissue and organ culture techniques and uses; Somatic cell cultures; morphogenesis: organogenesis and somatic embryogenesis; Micropropagation: *In vitro* grafting, meristem culture; Anther, pollen, embryo, ovule, ovary culture; Protoplast culture and somatic hybridization; Somaclonal variation.

Practical

Good laboratory practices;Media preparation and sterilization; Surface sterilization of explants; Establishment of callus/cell suspension cultures; Micropropagation; Embryo culture; Anther and pollen culture; Induction of plant regeneration; Hardening and transfer to soil.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
1	**History of plant tissue culture:** Concept of *in vitro* culture and micro-propagation,	06
2	Historical milestones.	
3	**Concept of totipotency:** Defination, expression and importance of totipotency in plant science.	10
4	Vascular Differentiation, Organogenic Differentiation,	
5	Totipotency of Epidermal Cells, Totipotency of Crown –gall Cells.	
6-7	**Concept of aseptic culture practices:** Need and importance of asepsis in plant tissue culture.	04
8	**Components of *in vitro* culture media**: Media Constituents, growth hormones, Gelling agent, pH of Media.	10
9	Different media used in plant tissue culture.	
10	**Role of different macro, micro nutrients and vitamins.**	
11, 12, 13	**Plant growth regulators and growth supplements:** Auxins, Cytokinins and Gibbrellins: Their role and ratio required in various stages of tissue culture.	10
14	**Sterilization techniques:** Dry heat sterilization, Steam sterilization, flame sterilization,	08
15	Surface sterilization, and filter sterilization etc.	
16	Different instruments used for sterilization.	
17	Various plant cell, tissue and organ culture techniques and uses. Somatic cell cultures:	04

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18	**Morphogenesis organogenesis:** Organogenic differentiation, concept of dedifferentiation and re-differentiation of cells.	10
19	Pathways of organogenesis.	
20	**Somatic embryogenesis:** Pathways for somatic embryogenesis. Steps involved in somatic embryogenesis,	
21-22	**Micropropagation**: Concept of explant and steps of micro-propagation.	10
23	Commercial application of micropropagation.	
24	*In vitro* **grafting** for production of virus free seedlings. **Meristem culture** for production of disease free seedlings.	
25	**Anther, pollen culture:** Technique of androgenesis,	14
26	Factors influencing anther culture, application to plant breeding.	
27	**Embryo Culture:** Culture of mature and immature embryos. Role of suspensor in embryo culture, Applications of embryo culture.	
28	**Ovule, ovary culture:** Ovule and ovary culture, In vitro pollination and its applications.	
29	**Protoplast culture and somatic hybridization**: Methods of isolation of protoplast, Sources of protoplast. Protoplast culture and regeneration.	8
30	Protoplast Fusion: Types of protoplast fusion. Selection of somatic hybrids and cybrids	
31	**Somaclonal variation:** Concept of somaclonal variation. Molecular basis of variation.	6
32	Applications of somaclonal variation in Plant Breeding.	
	Total:	**100**

Practical Exercise

Exercise No.	Title
1-2	Good laboratory practices
3-4	Media preparation and sterilization
5-6	Surface sterilization of explants
7-8	Establishment of callus/cell suspension cultures
9-10	Micropropagation
11-12	Embryo culture; Anther and pollen culture
13-14	Induction of plant regeneration
15-16	Hardening and transfer to soil

Text Books:

1. Bhojwani SS & Razdan MK. 1996. *Plant Tissue Culture: Theory and Practice.*Elsevier.
2. Bhojwani SS & Dantu PK. 2013. *Plant Tissue Culture: An Introductory Text*. Springer.
3. De K.. Plant Tissue Culture
4. Chawla HS. Introduction to Plant Biotechnology.

Reference Books:

1. Dixon RA & Gonzales RA. 2003. *Plant Cell Culture: A Practical Approach*. Oxford University press.
2. Helgason CD & Miller CL. 2005. *Basic Cell Culture Protocols*.3rd Ed. Humana Press.

Course No   : **BT-125**   Course Title   : **Molecular Biology**

Credits   : **3(2+1)**   Semester   : **II**

Theory

UNIT I

History of molecular biology; Central dogma of life; Structure of DNA and RNA; Gene structure and function; DNA replication; transcription; Genetic code and translation; Structure of prokaryotic and eukaryotic nuclear and organelle genomes; Gene regulation in prokaryotes: Lac operon concept, tryp concept.

UNIT II

Introduction to microbial genetics; conjugation, transformation and transduction; Tools in molecular biology: Role of enzymes in molecular biology; Principles of Polymerase Chain Reaction; Electrophoresis; PCR and hybridization based molecular markers.

Practical

Preparation of bacterial competent cells and transformation; Isolation and purification of plant and animal DNA; Measurement of nucleic acid concentration using spectrophotometer and gel electrophoresis; DNA amplification using RAPD, microsatellite primers and analysis; CAPS primers; Generation of linkage maps and mapping of qualitative genesgenes for Quantitative traits; Estimation of genetic similarities and generation of dendrograms.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
	UNIT I	
1	**History of molecular biology:** Concept, Historical evidences and prospects	4
2-3	**Central Dogma of Life:**Concept,direct evidences for DNA as the genetic material- the transformation experiments, identification of the "transforming" principle or substance, bacterial conjugation ; indirect evidences for DNA as the genetic material ; evidences for RNA as the genetic material.	5
4-5	**Structure of DNA and RNA:**History, DNA and RNA:Structure, types and function of nucleic acids (DNA & RNA), molar ratios of nitrogen bases, the equivalence rule, physical, molecular or geometrical organization of DNA, Watson and Crick's model of DNA, ploymorphism of DNA helix (or alternative forms of DNA double helices),	5
6-7	**Gene structure and function:** Gene: gene concept, unit of function, replication, recombination and mutation Fine structure of gene: bar locus, complex loci, rII locus and complementation analysis Gene function: one gene/one enzyme hypothesis, pathways of gene action.	5
8-10	**DNA Replication:** Outline of DNA replication, Crick's model for DNA replication, experimental evidence for semiconservative DNA replication in *E.coli*, Meselson and Stahl's experiment semi discontinuous replication, unidirectional and bidirectional DNA	8

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	replication, enzymes of DNA metabolism, roles of RNA primers in DNA replication, mechanism of DNA replication in prokaryotes; DNA replication in eukaryotes, model's of DNA Replication, repair replication, Functions of DNA.	
11-12	**Transcription:** Protein Synthesis: Prokaryotic transcription, eukaryotic transcription, RNA polymerases, General and specific transcription factors, Regulatory elements and mechanisms of transcription regulation, 5' Cap formation, Transcription termination, 3'end processing and polyadenylation, nuclear export of mRNA, mRNA stability RNA splicing: Nuclear splicing, spliceosome and small nuclear RNAs, group I and group II introns, *Cis-* and *Trans-* splicing reactions, tRNA splicing, alternate splicing.	8
13-15	**Genetic code and translation:** Amino acids involved in protein synthesis**,** characteristics of genetic code viz; triplet code, non-overlapping, commaless, polarity, codons and anticodons, initiation codons, termination codons, degenerate and universal, wobble hypothesistranslation, stages of polypeptide synthesis in eukaryotes, rate of protein synthesis, signal hypothesis, prokaryote and eukaryote protein synthesis, modification of released protein; antibiotics and protein synthesis.	8
16-18	**Prokaryote and Eukaryote nuclear and organelle genomes :**Genomeorganization: Genome organization in prokaryotes and eukaryotes special features of eukaryotic gene structure and organization, genome organization of mitochondria and chloroplast. Genome Anatomies; Overview of Genome Anatomies, Genomes of eukaryotes, Genomes of prokaryotes, the anatomy of the eukaryotic genome, Eukaryotic nuclear genomes, Eukaryotic organelle genomes their origin and genetic content, The Anatomy of the Prokaryotic Genome, physical structure of the prokaryotic genome, genetic organization of the prokaryotic genome	7
19-21	**Gene Regulation in Prokaryotes**: Regulation of gene expression: Induction and repression, operon theory, lac operon, trp operon, attenuation, ara operon, positive and negative control, catabolite repression, regulation of transcription by cAMP and CRP, and guanosine tetraphosphate, *Run off* transcription. Britten-Davidson and Mated models of gene regulation, regulation of gene expression in eukaryotes.,	12
UNIT II		
22-23	**Introduction to microbial genetics:** Scope and development of microbial genetics, Recombination in bacteria and viruses, Transformation: Competence factors,mechanism of transformation, Conjugation: Structure of F plasmid, Mechanism of transfer of F plasmid, Hfr, mechanism of integration of F plasmid into bacterial chromosome, circularization of chromosome, Transduction & Gene mapping, Transformation techniques Transduction-generalised and specialized transduction DNA transfer by transducing phages-transducing phages as cloning vectors.	6
24-26	**Tools in molecular biology:** **Role of enzymes in molecular biology:** Restriction endonucleases: Types and characteristics of restriction endonucleases and their uses.	10

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		Restriction mapping, restriction pattern, DNA modifying enzymes, host, cloning vectors- Plasmid, Bacteriophage, other vectors,expression vectors, Construction of genomic and c-DNA libraries, cloning, Homo polymer tailing, cohesive and blunt end ligation, adaptors, linkers.	
27-28	**Principles of PCR:** Concept and components of PCR, procedure of PCR, variants of PCR, applications of PCR		8
29-30	**Principles of electrophoresis:** Principles and types of electrophoresis, viz;SDS-PAGE, Agarose Electrophoresis, procedure of electrophoresis2D Electrophoresis,		6
31-32	**PCR and Hybridization based markers:** Introduction to molecular markers, characteristic, types of molecular markers, RFLP; PCR based markers-RAPD, ISSR, AFLP, SSR, SNP, VNTR, ESTs, SCAR, CAPS advantages and applications of molecular markers etc.		8
		Total:	**100**

Practical Exercise

Exercise No.	Title
1-2	Preparation of bacterial competent Cell
3-4	Study of bacterial transformation
5-6	Isolation and purification of Plant DNA
7-8	Isolation and purification of Animal DNA
09	Study on measurement of Nucleic Acid & Concentration using spectrophotometer& Gel electrophoresis
10	Study of DNA amplification using RAPD Primers
11	Designing of Microsatellite primers designing & analysis
12	Analysis of CAPS markers
13	Construction of linkage Map
14	QTL mapping
15	Estimation of genetic similarities
16	Generation of dendrograms & its analysis

Suggested Readings:

Text Book:
1. Allison LA. 2011. *Fundamental Molecular Biology*. Wiley Global Education.
2. Carson S, Miller HB & Witherow DS. 2012. *Molecular Biology Techniques A Classroom Laboratory manual*. Elsevier.
3. Kreuzer H & Massey A. 2008.*Molecular Biology and Biotechnology: A Guide for Teachers*. ASM Press.
4. Lodish H, Berk A, Kaiser CA, Krieger M, Bretscher A, Ploegh H, Amon A & Scott MP. 2012. *Molecular Cell Biology*. W. H. Freeman.

Reference Books:

1. Sambrook J & Russel D. 2001. *Molecular Cloning: A Laboratory Manual*. 3rd Ed Cold Spring Harbor Laboratory Press.
2. Surzycki S. 2000. *Basic Techniques in Molecular Biology*. Springer Berlin Heidelberg
3. Voet D, Voet JG & Pratt CM. 2004.*Fundamentals of Biochemistry*.2nd Ed. Wiley New York.
4. Walker JM & Rapley R. 2000.*Molecular Biology and Biotechnology*.4th Ed.The Royal Society of Chemistry.
5. Watson JD, Bakee TA, Bell SP, Gann A, Levine M & Losick R. 2008. *Molecular Biology of the Gene*.6th Ed. Pearson Education International.

Course No **: BOT-ZOO-121** Course Title **: Biodiversity & its Conservation**

Credits **: 2(2+0)** Semester : **II**

Theory

<u>UNIT I</u>

Concepts of biodiversity, bioresource and wildlife management, conservation strategies: *in situ* and *ex situ* conservation; Wild life 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.

<u>UNIT II</u>

Sustainable development; Diversification of cropping system; Diversity of indigenous livestock; 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 with weightage (%)

Lecture No.	Topics	Weightage (%)
UNIT I		
1-2	**Concepts of biodiversity:** Meaning and concept, Example with importance.	2
3	**Bioresource and wildlife management:** Meaning expression and importance of Bioresources in Nature.-Genetic resources -Plant and animal biotechnology -GMO -Agriculture -Water technology/waste treatment -Bioresources in ecosystems (ecosystem services) - carbon cycles - pollinators & dispersal agents.	5
4	**Wildlife management**: Defination and types of wild life management.	4
5	**Conservation strategies: in situ and ex situ conservation:** Meaning, concept and example with importance and introduction, role in biodiversity conservation	5
6	**Wild life conservation projects in India:** Tiger Project,	2
7	Wild life conservation society WCS etc.	2
8	**Protection of biodiversity for its suitable utilization;** Conservation: Protection and restoration techniques,	2
9	Protected areas, National parks, Wildlife sanctuary,	3
10	Forest reserves, Steps to conserve the forest cover, Zoological parks, Botanical gardens	3
11	**Threats to biodiversity;** Habitat Loss and Sustainability.	2
12	Overharvesting. Exotic Species.	2
13	Climate Change and Biodiversity	2
14	**WCU Red data book:** Purpose,	2
15	Eight categories of species by RDB.	3

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16	Eight categories of species by RDB.	3
17	**Biodiversity hotspots in India;** Meaning and concept and example with importance (Western Ghats, Eastern Himalayas).	3
18	**National bureaus of genetic resources:** Establishment , Research Network and activities of NBPGR, NBAGR, NBAIM, NBFGR, NBAII.	3
UNIT II		
19	**Sustainable development:** Meaning, Objectives-Economic development/ growth, social progress, environmental conservation and protection, Social progress.	5
20	**Diversification of cropping system:** Meaning and concept and importance.	4
21	**Diversity of indigenous livestock;** Meaning and importance of Livestock husbandry. Diversity of livestock.	5
22	**Vulnerability and extinction of flora and fauna;** Meaning and examples.	3
23	Concept of vulnerability	3
24	Importance of vulnerability of flora and fauna.	4
25-26	**Endangered species in various ecosystems;** Meaning and concept, example with importance	7
27-28	**Germplasm banks;** Meaning and concept, example with importance	7
29-30	**Environmental impact assessment;**Principles of Assessment, Meaning and concept, Methods Around the world and Trans-boundary application.	6
31	**Bioremediation and bio-safety;** Concept and meaning, introductory part of Bioremediation and bio-safety.	4
32	**Introduction to regulatory agencies and legislation:** policies and practices andRole of regulatory agencies and legislation	4
	Total:	**100**

Text Books

1. Das M.K & Choudhury B.P. 2008. *A Text book on Plant Nomenclature and Biodiversity Conservation.* Kalyani Publishers.

Reference Books

1 Hopsetti BB. & Venketashwarlaru M. 2001. *Trends in Wild Life Conservation and Management.*Vol. 2, Daya Publishing House, New Delhi.
2 Singh MP & Singh BS. 2002. *Plant Biodiversity and Taxonomy.* Daya Publishing House, New Delhi.

Course No **: HORT-121** Course Title : **Production Technologies forHorticultural Crops**

Credits   **: 3(2+1)**   Semester   : **II**

Theory

UNIT I

Importance and scope of fruit cultivation; Classification of fruit crops; Climatic requirement; Selection of site; Fencing and wind break; Lay out and planting systems; Sexual and asexual methods of plant propagation; Production technology of important tropical, sub tropical and temperate fruit crops.

UNIT II

Importance of vegetable cultivation for nutritional security; Production technology of important vegetable crops: potato, brinjal, tomato, chilli, onion, okra, cabbage, cauliflower, musk melon, water melon, cucumber and leafy vegetables.

UNIT III

Status and scope of floriculture in India and abroad; Production technology of commercial flower crops: Rose, chrysanthemum, gladiolus, marigold, gerbera, carnation, lilium, jasmine, anthurium and orchids.

Practical

Identification of different fruit, vegetables, ornamental and flower crops; Lay out and planning for planting orchards; Preparation of seed beds; Raising of seeds, rootstocks, and propagation techniques of major fruit, vegetable and flower crops; Visit to commercial nurseries and orchards.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightage (%)
	UNIT I	
1	Definition and meaning of horticulture, Importance and scope of fruit cultivation.	3
2	Branches of horticulture	3
3	Classification of fruit crops, vegetables and flowers;	3
4	Climatic zones of Maharashtra and India in relation to horticultural crops.	3
5	Selection of site; Fencing and wind break;	3
6	Lay out and planting systems of horticultural crops;	3
7	Sexual and asexual methods of plant propagation; Its advantages and disadvantages.	3
8	Asexual propagation: Cutting, layering, grafting, budding, etc	4
9	Production technology of important fruit crops-Mango.	3
10	Banana, Guava	4
11	Pomegranate, Sapota	4
12	Grape	3
13	Citrus spp.	4
14	Ber, Fig	3
15	Aonla, Papaya	3

16	Coconut, Cashewnut	3
17	Arecanut, Jackfruit	3
	UNIT II	
18	Importance of vegetable cultivation for nutritional security	3
19	Production technology of important vegetable crops: potato, brinjal,	4
20	Tomato, Chilli,	4
21	Onion, Okra	3
22	Cabbage, cauliflower.	3
23	Musk melon, water melon, cucumber.	4
24	Leafy vegetables.	3
	UNIT III	
25	Status and scope of floriculture in India and abroad;	3
26	Production technology of commercial flower crops: Chrysanthemum, Rose	4
27	Gladiolus, Marigold	3
28	Gerbera, carnation.	3
29	Lilium, jasmine,	2
30	Anthurium, orchids	2
31	Major pests of horticultural crops and their control	2
32	Major diseases of horticultural crops and their control	2
	Total	**100**

Practical Exercise

Exercise No.	Title
1-2	Identification of different fruit and vegetables.
2	Identification of differentornamental and flower crops.
3-4	Lay out and planning for planting orchards.
5-6	Preparation of seed beds.
7-8	Raising of seeds of horticultural crops
9-10	Raising of rootstocks
11-12	Propagation techniques of major fruit crops
13-14	Propagation techniques of major vegetable and flower crops
15-16	Visit to commercial nurseries and orchards.

Suggested Readings

Arora JS. 2013. Introductory Ornamental Horticulture. Kalyani Publishers.

Bal JS. 2013. Fruit Growing. Kalyani Publishers.

Chadha KL. 2012. Handbook of Horticulture. ICAR, New Delhi

Dhaliwal MS. 2014. Handbook of Vegetable Crops. Kalyani Publishers

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Course No   : **AS-121**   Course Title   : **Anatomy and Physiology of Livestock**

Credits   : **3(3+0)**   Semester   : **II**

Theory

UNIT I

Definition of terms used in Ceterinary Anatomy, topography, contour, landmarks and functional anatomy of various organs in cow, buffalo, sheep and goat structural and functional classification of muscles.

UNIT II

Structure of animal cell and tissues: study of microscopic structure of organs from digestive, urinary, respiratory, reproductive, nervous, cardiovascular and endocrine systems; Gametogenesis, fertilization, cleavage, gastrulation and the development of fetal membranes in livestock, structure and types of mammalian placenta; Development of the organs of digestive, urogenital, cardiovascular, nervous and endocrine glands.

UNIT III

Introduction to blood physiology; Genetic and endocrine control of reproductive system; maternal recognition of pregnancy; Introduction to physiology of mammary glands: structure and development, hormonal control of mammary growth, lactogenesis and lactation cycle.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightage (%)
1	**Definition of terms used in Veterinary Anatomy, Topography, Contour, Landmarks:-** Introduction, Anatomical organization, Musculoskeletal system, Gastrointestinal tract, Reproductive system, Cardiovascular system,	03
2-3	Respiratory tract, Hematology, Immunology, Endocrine system, Integumentary system, Nervous system, Eyes and Ears, Urinary system, Horse, Ruminants, Swine, exotics, Lab. Animals	03
4	**Functional anatomy of various organs in cow, buffalo, sheep and goat:** Study of anatomy of various organs	04
5-6	**Structural and functional classification of muscles:** Skeletal, Cardiac, Smooth. Classification of muscle according to shape and fascicular architecture	04
7	**Structure of animal cell:** -Animal Cells- Light Microscope -Animal Cells-Electron Microscope -All cell organelles of animal cell	03
8	**Types of tissues:** Epithelial, Connective/Supporting (Including blood), Muscular and Nervous	03
9-10	**Study of microscopic structure of organs of Digestive systems of animals:** Mouth, Tongue, Pharynx, Esophagus, Stomach : Simple and Ruminant stomachs, Small intestine, Large intestine, Anus, Liver,	04

	Pancreas, gall bladder,	
11	**Study of microscopic structure of organs of Urinary system:** Kidneys, Ureters, Bladder, Urethra	04
12	**Study of microscopic structure of organs from Respiratory: Nose,** Nasal cavity, Nostrils, Pharynx, Larynx, Trachea, Lungs,	04
13-14	**Study of microscopic structure of organs from Reproductive:** Functions of the reproductive system, Parts of the reproductive system: a. Female animals b. Male animals , Production of offspring,	04
15-16	**Study of microscopic structure of organs from Nervous:** The central and peripheral nervous system.	03
17-19	**Study of microscopic structure of organs from Cardiovascular:** Heart, Arteries, Veins Capillaries	03
20-21	**Study of microscopic structure of organs from Endocrine systems:** •Hormones and functions (Steroids, Peptides, Amines) •Lipids •Steroid hormones (Progesterone and Testosterone) •Peptides and hormones (Oxytocin, LH, Thyrotropin,)	03
22-25	•Amines [epinephrine, norepinephrine, T3 (triiodothyroxin), and T4 (tetraiodothyroxin)] •Hypothalamus gland •Pituitary gland •Thyroid gland •Parathyroid gland •Adrenal glands.	03
26-28	**Gametogenesis** Process of producing gametes, Spermatogenesis, Oogenesis, Meiotic cell division, Packaging of material into oocytes, Removal of cytoplasm from sperm	06
29-32	**Fertilization: 4 major steps:**	12
33-34	**Structure and types of mammalian placenta:-**	03
35-36	**Development of the organs of Digestive:** **The embryology of digestive system and the body cavities**	04
37	**The embryology of Urogenital system**	04
38	**The embryology of Cardiovascular System**	04
39-40	**The embryology of Nervous system**	04
41-42	**Introduction to blood physiology:** Blood composition and properties, Blood cells: Hematopoiesis, RBC: function, anemia, WBC, Platelet: function, coagulation and fibrinolysis. Blood grouping and transfusion	02
43	**Genetic and endocrine control of reproductive system:** **Genetic-** Animal cell, Cell division, Fertilization, chromosome, genes **Endocrine control of reproductive system-** Chemical signaling, Hormone from a neurosecretary cell, Antagonistic hormones and homeostatis, Feedback control loops regulating the secretion of thyroid hormones, Homeostasis	02
44	**Maternal recognition of pregnancy:** Luteal Regression, CL Status - Recognition of Pregnancy (Conceptus Secretions • Proteins • Steroids) -Recognition of Pregnancy in Bovine and Ovine (Mechanism • Antiluteolytic • Inhibit oxytocin receptor synthesis • Inhibit PGF2α synthesis)- Recognition of Pregnancy in the Porcine - Recognition of Pregnancy in the Mare	03
45	**Introduction to physiology of mammary glands:** Introduction, Lymph nodes, Adipose tissue, Areola, Nipple, Milk flow, Mammary gland development, Endocrine control, Factors affecting secretion	03

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	Structure and development of mammary growth: Mammary gland anatomy (4 glands, 2 halves, Fore and rear quarters of each half, 7 tissue of udder, teat, gland cistern, ducts), Secretary tissue, Lobes and lobules, Grandular tissue, Connective tissue/Stroma, Skin, Ligaments, Blood, Nerves. **Developmentof mammary growth:-**Rudimentary duct system-Ductal elongation/Bifurgation-Sidebranching-Alveologenesis/Lactogenic differentiation. **Hormonal control of mammary growth:**Estrogen (Puberty), Progesterone (Adulthood estrous cycle), Prolactin (Pregnancy, Lactation). **Lactogenesis:** Lactogenesis I, Lactogenesis II, Lactogenesis III,Lactogenesis IV **Lactation cycle:** Definition, Early lactation, Mid lactation, Late lactation, Dry period.	
46-48		05
	Total:	**100**

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Suggested Readings:

Text Books:

1. Dyce K, Sack W & Wensing CJG. 2009. Textbook of Veterinary Anatomy, 4th Edition. Elsevier Health Sciences.
2. Frandson RD, Wilke WL & Fails AD. 2009. Anatomy and Physiology of Farm Animals. 7th Edition.Wiley–Blackwell.

Reference Books:

Reece WO. 2004. Duke's Physiology of Domestic Animals. 12th Edition.Comstock Publishing Associates.

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Course No   : **MICRO-121**   Course Title   : **Microbiology**
Credits   : **3(2+1)**   Semester   : **II**

Theory

UNIT I

History of Microbiology-its applied areas; Microorganisms and their role in fermentation; Germ theory of diseases and protection; Introduction to eukaryotic and prokaryotic cell; Major groups of eukaryotes- fungi, algae and protozoa; Major groups of prokaryotes – Actinomycetes, Cyanobacteria, Archaebacteria, Rickettsias and Chlamydia; Preservation of microorganisms; Microbial repositories at national and international level.

UNIT II

Bacterial growth; Metabolism in bacteria- ATP generation, chemoautotrophy, photoautotrophy, respiration, fermentation; Viruses: Bacteriophages - structure and properties, lytic and lysogenic cycles; viriods, prions.

UNIT III

Microbial groups in soil; Microbes in biotic and abiotic stressed environments; Microbial transformation of carbon, nitrogen and sulphur; Biological nitrogen fixation; Beneficial microorganisms in agriculture-biofertilizers, microbial pesticides; Plant microbe interaction; 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; Micrometery.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
	UNIT I	
1-2	**History of Microbiology-its applied areas:** The microscope, spontaneous generation versus biogenesis, Fermentation, The germ theory of disease, Laboratory techniques and pure cultures, Protection against infection: Immunity, Widening horizons, Microbiology and society.	5
3	Microorganisms and their role in fermentation	5
4-5	**Germ theory of diseases and protection:** Germ theory of diseases, Laboratory techniques and pure cultures, Protection against infection: Immunity.	5
6-7	**Introduction to eukaryotic and prokaryotic cell:** Introduction, Organelle details and their functions in eukaryotic and prokaryotic	10
8-10	**Major groups of eukaryotes** **Fungi:** The importance of fungi, Distinguishing characteristics of fungi, Morphology, Reproduction, Physiology, Cultivation, Classification, Some	10

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	fungi of special interest, Moulds and Association with other organisms **Algae:** Occurrence, The biological and economic importance, Characteristics, Classification, Lichens **Protozoa:** Occurrence, Ecology, Importance, Morphology, Reproduction, Classification, Characteristics of some major groups of protozoa.	
11-13	**Major groups of prokaryotes** **Actinomycetes:** Morphology, Occurrence **Cyanobacteria:** Occurrence, Characteristics, Importance **Archaebacteria:** Morphology, Characteristics, Categories (methanogens, halophiles and thermoacidophiles) **Rickettsias:** Morphology, Characteristics, Diseases caused by rickettsias **Chlamydia:** Characteristics, Diseases caused by Chlamydia Mycoplasma: Morphology, Characteristics, Diseases caused by Mycoplasma	10
14-15	**Preservation of microorganisms:**1)**Agar Slant Culture**2) **Agar Slant Culture Covered with Mineral Oil 3) Storage in Saline Suspension 4) Preservation by Drying in Vacuum 5) Cryo-preservation 6) Lyophilisation or Freeze-drying** **Microbial repositories at national and international level:** National- NCCS Pune, MTCC Chandigarh, NBAIM New Delhi, NCIM NCL Pune, International- NCTC England, ATCC America, BCCM/LMG Russia,	5

UNIT II

16-18	**Bacterial growth:** normal growth cycle (growth curve) of bacteria, transitional periods between growth phases, synchronous growth, continuous culture **Metabolism in bacteria-** ATP generation, chemoautotrophy, photoautotrophy, respiration, fermentation **Viruses:** Bacteriophages - structure and properties, lytic and lysogenic cycles;viriods, prions.	10

UNIT III

19-22	**Microbial groups in soil:** Bacteria, Fungi, Algae, Protozoa, Viruses, The Rhizosphere **Microbes in biotic and abiotic stressed environments: Microbial transformation of carbon:**Carbon dioxide fixation, organic carbon compound degradation, Microorganisms involved in carbon cycle **Microbial transformation of nitrogen:** Proteolysis, Ammonification, Nitrification, Reduction of nitrate to ammonia, Denitrification **Microbial transformation of sulphur:** sulphur cycle showing the role of microorganisms	10
23-24	**Biological nitrogen fixation:**Microorganisms involved in symbiotic nitrogen fixation, Mechanisms, Significance	5
25-27	**Beneficial microorganisms in agriculture** **Biofertilizers:**Definition, Microorganisms – Bacteria (*Rhizobium spp., Azospirillum, Azotobacter),* Fungi (Mycorrhizae*Glomus*), Blue green algae or Cyanobacteria(*Anabaena, Nostac*) and *Azolla*. Advantages and limitations of biofertilizers. **Microbial pesticides:** Definition,Biocontrol agents used against insect (viruses, bacteria, fungi, protozoa, mites), Weed (*Phytophthora, Palmivora, Colletotrichumgleospirodes*), disease (fungi, bacteria). Advantages and limitations of biopesticides.	10

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28-30	**Plant microbe interaction:** **Microbes in composting and biodegradation:**	5
31-32	**Microbiology of water:** Water purification, Determining sanitary quality, Waste water, Microorganisms and waste water treatment procedures. **Food:** Microbial flora of fresh foods, Microbial spoilage of foods, Microbiological examination of foods, Preservation of foods, Fermented foods, Microorganisms as a food- single cell proteins.	10
Total:		**100**

Practical Exercise

Exercise No.	Title
1	Microscope and other instruments in a microbiological laboratory.
2	Micrometery.
3	Methods of sterilization
4	Nutritional media and their preparation,
5	Methods of isolation and purification of microbial culture
6	Preservation and storage of Microorganisms
7	Identification of bacteria by staining methods. Simple staining
8	Identification of bacteria by Gram staining
9	Identification of bacteria by flagella staining
10	Identification of bacteria by spore staining
11	Enumeration of bacteria by pour plate and spread plate methods.
12	Isolation of Rhizobium fromlegume root nodule
13	Isolation of Azotobacter from soil
14	Isolation of P and silica solubilizing microbes
15	Isolation of microorganisms from soil, food and drainage water.
16	Isolation of *E.coli* from milk

Reference Book:

1. Brock TD. 1961. *Milestones in Microbiology.*Infinity Books.
2. Pelczar M.J, Chan E.C.S & Kreig N.R. 1997.*Microbiology: Concepts and Application.*Tata McGraw Hill.
3. Stainier RY, Ingraham J.L, Wheelis M.L & Painter P.R. 2003. *General Microbiology.* MacMillan.
4. Tauro P, Kapoor K.K.& Yadav K.S. 1996. *Introduction to Microbiology.*Wiley Eastern.
5. Prescott, L.M. Harley, J.P. and Klein, D.A (5ed) 2002. *Microbiology*. Mc Graw Hill Publishers, Newyork.
6. Jamaluddin, M. Malvidya, N. and Sharma, A. 2006. *General Microbiology*. Scientific Publishers, Washington.
7. Sullia, S.B, and Shantaram 1998. *General Microbiology*. Oxford and IBH.
8. Madigan, M. Martinkoj, M. and Parker (10 ed.) 2003. *Biology of Microorganisms*. PrenticeHall of India Pvt. Ltd., New Delhi.
9. Borkar,S.G. 2015.Beneficial Microbes as Biofertilizers and its Production Technology Woodhead Publisher,India,New Delhi

Course No   : **PB-121**   Course Title   **: Principles of Plant Breeding**

Credits   : **3(2+1)**   Semester   **: II**

Theory

UNIT I

History, aims and objectives of Plant breeding; Role of related sciences in plant breeding; Modes of reproduction - sexual, asexual, apomixes: Significance in plant breeding; Modes of pollination, genetic consequences, differences between self- and cross pollinated crops; Germplasm resources and their utilization.

UNIT II

Methods of breeding: Introduction and Acclimatization; Selection: Mass selection, Johannesen'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, back cross method; Heterosis, inbreeding depression, various theories of heterosis, exploitation of hybrid vigor, Hardy Weinberg law, selection in cross pollinated crops; Population improvement programmes; Synthetics and composites; Methods of breeding vegetatively propagated crops.

UNIT III

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.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
	UNIT I	
1	Definition of Plant Breeding, history of Plant Breeding	4
2	Aims and objective of Plant Breeding	4
3	Role of related sciences in Plant Breeding	4
4	Modes of reproduction, sexual and asexual reproduction	5
5	Apomixis types of apomixes, Applications of apomixis	5
6	Modes of pollinations, types of pollination, difference between self and cross pollination	5
7	Genetic consequences (mechanisms for self and cross pollination in crop plants)	4
8	Germplasm: Definition, Different methods of collection and conservation. National institutes for germplasm conservation	4
	UNIT II	
9	Methods of breeding in self pollinated crops	4
10	Methods of breeding in cross pollinated crops	4
11	Johnson's pure line theory, Genetic basis, Pure line selection method	4
12	Hybridization: Aims and objectives, Types of hybridization	4
13	Methods of handling segregating generation (Pedigree method)	2
14	Methods of handling segregating generation (Bulk method)	2
15	Methods of handling segregating generation (Back cross methods)	2
16	Heterosis : Definition, Types of heterosis, different theories of	3

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	heterosis	
17	Inbreeding depression, Exploitation of Hybrid vigour/heterosis in crop plants	3
18	Hardy-Weinberg law, selection in cross pollinated crops	2
19	Population improvement programme :Synthetic, definitions and procedure of development of Synthetic	3
20	Composite : Definition and procedure of development of composite	3
21	Breeding method in asexually propagated crop : Clonal selection procedure of clonal selection	3
UNIT III		
22-23	Male sterility : Definition: types and use of male sterility in crop improvement	4
23-24	Self incompatibility, definition, types and use of self incompatibility in crop impartment	4
25-26	Mutation : Definition, classification of mutation, mutagenic agents and induction of mutation	4
27-28	Ploidy Breeding : Definition of polyploidy, types of polyploidy , application of polyploidy in crop improvement	4
29	Wide hybridization : Definition, types of wide hybridization ,	3
30	Incompatibility barriers for wide hybridization, Technique to over come incompatibility barriers	3
31-32	Procedure for release of new varieties	4
Total		**100**

Practical Exercise

Exercise No.	Title
1.	Classification of crop plants
2.	Botanical description and floral biology of Rice and Wheat
3.	Botanical description and floral biology of Sorghum and Maize
4	Botanical description and floral biology of Bajra and Sugarcane
5	Botanical description and floral biology of Brassica and Groundnut
6	Botanical description and floral biology of Sunflower and Sesamum
7	Botanical description and floral biology of Red gram and Bengal gram
8	Botanical description and floral biology of Green gram and Black gram
9	Botanical description and floral biology of Soybean and Cotton
10	Study of megasporogenesis and microsporogenesis
11	Study of magagametogenesis and microgametogenesis
12	Fertilizations and life cycle of angiosperm plant
13	Hybridization techniques and precautions to be taken
14	Study of selfing techniques
15	Study of emasculation and crossing techniques
16	Study of male sterility and self incompatibility

Suggested reading:

1. Singh BD. 2015. Plant Breeding Principles and Methods. Kalyani Publishers, New Delhi.
2. Singh P. 2015. Essentials of Plant Breeding. 5th Kalyani Publishers, New Delhi.
3. Sharma JR. 1994. Principles and Practices ofPlant Breeding. Tata McGraw Hill Publishing Company Limited, New Delhi.
4. Chopra VL. 1989. Plant Breeding: Theory and Practices. Oxford and IBH. Publishing CompanyNew Delhi.
5. Chaudhary RC. 1994. Introduction to Plant Breeding. Oxford and IBH. Publishing Company , New Delhi.
6. Chaudhary HK. 1971. Elementary Principles of Plant Breeding.Oxford and IBH. Publishing Company, New Delhi.

Course No   : **AS-122**   Course Title   : **Introduction to Animal Breeding**

Credits   : **3(2+1)**   Semester   : **II**

Theory

UNIT I

Population and Population Genetics; Hardy- Weinberg Law; Hardy Weinberg Equilibrium; Approaching to Equilibrium for sex linked trait; Linkage Equilibrium; Effect of linkage on HW-equilibrium; Stochastic and Deterministic Forces acting on Population; Mutation; Migration; Selection.

UNIT II

Dissection of Phenotype into its components; Transmitting Ability, Substitution effect of allele; Breeding Value: Definition, concept; Heritability: Definition, Concept, Estimation of heritability from regression of offspring to parents; Repeatability: Definition, Concept and estimation; Correlated traits: Phenotypic and Genetic correlation, Environmental correlation; Selection Index: Basic concept and types; Bases of selection.

UNIT III

Breeding strategies in large ruminants (cattle, buffalo), small ruminants (sheep, goat) and swine; Poultry breeding; Lab animal breeding; Breed improvement programs conducted in India; Molecular breeding: complementation of traditional breeding strategies with molecular genetics.

Practical

Chi-square test for determining goodness of fit for HW-equilibrium; Estimation of effect of allelic substitution; Estimation of heritability: regression of offspring on parents; Estimation of repeatability; Phenotypic correlation, genetic correlation, environmental correlation; Chi-square test for determining goodness of fit for HW-equilibrium; Linkage analysis from pedigree data ; Selection index.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightages (%)
	UNIT – I	
1	**Population and Population Genetics**: Mendelian Population / Random Mating population, sample	4
2	Gene, genotype, gene and genotype frequency, Gene pool, Random drift	3
3	**Hardy-Weinberg Law**: Random Union of Gametes, Random mating among genotypes,	3
4	**Hardy- Weinberg Lawof Equilibrium**; Approaching to Equilibrium for sex linked trait	3
5	Linkage Equilibrium	2
6	Effect of linkage on HW-equilibrium;	2
7	Equilibrium for one gene	2
8	Two gene and Equilibrium for genes showing dominance	2
9	Stochastic and Deterministic Forces acting on Population	2
10	**Mutation**: Def, Type: Recurrent and non recurrent , significance and	2

	non significances	
11	**Migration:** Definition and its significances	2
12	**Selection:** Definition, types and basis for selection: Gametic and zygotic selection, selection against recessive and dominant phenotypes	2
UNIT – II		
13	**Dissection of Phenotype into its components**:	4
14	**Transmitting Ability**: Definition, types: Predicted	4
15	Estimated transmitting ability	3
18	**Substitution effect of allele**: Def, Allele shuffling, concept of substitution: Gene effects and genotype substitution, expectation,	3
19	Deviation, additive genetic variance: Genic variance and Quasi dominance variance, other types of variance	4
20	**Breeding Value**: Definition, concept of breeding, dominance	3
21	Effects of environmental factors	2
22	**Heritability**: Definition, Concept and estimation from regression of offspring to parents	3
23	**Repeatability**: Definition, Concept and estimation;	3
24-25	**Correlated traits**: Phenotypic and Genetic correlation,	6
26	**Environmental correlation**: effects of environmental factors on expression of genes	3
27	**Selection Index**: Basic concept and types of selection. **Bases of selection**: Basic principle, selection tools, methods of selection for single and multiple traits, significance	3
UNIT - III		
28	**Breeding strategies in large ruminants (Cattle, Buffalo)**: Definitions, Strategies: Pedigree and Performance Recording Scheme (PPRS) and Progeny Testing Program, Inbreeding, Outbreeding, Applications , Open nucleus breeding system.	5
29	**Small ruminants (sheep, goat) and swine:** Breeding strategies: Screening and selection, Crossbreeding and inbreeding, Upgrading local breeds, applications	5
30	**Poultry breeding**: **strategies in upgrading the native chicken: Introduction of purebred hatching eggs, Introduction of purebred chicks, Cockerel exchange program,** Local farmers buying male purebred broiler from small broiler raisers,	4
31	**Lab animal breeding**: various breeding strategies like gathering and culturing embryos and the possibilities of *in vitro* breeding of Mouse, Rabbit, Zebrafish, etc.	4
	Breed improvement programs conducted in India: concept, history and Advantages	4
32	**Molecular breeding**: Definition, content: Association mapping /QTL mapping or gene discovery	8
	Marker assisted selection and genomic selection, Genetic engineering	
	Genetic transformation, Advantages, Complementation of traditional breeding strategies with molecular genetics.	
	Total	**100**

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Practical Exercise

Exercise No.	Title
1-2	Chi-squared test for determining goodness of fit for HW-equilibrium
3	Estimation of effect of allelic substitution
4	Estimation of heritability
5-6	Regression of offspring on parents
7	Estimation of repeatability
8-9	Phenotypic correlation, genetic correlation, environmental correlation
10-11	Chi-squared test for determining goodness of fit for HW-equilibrium
12-14	Linkage analysis from pedigree data
15-16	Selection index

Text Books:

1. Brah GS. 2014. Animal Genetics: Concepts and Implications. 2nd Ed. Kalyani Publishers.
2. Bourdon RM. 1999. Understanding Animal Breeding. 2nd Ed. Prentice Hall.

Reference Books:

1. Nicholas FW. 2010. Introduction to Veterinary Genetics. 3rd Ed. Wiley-Blackwell Publication.

Course No   : **STAT-121**   Course Title   : **Basic Statistics**

Credits   : **2(1+1)**   Semester   : **II**

Theory

UNIT I

Definition of statistics, its use and limitations; Frequency distribution and frequency curve and cumulative frequency curve; Measures of central tendency; Measures of dispersion; Probability: Definition, additive and multiplicative law for two events; Normal distribution and its properties; Introduction to sampling; Sampling techniques.

UNIT II

Tests of significance: Null hypothesis, alternate hypothesis, Type I & II Error, one and two tail tests, level of significance and confidence interval; SND test for means: Single sample and two samples Z-test; Student's t-test for means, single sample, two samples and paired t-test; F-test;

UNIT III

Chi-square test in 2x2 contingency table; Yate's correction for continuity; Correlation: Scatter diagram and Karl Pearson's coefficient of correlation for ungrouped data and its testing; Linear regression and its properties; Analysis of variance and its assumptions, Analysis of CRD and RBD; Analysis of Latin Square Design.

Practical

Construction of frequency distribution tables and frequency curves; Computation of Arithmetic: Mean, median, mode; Standard deviation; Variance and coefficient of variation for ungrouped and grouped data; SND test for means; Student's t-test; F-test and Chi-square test; Correlation coefficient 'r' and its testing; Fitting of regression equations; Analysis of CRD, RBD and LSD.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
1	**Introduction**: Definition of Statistics and its applications in biotechnology, limitations, Type's ofdata, classifications and frequency distribution, **Graphical presentation:** Histogram, frequency curve, frequency polygon, cumulative frequency curve (ogive curve).	10
2	**Measures of central tendency**: Arithmetic mean, median, mode, GM, HM, weighted average,quartiles, percentiles and deciles,Characteristics of ideal measure its merits and demerits (grouped and ungrouped data).	08
3- 4	**Measures of Dispersion:** Range, mean deviation, quartile deviation, standard deviation and variance and respective relative measures (grouped and ungrouped Data),Concept of measures of skewness& kurtosis.	05
5	**Sampling:** Definitions of population, sample, parameter, statistic, need of sampling, sampling versus complete enumeration and introduction to simple random, stratified and multistage sampling methods. Simple random sampling with and without replacement, Use of random number tables for selection of simple random sampling.	08

6	**Probability:** Random experiment, events (simple, compound, equally likely, complementary, independent) Definitions of probability (mathematical, statistical and axiomatic), additionand multiplication theorem (without proof). Simple problems based on probability.	08
7	**Probability distributions:** Random variable, discrete and continuous random variable, probability mass and density function, definition and properties of Normal distributions.	08
8	**Test of Significance:** Null and alternate hypothesis, types of errors, degrees of freedom, level of significance, one and two tailed tests, critical region, steps in testing of hypothesis, confidence interval.	05
9	**Large sample tests:** One sample and two samples Z-test for mean and proportion.	05
10	**Small sample test:** One sample, two sample and paired 't' test.	05
11	Chi-square test of goodness of fit,Chi-square test of independence of attributes in 2×2 contingency table, Yate's correction for continuity, F test for equality of variance.	08
12	**Correlation:** Definition of correlation, types, scatter diagram. Karl Pearson's coefficient of correlation and its test of significance. Spearman's rank correlation coefficient.	07
13	**Regression**: Linear regression equations, definition & properties of regression coefficient, constant, fitting of regression lines with test of significance, comparison of regression and correlation coefficients.	08
14	**Analysis of Variance and Experimental Designs:**Introduction to analysis of variance, assumptions of ANOVA, Principles of design of experiments, analysis of one way classification Completely Randomized Design(CRD).	05
15	Analysis of two way classification Randomized Block Design (RBD).	05
16	Analysis of Latin Square Design.	05
Total		**100**

Practical Exercise

Exercise No.	Name of the Practical Exercise
1	**Graphical presentation:** Histogram, frequency curve, frequency polygon, cumulative frequency curve (ogive curve).
2, 3	**Measures of central tendency**: Computations of arithmetic mean, mode, median, GM and HM, quartiles, deciles & percentiles (grouped and ungrouped data).
4,5	**Measures of Dispersion:** Computations of range, mean deviation, quartile deviation, standard deviation, variance and respective relative measures (grouped and ungrouped Data).
6, 7	**Test of Significance**: One sample, two sample 'Z' test for mean and proportion.
8	**Student's 't' test and F test** : One sample, two sample 't' test, paired t-test and its uses applications, F test for equality of variance.
9,10	Chi-Square test of Goodness of Fit, Chi-square test of independence of Attributes for 2×2 contingency table, Yate's correction for continuity.
11	**Correlation:** Computations of Karl Pearson's coefficient of correlation with its test

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	of significance.
12	Computation of Spearman's rank correlation coefficient.
13	**Regression**: Fitting of linear regression equation with test of significance of regression coefficient.
14	**Design of Experiment :**Analysis of Completely Randomized Design.
15	Analysis of Randomized Block Design.
16	Analysis of Latin Square Design.

Text books :

1. Rangaswami R. 2009. A Text book of Agriculture Statistics. New Age International Pvt. Limited, Hyderabad.
2. Rao NG. 2007. Statistics for Agricultural Sciences. . New Delhi: BS Publications.
3. Nigam AK and Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publication, NewDelhi.

Reference books:

1. Panse VG and Sukhatme PV. 1985. Statistical methods for Agricultural workers.Indian Council of Agricultural Research New Delhi
2. Snedecor GW. and Cochran WG. 1989. Statistical Methods. Iowa State University Press.
3. Das MN and Giri NC. 1986. Design and Analysis of Experiments. Wiley Eastern Ltd., New Delhi.
4. Gomez AA and Gomez AA. 1984. Statistical Procedures for Agricultural Research.John Wiley and Sons. New York.
5. Roger PG. 1994. Agricultural Field Experiments Design and Analysis. Marcel Dekker, NewYork.
6. Gupta SC. 2016. Fundamentals of Statistics. Himalaya Publishing House Mumbai.
7. Kapoor VK. 2007. Fundamentals of Applied Statistics. Sultan Chand and Sons, New Delhi.

Course No   : **NSS-122**   Course Title   : **National Service Scheme II**

Credits   : **1(0+1)**   Semester   : **II**

Syllabus:

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, inter personal communication

Youth development programmes
Development of youth programmes and policy at the national level, state level and voluntary sector; youth-focused and youth-led organstions

Health, hygiene and sanitation
Definition needs and scope of health education; role of food, nutrition, safe drinking water, water born diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programmes 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

Practical Exercise

Exercise No.	Topic	Weightages (%)
1.	**Importance and role of youth leadership** Meaning, types and traits of leadership,	7
2.	Qualities of good leaders;	6
3.	Importance and roles of youth leadership	6
4.	**Life competencies** Definition and importance of life competencies, ,	6
5.	**Life competencies** Problem-solving and decision-making	6
6.	**Life competencies** Inter personal communication	6
7.	**Youth development programmes** Development of youth programmes and policy at the national level,	7
8.	**Youth development programmes** state level and voluntary sector; youth-focused and youth-led organstions	6
9.	**Health, hygiene and sanitation** Definition needs and scope of health education;	6
10.	Role of food, nutrition,	6

11.	Safe drinking water, Water born diseases and sanitation (Swachh Bharat Abhiyan) for health;	7
12.	National health programmes and reproductive health.	6
13.	**Youth health, lifestyle, HIV AIDS and first aid** Healthy lifestyles, HIV AIDS, drugs and substance abuse,	7
14.	Home nursing and first aid	6
15.	**Youth and yoga** History, philosophy, concept, myths and misconceptions about yoga;	6
16.	**Youth and yoga** yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method	6
Total		**100**

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Course No   : **PHYEDN-111**   Course Title   : **Physical Education and Yoga**

Credits   : **1(0+1)**   Semester   : **II**

Syllabus:

Physical Education (Practical)

Introduction to physical education definition, objectives, scope, and importance; physical culture; Warming up - Need and requirement of first aid.Meaning and importance of Physical Fitness and Wellness; Physical fitness components -speed, strength, endurance, power, flexibility, agility, coordination and balance;Methods of Training; aerobic and anaerobic exercises; weight training, circuit training, Interval training, Fartlek training;

Skill of Volleyball, Rules & Regulation, Advance Skill of Volleyball, Specific Warming up,Skill of Football Rules & Regulations, Advance Skill of Foot ball& Specific Warming up, Skill of Kabaddi Rules & Regulations. Advance Skill of Kabaddi, Skill of Kho-Kho, Rules & Regulations. Advance Skill of Kho-Kho, & Specific Warming up,

Yoga (Practical)

Yoga- History, Meaning and importance, Role of yoga in life.Asans and indigenous way for physical fitness, and curative exercise.Introduction to asanas and its importance, pranayama, meditation and yogickriya.Omkar, Yogic Suksmavyayamas,

Yogasan- Asanas in Standing posture (Tadasana, Vrikshasana, Padahastasana, Ardha-Chakrasana, Trikonasana), Sitting postures (Asanasviz: Bhadrasana, Vjrasana, Ardha-Ustrasana, Ushtrasana, sasakasana and Vakrasana), Prone postures (Makarasana, Bhujangasana and Salabhasana) and Supine posture (Setubandhasana, uttanapadasana, Ardha-halasana, and Pavanamuktasana, Shavasana),

Suryanamaskar, Yognidra, Kapalbhati, Pranayam, Meditation in different mudras

Teaching Schedule (Practical)

Exercise	Topic	Weightage (%)
1	Introduction to physical education definition, objectives, scope, and importance; physical culture; Warming up - Need and requirement of first aid.	04
2	Meaning and importance of Physical Fitness and Wellness; Physical fitness components -speed, strength, endurance, power, flexibility, agility, coordination and balance; Methods of Training; aerobic and anaerobic exercises; weight training, circuit training, Interval training, Fartlek training;	06
3	Skill of Volleyball, Rules & Regulation, Advance Skill of	06

Exercise	Topic	Weightage (%)
	Volleyball, Specific Warming up,	
4	Skill of Football Rules & Regulations, Advance Skill of Foot ball& Specific Warming up	06
5	Skill of Kabaddi Rules& Regulations. Advance Skill of Kabaddi, Skill of Kho-Kho, Rules & Regulations. Advance Skill of Kho-Kho, & Specific Warming up	10
6	Skill of Basket ball Rules & Regulation, Advance skill of Basket ball& Specific warming up	06
7	Skill of Table tennis, Rules & Regulations, Advance skill of Table tennis. Sikll of Badminton, Rules & Regulations. Advance skill of Badminton, Specific Warming up.	06
8	Skill of Athletics, Long and Short Distance running, Sill of Athletics Jumping events, Throwing events	06
9	Yoga- History, Meaning and importance, Role of yoga in life	06
10	Omkar, Yogickriya, Yogic Suksmavyayamas	06
11	Yogasana- in Standing posture (Tadasana, Vrikshasana, Padahastasana, Ardha-Chakrasana, Trikonasana),	06
12	Yogasana- in Sitting postures (Asanasviz: Bhadrasana, Vjrasana, Ardha-Ustrasana, Ushtrasana, sasakasana and Vakrasana)	07
13	Yogasana- in Prone postures (Makarasana, Bhujangasana and Salabhasana)	06
14	Yogasana- in Supine posture (Setubandhasana, Uttanapadasana, Ardha-halasana, and Pavanamuktasana, Shavasana)	06
15	Suryananskars, Yognidra	06
16	Kapalbhati,Pranayam, Meditation in different mudras,	07
	Total	**100**

Suggested Reading:

1) O.P. Aneja. Encyclopedia of Physical education, sports and exercise science (4 volumes).

2) Anil Sharma. Encyclopedia of Health and Physical Education (7 Volumes).

3) N V Chaudhery, R Jain. Encyclopedia of Yoga Health and Physical Education (7 Volumes).

4) PintuModak, O P Sharma, Deepak Jain. Encyclopedia of Sports and Games with latest rules and regulations (8 volumes).

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5) Physical Education And Recreational Activities by Deepak Jain, Year of Pub.: 2011

6) Dimensions of Physical Education by Anil Sharma, Year of Pub.: 2011

7) Physical Fitness by Vijaya Lakshmi Year of Pub.: 2005

8) Research Process In Physical Education And Sports: An Introduction by K. G. Jadhav, Sachin B. Pagare and Sinku Kumar Singh, Year of Pub.: 2011

9) Sports Training And Biomechanics In Physical Education by Sinku Kumar Singh Year of Pub.: 2011

10) Test, Measurement and Evaluation in Physical Education by P. L. Karad Year of Pub.: 2011

11) Foundations of Physical Education, Exercise Science, and Sport by Deborah A. Wuest, Charles A. Bucher

12) Light on Yoga by B. K. S Iyangar, Publication:Schocken, Edn. 31st : 1995,

13) The Key Muscles of Hatha Yoga by Ray Long, Publication: Bandh Yoga, Edn.; 3rd : 2006

14) Hatha YogasPradipika by Yogi Swatmarama, Publishcation: Bihar School of Yoga, Edn. 26th :1998

15) Yoganidraby swami saraswati, pblication, yoga publication trust, munger, edn 3rd 1976

16) YogDarshan of Patanjali by Harikrishna Das Goyenka, Publication: Geeta Press Gorakhpur, Year: 2013

17) PatanjaliYogasutras by Swami Premeshanand, Publication: AdvaitaAsharm, Edn.: 2015

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SEMESTER-III

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Course No	: **AS-233**	Course Title	: **Livestock Production and Management**
Credits	: **3(2+1)**	Semester	: **III**

Theory

UNIT I

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 and parasite control & hygiene care.

UNIT II

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; Maintenance of farm records;

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Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightages (%)
UNIT – I		
1	Livestock history in India (Importance of Livestock in Vedic, Medieval and modern era)	3
2	Demographic distribution of Livestock Zoological/topographical/utility classification	2
3	Importance of Livestock in national economy	2
4	Introductory animal husbandry, its role and importance	3
5	Breed of livestock (with their characteristics, productive and reproductive traits and purpose of raring) Major breeds of bovine	3
6	Major breeds of buffaloes, Sheep and Goats	4
7	Important traits of livestock	3
8	General management	3
9	Feeding practices of livestock (Feeding standards, thumb rule, Dry matter requirement of animal)	3
10	Housing system (modern, closed, semi-closed for cattle, buffalo, sheep and goat)	3
11	Care of new born calf, young one of sheep and goats	3
12	Handling and restraining of animals	3
13	Importance of grassland and fodder in livestockproduction	3
14	Common/Daily farm management practices including culling, flushing, disinfection, isolation, washing, grooming, quarantine and disposal of carcass.	3
15	Importance of culling in livestock and flushing in sheep and goats	3
16	Common vices of animals	3
17	Preventive measures for hygiene care, Vaccination programme of different livestock	3
18	Major diseases in livestock (cattle and buffalo) with their symptoms and control measures	3
19	Major diseases in sheep and goat with their symptoms and control measures	3
UNIT - II		
20	History and economic importance of poultry, common terminology in poultry	3
21	Different poultry breeds and their classification	3
22	Reproductive system of male and female birds	3
23	Study of digestive systemof birds, cattle and difference between their digestive system	3
24	Formation and structure of egg,	3
25	Egg production, weight, quality, grading of egg	3
26	Fertility and hatching of egg	3
27	Plumage characteristics and comb type	3
28	Care and managements of chicks, grower, layers/broiler	4

29	Feeding for poultry and classification of feeds	4
30	Different terminology used in poultry and introduction to common equipments used in poultry managements	4
31	Management in poultry including brooding management, housing of poultry and hatchery practices	4
32	Hygiene care, poultry diseases, symptoms and preventive and curative measures, Vaccination programme and importance of vaccination programme in poultry	4
		100

Practical Exercise

Exercise No.	Title
1	Visit to live stock farm/demonstration centres of cattle, buffalo, sheep, goat and pigs and observation on the different breeds and their management.
2	External body parts of cattle, goat and pigs and their important functions
3	Method of handling and restraining of cattle, buffalo, sheep, goat swine and poultry
4	Study of male and female reproductive systems of cattle
5	Artificial Insemination
6	Preparation of feeding schedule and feeding of different categories of cattle, buffalo, sheep, goat , swine and poultry
7	Method for identification of animals
8	Milking method
9	Record keeping on dairy farm
10	Visit to poultry farm
11	External body parts of chicken, duck, quail and turkey
12	Housing system of poultry
13	Method for identification and sexing of poultry
14	Male and female reproductive systems of poultry
15	Identification of diseases and control measures in poultry, Vaccination programme in poultry
16	Study of hatchery layout and different equipments in poultry business; Maintenance of poultry farming record

Text Books:

1. Banerjee GC. 1989. Text Book of Animal Husbandry.Oxford and IBH.
2. Parsad Jagdish. 2001. Poultry Production and Management.Kalyani Publishers.
3. Singh RA. 1990. Poultry Production.Kalyani Publishers.
4. Thomas CK & Sastry N.S.R. 2013.Livestock Production Management.Kalyani Publishers.

Reference Books:

1. ICAR. 1962. Handbook of Animal Husbandry. ICAR Publication.
2. Sastry NSR & Thomas CK. 1991. Dairy Bovine Production.Kalyani Publishers.

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Course No   : **BT-236**   Course Title   : **Recombinant DNA Technology**

Credits   : **3(2+1)**   Semester   : **III**

Theory

UNIT I

Recombinant DNA technology; Restriction endonucleases: Types and uses; DNA ligases; Vectors: plasmids, cosmids, phagemids, BACs, PACs, YACs, transposon vectors, expression vectors, shuttle vectors, binary plant vectors, co-integrating vectors.

UNIT II

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.

Practical

Orientation to recombinant DNA lab; preparation of stock solutions and buffers; Plasmid DNA isolation; Genomic DNA isolation; Quality and quantity determination of DNA; restriction digestion of DNA; Agarose gel electrophoresis, SDS-PAGE; PCR; Genetic transformation of *E. coli*; Screening of recombinant DNA clones in *E. coli*.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
	UNIT I	
1	**Recombinant DNA Technology**: Introduction	4
2	Milestones, Steps, Tools used in Recombinant DNA Technology	4
3	Techniques in Recombinant DNA Technology and application	4
4	**Restriction Endonucleases:** Definition, Discovery, Source of Restriction enzyme, Nomenclature.	4
5	Types and uses, Cleavage Pattern, Examples and application	4
6	**DNA ligases:** Definition, Classification , types Ligase mechanism, Example : E. coli DNA ligase	2
7	**Vectors:** Definition, types, Properties of good vectors	2
8	**Plasmids:** Definition, Types, example : pBR 322 & pUC 19,	2
9	**Cosmids:** Definition, basic feature of cosmid, structure, properties	2
10	**Phagemids:**Definition, structure, properties	2
11	**BACs:** Basic features, structure, properties	2
12	**PACs:** Basic features, structure, properties	2
13	**YACs:** Organization of YAC vector, properties	2
14	**Transposon:** Discovery, Classification, Class I (retrotransposons), ass II (DNA transposons), examples.	2
15	**Expression vectors:** Definition, properties and example	2
16	**Shuttle vectors:** Definition and Properties and example	2
17	**Binary plant vectors:** transfer of DNA (binary system) , development of primary system and example	2
18	**co-integrate vectors**	2
	UNIT II	

19	**Competent cells;;** Definition & methodology	5
20	**Gene isolation :** Definition & methodology	5
21	**Cloning:** Definition & methodology	5
22-23	**Genetic transformation of E. coli:** Definition, types, methodology, screening	8
24-25	**Gel electrophoresis;** Definition, types, principles methodology of Agarose gel electrophoresis	5
26	**Preparation of probes:** methodology,	3
27-28	**Southern blotting:** methodology and Diagram, Applications and Advantages	6
29	**Northern blotting;** methodology and Diagram	4
30	**Western blotting;** Steps involved in the process, Diagram	4
31-32	**PCR:** Definition, types, stages of PCR, Amplification and its application	9
	Total:	**100**

Practical Exercise

Exercise No.	Title
1	**Orientation to recombinant DNA lab**; lab rules and introduction to RDT laboratory. Introduction to various instruments used and their working principle.
2	**Preparation of stock solutions and buffers;** Preparation of solutions of different molarities, normalities, percentages etc. Preparation of stocks of various acid and bases, phosphates buffer, citrate buffer, carbonate buffer.
3-4	**Plasmid DNA isolation**; Isolation of Plasmid DNA from Bacterial source**.**
5-6	**Genomic DNA isolation;** Isolation of Genomic DNA from Plant Source using liquid Nitrogen
7	**Quality and quantity determination of DNA;** Qualitative and quantitative analysis of DNA using Spectrophotometer.
8-9	**Restriction digestion of DNA**; Digestion of DNA isolated form different sources with different restriction enzymes and visualization of bands on Agarose gel by electrophoresis,.
10	**Agarose gel electrophoresis**, Electrophoresis of Plasmid, Plant, Animal, Bacterial DNA and Ladder . Calculation of Molecular weight.
11-12	**SDS-PAGE;** To perform SDS PAGE of DNA isolated from Plant.
13-14	**PCR;** To perform any gene amplification (Transgene Detection and RAPD). Preparation of chemicals , addition using micropipette in PCR tubes, Programming of PCR Machine and Visualization of Bands on Gel by electrophoresis.
15	**Genetic transformation of *E. coli*;** Preparation of Competent cells of E.Coli and their Plasmid transformation using Heat shock method.
16	**Screening of recombinant DNA clones in *E. coli*.:** Blue white screening

Text Book
1. Brown TA. 1998. Genetics: A Molecular Approach. 3rd Ed. Stanley Thornes.
2. Singer M & Berg P. 1991. Genes & Genome.University Science Books.

Reference book:
1. Watson JD, Gilman M., Witkowski J & Zoller M. 1992 Recombinant DNA: A Short Course. 3rd Ed. WH Freeman and Co, Ltd.
2. Winnacker EL. 2003. From Genes to Clones: Introduction to Gene Technology. 4th Ed. Panima Publishers.

B.Tech. (Biotechnology)

Course No   : **BOT-232**   Course Title   : **Plant Physiology**
Credits   : **3(2+1)**   Semester   : **III**

Theory

UNIT I

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.

UNIT II

Concepts of photosynthesis, photorespiration, respiration and translocation of photoassimilates; Dynamics of growth; Stress physiology; Nitrogen and sulphur metabolism; Plant growth regulators: Their biosynthesis and physiological roles, seed germination & seed dormancy, senescence, vernalization.

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 with weightage (%)

Lecture No	Topics	Weightage (%)
1	Introduction to Plant Physiology and its importance in Agriculture	5
2	Osmosis, imbibition and water potential in plant	5
3	Absorption of water and path of water.	5
4	Translocation of water in plants	5
5	Transpiration- Definition, types, structure of stomata, physiology of stomata, factors affecting transpiration.	5
6-7	Mineral nutrition of plants. Classification of mineral elements, criteria of essentiality. Mechanism of absorption and translocation of mineral element	5
8	General and specific role of mineral elements and deficiency symptoms	5
9-10	Photosynthesis : Definition, pigments involved, structure of chloroplast, light reaction- Photolysis of water,	10
11-12	Emersion effect, Pigment system I and II, Cyclic and non cyclic electron transfer, Significance of light reaction.	5
13-14	Dark reaction- C_3, C_4 and CAM plants, factors affecting photosynthesis, Photorespiration	5
15	Photorespiration – Definition, mechanism and significance, difference between C^3 and C^4 plants.	5
16-17	Respiration- Definition, types, glycolsis, TCA cycle and electron transport chain	5
18-19	Translocation of photoassimilates and sink source relationship phloem	5

	loading and unloading	
20-21	Plant growth regulators, Definition, types,biosynthesis physiological role	10
22-23	Dynamics of Growth : Definition, types of growth, measurement of growth, growth analysis	4
24-25	Stress physiology – Definition, types – study of water, temperature and salinity stress and mechanism of tolerance	4
26-27	Seed dormancy – Definition, causes and methods of breaking dormancy	4
28-30	Senescence – Definition , types, biological significance , mechanism of senescence	4
31-32	Vernalization- Definition, technique and mechanism of vernalization	4
	Total	**100**

Practical Exercise

Lecture No	Title
1.	Study of Diffusion and imbibitions
2.	Study of osmosis and plasmolysis
3.	Study of water potential in plants
4.	Study of relative water content of leaf
5.	Study of ascent of sap and measurement of root pressure
6.	Measurement of rate of transpiration
7.	Study of deficiency symptoms of nutrients in crop plants by Hoagland solution method .
8.	Study of plant growth by direct method and indirect method- growth analysis methods.
9.	Study of separation of photosynthetic pigment by solvent extraction methods.
10.	Estimation of plant pigment by quantitative method – colorimetric method.
11.	Measurement of rate of photosynthesis by different methods.
12.	Study of respiration and respiratory quotient.
13.	Study of use of PGR in fruit ripening.
14.	Study of seed germination.
15.	Study of dormancy and methods of breaking dormancy.
16.	Estimation of proline content in plant tissue

Text Books:
1. Verma V. 2007. Textbook of Plant Physiology, Ane Books, India.
2. Pandey SN & Sinha BK. 2001. Plant Physiology, Vikas Publishing House, New Delhi.
3. Amar Singh. 1967. Practical Plant Physiology. Kalyani Publisher, Ludhiana
4. Malik CP. Plant Physiology2005, Kalyani Publisher, Ludhiana
5. Chore CN, Ghadekar SR & Patil RK. 2008 Crop Physiology; Agromet Publisher, Nagpur
6. Taiz L. & Zeiger E. 2010. Plant Physiology. 5th Ed. Sinaur Asso.Inc, USA.
7. Noggle GR & Friz G. 2013. Introductory Plant Physiology. PHI Learning Pvt Ltd, New Delhi.
8. Malik CP & Srivastava AK.2005 A Text Book Plant Physiology. Kalyani Publisher, Ludhiana.
9. Devlin RM & Witham FH. 1986. Plant Physiology. CBS Publisher & Distributors, Delhi.

Reference Books:

1. Dhumal KN, More TN and Munnali MR. Plant Physiology; Nirali Prakashan, Pune
2. Shrivastava HS. 1996. Plant Physiology; Rustogi Publications, Meerut.
3. Mukharji S and Ghosh AK. 2005. Plant Physiology. New Central Book Agency, Kolkatta
4. Chandra Datta S.1993. Plant Physiology. Wiley Eastern Ltd, Daryaganj, New Delhi.
5. Kumar A & Purohit SS. 2005. Plant Physiology –Fundamentals &Applications; Agrobios (India), Jodhpur.
6. Sinha RK. 2007. Modern Plant Physiology. Narosa Publishing House, Panchshil Park, New Delhi

Course No   : **ICT- 231**   Course Title   : **Information &Communication Technology**
Credits   : **2(1+1)**   Semester   : **III**

Theory

UNIT I

IT and its importance; IT tools; IT-enabled services and their impact on society; Computer fundamentals; Hardware and software; Input and output devices; Word and character representation.

UNIT II

Features of machine language, assembly language, high-level language and their advantages and disadvantages; Principles of programming - algorithms and flowcharts.

UNIT III

Operating systems (OS) - definition, basic concepts; Introduction to WINDOWS and LINUX Operating Systems; Local area network (LAN); Wide area network (WAN); Internet and World Wide Web; HTML and IP.

UNIT IV

Introduction to MS Office - Word, Excel, Power Point; Audio visual aids - definition, advantages, classification and choice of A.V. aids; Criteria for selection and evaluation of A.V aids; Video conferencing; Communication process, Berlo's model, feedback and barriers to communication.

Practical

Exercises on binary number system; Algorithm and flow chart; MS Word; MS Excel; MS Power Point; Internet applications: web browsing, creation and operation of email account; Analysis of data using MS Excel; Handling of audio visual equipments; Planning, preparation, presentation of posters, charts, overhead transparencies and slides; Organization of an audio visual programme.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
1	Introduction to Computers, Definition: Hardware, Software & firmware. Type's of software.	2
2	Data Representation, Number systems (Binary, Hexadecimal). Difference between ASCII&UNICODE (Different EncodingSchemes)	3
3	Primary, Secondary Memory, Units usedfor measurement of memory, Input Outputdevices	8
4	Operating Systems, definition andtypes	2
5	FileManagement.	3
6	Applications used for document creation&Editing, Data presentation usingslides.	2
7	Use of Spreadsheets for statisticalanalysis, evaluating mathematical & logicalexpressions.	20

8	Use of Spreadsheets for Interpretation andgraph creation.	10
9	Database, concepts and types, uses of DBMS/RDBMS inAgriculture	5
10	Database design,creation,	10
11	Database, concepts and types, uses of DBMS/RDBMS inAgriculture	5
12	Database design,creation,	10
13	Preparation of presentation. Import export operations, using numericaltabular data/text/graph/slides within different applications usingcut-paste.	5
14	SmartphoneAppsinAgricultureforfarmadvises, market price, postharvest managementetc; Geospatial technology for generatingvaluable agri-information	5
15	Decision support systems, concepts,components and applications in Agriculture,Agriculture Expert System, Soil Information Systems etc. for supporting Farmdecisions.	5
16	Communication process, Berlo's model, feedback and barriers tocommunication.	5
	Total:	**100**

Practical Exercise

Exercise	Title
1	Study of Computer Components,accessories
2	Practice of important DOSCommands
3	Introduction of different operating systems suchasMS-Windows, Unix/ Linux, Creating, Files& Folders, FileManagement.
4	Word-Processing –1
5	Word Processing –2
6	Presentation
7	Spreadsheet-1
8	Spreadsheet-2
9	Spreadsheet-3
10	DBMS/RDBMS Creating, Updatingdatabase
11	Querying/Retrieving data ,relation
12	Introduction to World Wide Web(WWW).Demonstration of Agri-informationsystem.
13	Hands on Crop Simulation Models (CSM) suchasDSSAT/Crop-Info/CropSyst/Wofost;Computation of water and nutrient requirements of cropusingCSM and IT tools
14	Introduction of Geospatial Technology for generating valuable information forAgriculture.
15	Hands on Decision SupportSystem
16	Introduction of programming languages.Preparation of contingent cropplanning.

Text Books/ Websites:

1) Sinha PK and Sinha P. 2007. Computer Fundamentals by, 6th ed. BPB Publications, New Delhi..
2) Panse VG and Sukhatme PV. 1985. Statistical Methods for Agricultural Workers, ICAR, NewDelhi.
3) http://www.tutorialsforopenoffice.org/category_index/base.html
4) http://mkisan.gov.in/downloadmobileapps.aspx
5) http://www.nrsc.gov.in/Agriculture
6) http://iasri.res.in/
7) http://communicationtheory.org/berlos-smcr-model-of-communication/

Course No : **ECON-231**   Course Title   : **Economics and Marketing**

Credits   : **3(2+1)**   Semester   : **III**

Theory

UNIT I

Economics – Terms and definitions; Consumption, demand, price and supply; Factors of production; Gross Domestic Product; Role of Biotechnology/ Agriculture sector in national GDP.

UNIT II

Marketing – definition; Marketing process; Need for marketing; Role of marketing; Marketing functions; Classification of markets; Marketing of various channels; Price spread; Marketing efficiency; Constraints in marketing of agricultural produce; Market intelligence.

UNIT III

Basic guidelines for preparation of project reports; Bank norms; Insurance; SWOT analysis; Crisis management.

Practical

Techno-economic parameters for preparation of projects; Preparation of bankable projects for various biotechnology/ agricultural products and value added products; Identification of marketing channel; Calculation of price spread; Identification of market structure; Visit to different markets, market institutions; Study of SWC, CWC and STC; Analysis of information of daily prices; Marketed and marketable surplus of different commodities.

Teaching Schedule-Theory with weightage (%)

Lecture No.	Topics	Weightage (%)
1-2	Economics:, Meaning -Definition : Adam Smith, Marshall, Robbins Subject matter of Economics: Economic activities, (Wants, efforts , satisfaction), Traditional view & Modern view & approaches.	8
3-4	Basic Terms, Goods (Classification, types) utility – Meaning -forms of utility, value, wealth, and Price.	8
5-6	Consumption – Meaning, types of consumption, Engles law, Standard of living, factors affecting Standard of living, factors affecting consumption	4
7-8	Demand – Meaning, definition, kinds of demand, demand schedule, demand curve, Law of demand, exception to law of Demand, Extension and Contraction, increase decrease in demand.	5
9-10	Elasticity of demand – Meaning, types & methods of measurement of elasticity of demand (3 methods), factors affecting elasticity of demand	3
11-12	Supply – Definition, Kinds of supply, Supply schedule, Law of Supply, Extension & Contraction of supply, Increase & decrease of supply, factors affecting supply.	5
13-14	Elasticity of supply – Meaning, elastic, inelastic supply, Measurement	3

	of elasticity of supply & its importance.	
15	Production – Meaning, factors of production: Land, Labour, Capital & Management	3
16-17	National Income –Concepts of National Income: GNP, NNP,PI Methods of measurement of National Income its Importance.	8
18-19	Role of Bio-technology in the National Income and GDP.	3
	UNIT- II	
20-21	Market –Meaning, Definition, Marketing, meaning, definition, Role & scope of Marketing.	4
22-24	Classification of Markets, Marketing functions and its Classification.	16
25-26	Marketing channels – Meaning, and types of marketing channels, price spread- meaning, marketing efficiency, constraints in marketing of Biotech Products.	16
27	Market intelligence- meaning and its importance	4
	UNIT- III	
28	Project : Meaning, Definition, types of projects, project cycles	4
29-30	Basic guidelines for preparation of project proposals- Introduction, overview of project, project description, technical feasibility, commercial feasibility, cost estimates, finance (Requirement), financial feasibility, managerial aspects and project benefits. Bank norms, insurance – Definition, meaning, its importance	4
31-32	SWOT – Analysis- Biotech projects, Crisis management- meaning, importance.	2
Total		**100**

Practical Exercise

Exercise No	Title
1	Techno –economic parameters for preparation of Biotech Projects
2- 3	Preparation of Bankable proposal for Biotech projects (Statements)
4	Study of different- marketing channels for different Biotech Products.
5-6	Study of price spread and producer's share in consumer's rupee, marketing cost & margin for different Biotech Products.
7-8	Study of the market structure
9-10	Visit to various markets in the area
11-12	Visit to different market institutions (NAFED, APMC, Marketing Society)
13	Study of SWC, CWC & STC institution (History, objectives, functions & reference)
14	Study of price behavior of Biotech Products
15-16	Study of the Producer's Surplus for different Biotech Products.

Text Books:
1. Dewett KK and Varma JD. 2013. Elementary Economic Theory. , S. Chand and Company Pvt. Limited, New Delhi.
2. Acharya SS and Agrawal NL. 2008. Agricultural Marketing in India Oxford and IBH Publishing Company Pvt. Limited, New Delhi.

Reference Books:

1. Dewett KK. 2009. Modern Economic Theory S. Chand and Company Pvt. Limited, New Delhi.
2. Reddy SS Raghuram P and Shastri NK. 2005. Agricultural Economics. Oxford and IBH Publishing Company Pvt. Limited, New Delhi.
3. Reddy SS and Raghuram P. 2015 Agricultural Finance and Management. Oxford and IBH Publishing Company Pvt. Limited, New Delhi.
4. Barde SD and Karmakar KG. 1995. Agricultural Project Management for Banks, Popular Prakashan Pvt. Limited Mumbai.

Course No: **ENT-PL.PATH - 231**   Course Title   : **Fundamentals of Crop Protection**
Credits: **3(2+1)**   Semester   : **III**

Theory

UNIT I

Insects - their general body structure; Importance of insects in agriculture; Life cycle of insects; Insects diversity; Feeding stages of insects and kinds (modifications) of mouth parts; Concepts in population build-up of insects – GEP, DB, EIL, ETH and pest status; Causes of insect-pests out break; General symptoms of insects attack; Principles and methods of insect-pests management; Integrated Pest Management concept; Bioecology and management of important pests of major crops and storage products.

UNIT II

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   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   silk   worms;   Acquaintance   with   various   pesticidal formulations; Principles and working of common plant protection appliances; Calculation for preparing spray material; Acquaintance to 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 vegetables crops and their characteristic symptoms.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightage (%)
UNIT I		
1	Introduction ; Definition of Insect, Entomology Importance of insects in agricultureInsect dominance	2
2	Insect diversity: Classification of insects	2
3	Insect's general body segmentation: Head, thorax and abdomen	2
4	Feeding stages of insects, Structure and modifications of insect mouth parts	2
5	Growth and Metamorphosis : Life cycle of insects	2
6	Concept of population buildup of insect: Population, `Population dynamics, characteristics of population,	3

		factors affecting populations (Abiotic and biotic)	
7		Classification of pests and causes of insect-pests outbreak	4
8		Types of damage to plants by insects orGeneral symptom of insect attack	3
9		Principles and methods of insect-pest management Natural control, Applied control	3
10		Cultural, mechanical, physical, biological, legal, chemical methods of pest control, recent trends in pest contol	4
11		Concept of Integrated pest management, merits, demerits and constraints of IPM Concept of GEP, DB, EIL, ETL, etc	4
12		Insect-pests of cereals (Paddy, sorghum, bajara, wheat and maize), pulses (Pigeonpea and chickpea), oilseeds (Groundnut, sunflower, safflower and soybean) and their management	5
13		Insect-pests of cotton, sugarcane and their management	5
14		Insect-pests of fruit crops (Mango, citrus, grape, banana, pomegranate and coconut) and their management	3
15		Insect-pests of vegetables (Potato, tomato, brinjal, okra, cruciferous and cucurbita) and their management	3
16		Insect-pests of spices, condiments (Black paper, turmeric and ginger) and their management,insect-pests of stored grains and their management	4
UNIT II			
17		Plant pathology: Definition, objectives, Importance and scope	4
18		Concept of disease and disease triangle	3
19		Nature and classification of plant diseases.	4
20-21		Importance and general characters of fungi, bacteria, fastidious bacteria, nematodes, phytoplasmas, spiroplasmas, etc.	6
22-23		Importance andgeneral characters of nematodes, viruses, viroids, algae, protozoa and phanerogamic plant parasites.	6
24-25		Pathogenesis due to obligate and facultative parasites.	4
26		Variability in plant pathogens.	5
27-28		Plant disease epidemics: elements, factors (host pathogen, environment) and measurement of epidemics	6
29-30		Survival and dispersal of plant pathogens	4
31-32		Management of major diseases and nematodes of major crops.	7
		Total:	**100**

B.Tech. (Biotechnology)

Practical Exercise

Exercise No.	Title
1	Study of generalized insect's body structure and appendages Dissection of mouth parts (Cockroach/grasshopper, red cotton bug and honeybee)
2	Study of life stages of insect (Types of larvae and pupae) Study of Important features of agriculturally important insect Orders with examples: Isoptera, Orthoptera, Hemiptera, Thysanoptera, Neuroptera, Diptera, Coleoptera, Lepidoptera, Hymenoptera
3	Identification of important insect-pests of cereals (Paddy, sorghum, bajara, wheat and maize) and pulses (Pigeonpea and chickpea) and their symptoms of damage
4	Identification of important insect-pests of oilseeds (Groundnut, sunflower, safflower and soybean), cotton and sugarcane and their symptoms of damage
5	Identification of important insect-pests of fruit crops (Mango, citrus, grape, banana, pomegranate and coconut) and vegetable crops(Potato, tomato, brinjal, okra, cruciferous and cucurbita) and their symptoms of damage
6	Identification of important insect-pests of spices, condiments (Black paper, turmeric and ginger) and stored grain and their symptoms of damage
7	Acquaintance with useful insects: Predators, Parasitoids, Pollinators Acquaintance with useful insects: Honey bees, Silkworms and Lac insects
8	Acquaintance with various pesticidal formulations
9	Principles and working of common plant protection appliances Calculation for preparing spray material
10	Acquaintance to plant pathology laboratory equipment.
11	Preparation of culture media for fungi and bacteria.
12	Demonstration of Koch's postulates for major plant pathogens.
13	Diagnosis and identification of important diseases of cereals, oilseeds and pulses and their characteristic symptoms
14	Diagnosis and identification of important diseases of cotton and sugarcane and their characteristic symptoms.
15	Diagnosis and identification of important diseases of fruit and vegetable crops and their characteristic symptoms.
16	Study of different groups of fungicides and antibiotics and methods of their laboratory evaluation.

Text Books:

1. Chapman RF. 1998. *The Insects: Structure and Function*. Cambridge Univ. Press, Cambridge.
2. Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology.* 10th Ed. Chapman & Hall, London.
3. Dhaliwal GS & Arora R. 2003. *Integrated Pest Management – Concepts and Approaches.* Kalyani Publ., New Delhi.
4. Atwal AS & Dhaliwal GS. 2002. *Agricultural Pests of South Asia and their Management.* Kalyani Publ., New Delhi.
5. Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology.* Kalyani Publ., New Delhi.
6. David BV & Ramamurthy VV. 2011. *Essentials of Economic Entomology.* Namrutha Publ., Chennai.

Text Book of Plant Pathology

1. Schumann G.L. &Darcy C. 2009.. Essential Plant Pathology, APS Press, USA.
2. Agrios GN. 2005. Plant Pathology.5th Edition.Elsevier Academic Press Publication.
3. Singh RS 2010. Introduction to Principles of Plant Pathology, 4th ed.. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Mehrotra RS & Agraval A. 2003. Plant Pathology. 2nd ed. McGraw Hill Education (India) Private Limited, New Delhi.

B.Tech. (Biotechnology)

Course No   : **AS 234**   Course Title   : **Livestock Product Technology**
Credit   : 3 (**2+1**)   Semester   : **III**

Theory

UNIT I

Composition and nutritive value of milk and factors effecting composition of milk; Physiochemical properties of milk; Determination of microbial load in milk and milk products; Milk Processing: Collection, chilling, standardization, pasteurization and homogenization; Toxins and pesticide residues in milk and milk products; Organic milk food products; Bureau of Indian Standards for milk and milk products; Sanitation in milk plant.

UNIT II

Retrospect and prospects of meat industry in India; Structure and composition of muscle (including poultry), nutritive value of meat, Meat adulteration, preservation of meat, Physico – chemical and microbiological quality of meat and meat products. Laws governing national, international trade in meat and meat products, organic meat food products, food products of genetically modified animals.

Practical

Sampling of milk, estimation of fat, solids not fat (SNF) and total solids, Platform tests, cream separation, Microbiological quality of milk, meat and meat products. Chilling/freezing of meat, meat products, preservation of meat and meat products. Visit to modern milk and meat processing units.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
1	**Composition of milk-** Constituents of milk, Livestock species wise distribution of fat, protein, lactose, ash, total solids in milk.	7
2	**Nutritive value of milk:** Contribution of milk to nutrient intake (% total), Nutrients in Milk -Vitamins and minerals (B Vitamins, Calcium, Iodine, Phosphorus, Potassium), Macronutrients (Protein, Carbohydrate, Fat)	7
3	**Factors effecting composition of milk:** **Factors Affecting Milk Fat Content** Breed/Genetics, Environment/Management, Health/Physiology, Nutrition	10
4	**Factors Affecting Milk Protein Content** Breed/Genetics, Environment/Management, Health/Physiology, Nutrition	
5	**Factors Affecting Milk Mineral Content** Breed/Genetics, Environment/Management, Health/Physiology, -Nutrition	
6	**Physiochemical properties of milk:** Acid–Base Equilibria, The pH and Buffering properties of Milk, Titratable Acidity, Oxidation–Reduction Equilibria, Surface and	5

	Interfacial Tension, Light Absorption and Scattering, Refractive Index, Freezing Point, Density, Newtonian Behaviour, Non-Newtonian Behaviour in Milks and Creams, Effects of Technological Treatments on the Viscosity of Milk	
7	**Determination of microbial load in milk and milk products:** -Direct Microscopic Count (DMC) Method -The Standard Plate Count (SPC) of raw milk - The Preliminary Incubation Count (PI) - The Lab Pasteurized Count (LPC) - The Coliform Count (Coli Count)	3
8	**Dye Reduction Test:-** **-Methylene Blue Reduction (MBR) Test** **-Resazurin Reduction (RR) Test** **-Coliform Test** **-Yeast and Mould Count**	2
9	**Milk Processing:** Collection: (Collection from small producers, Bulk collection) Chilling,	3
10	Standardization, Pasteurization and Homogenization	4
11-12	**Toxins and pesticide residues in milk and milk products:** Toxins residues in milk Pesticide residues in milk & milk products	5
13-14	Toxins residues in milk Pesticide residues in milk products	4
15-16	**Organic milk food products:**	5
17-18	**Bureau of Indian Standards for milk and milk products:** Food Safety Standard Authority of India e.g. BIS, FSSAI, HACCP (Law, regulation, provision, Licencing etc.) **Sanitation in milk plant:**	8
19-21	**Retrospect and prospects of meat industry in India:** Present status of meat industry in Maharashtra and India	4
22-23	Structure and composition of muscle (including poultry)	6
24-25	Nutritive value of meat, Meat adulteration, Preservation of meat	7
26-27	Physico – chemical and microbiological quality of meat and meat products.	5
28-29	Laws governing national, international trade in meat and meat products,	5
30-31	Organic meat food products-	5
32	Food products of genetically modified animals-	5
	Total:	**100**

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Practical Exercise

Exercise No.	Name of the Title
1	Sampling of milk,
2	Platform tests of milk
3	Determination of acidity in milk
4	Determination of specific gravity of milk
5	Determination of fat in milk
6	Determination of total solids in milk by Gravimetric method
7	Estimation of protein in milk
8	Standardization of milk.
9	Bacteriological examination of milk.
10	Bacteriological examination of meat.
11	Bacteriological examination of meat products.
12	Chilling/freezing of meat, meat products.
13	Preservation of meat and meat products.
14	Detection of adulterants, preservatives and neutralizers in milk.
15	Detection of preservatives and neutralizers in milk.
16	Visit to modern milk and meat processing units.

Text Books:

1. Aberle ED, Forrest JC, Gerrard DE & Mills EW. 2012. Principles of Meat Science. 5th Eds. Kendall Hunt Publishing.
2. Ledward DA & Lawrie RA. 2006. Lawrie's Meat Science, 7th Eds. Woodhead Publishing.
3. Sharma BD. 1999. Meat and Meat Products Technology: Including Poultry Products Technology. Jaypee Bros. Medical Publishers.

Reference Books:

1. Sukumar De. 2001. Outlines of Dairy Technology. Oxford University Press.
2. Varnam A & Sutherland JP. 2001. Milk and Milk Products: Technology, Chemistry and Microbiology. Springer Science & Business Media.

Course No   : **MATH-233**   Course Title   : **Biomathematics**
Credits   : **3(2+1)**   Semester   : **III**

Theory

UNIT-I

Rolle's theorem; Lagrange's theorem; Taylor's and Maclaurin's series; Functions of two or more independent variables, Partial differentiation, Euler's theorem on homogeneous function, change of variable; Jacobian, maxima and minima of two or more than two variables eigen values and eigen vectors of a matrix; Reduction formulae, definite integrals and its applications.

UNIT-II

Solution of ordinary differential equation of first degree and first order and their application for determination of volume of blood and drug distribution; Epidemic models, Simultaneous differential equation of first order and their applications to predator models; Linear differential equations of higher order and their applications to simple biological problem; Numerical methods for solving algebraic and transcendental equations.

Practical

Taylor's and Maclaurin's expansions; Partial differentiation; Euler's theorem; Change of variable, total derivative, implicit function, maxima and minima, eigen values and eigen vectors of matrix, reduction formulae, definite integrals and their properties; Epidemic models, predator models; Determination of volume of blood and drug distribution; Ordinary differential equation of first order, linear differential equation of higher older and their applications to biological problems, numerical methods.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightages (%)
	Differential Calculus	
1	Rolle's theorem.	3
2	Lagrange's theorem	3
3	Taylor's series	3
4	Maclaurin's series	3
5	Functions of two or more independent variables	3
6	Partial differentiation	3
7	Partial derivatives of higher orders.	3
8	Homogeneous function	3
9	Euler's theorem on homogeneous function	3
10	Change of variable	4
	Matrices	
11	Characteristic Equation of a matrix	3

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12	Repeated and non repeated Eigen values of a matrix	3
13	Eigen vectors of a matrix	3
Integral Calculus		
14	Reduction formulae	3
15	Definite integrals	3
16	Examples on definite integrals.	3
Differential Calculus		
17	Definition, order and degree of differential equation	3
18	Equations of first order and first degree	3
19	Solution of ordinary differential equation of first order and first degree	3
20	Variable separable method	3
21	Linear differential equation	3
22	Equations reducible to Linear differential equation	3
23	Exat differential equation	3
24	Simultaneous differential equation of first order	3
25	Solution of Simultaneous differential equation of first order	3
26	Linear differential equations of higher order	4
Numerical Methods		
27	Introduction, Definition of algebraic and transcendental equations with examples.	4
28	Solution of the equations graphically	4
29	Bisection method	3
30	Newton Raphson method or successive substitution method.	3
31	Rule of false position (Regula falsi)	3
32	Iteration method	3
	Total:	**100**

Practical Exercise

Exercise No.	Title
1	Applications of Rolles theorem
2	Applications of Lagranges theorem
3	Applications of Taylor's series
4	Applications of Maclaurin's series
5	Applications of Partial differentiation
6	Euler's theorem
7	Application: Jacobian
8	Maxima and Minima
9	Applications of Eigen values and Eigen vectors
10	Applications of Integrations

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11	Applications of ordinary differential equation of first order and first degree and their application for determination of volume of blood and drug distribution.
12	Linear differential equations of higher order and their applications to simple biological problem
13	Simultaneous differential equation of first order.
14	Simultaneous differential equation of first order and their applications to predator models
15	Numerical methods for solving algebraic equations.
16	Numerical methods for solving transcendental equations.

Text Books

1) Grewal BS. 2015. Higher Engineering Mathematics. 43rd Ed. Khanna Publishers Delhi.
2) Rastogi SK. 2008. Biomathematics. Krishna Prakashan Media Pvt. Ltd.

Reference Books

1) Srivastava AC & Srivastava PK. 2011. Engineering Mathematics.Vol.I . PHI Learning Pvt. Ltd.
2) Srivastava AC & Srivastava PK. 2011. Engineering Mathematics.Vol.III . PHI Learning Pvt. Ltd.

Course No   : **PB-232**   Course Title   : **Breeding of Field Crops**
Credits   : **3(2+1)**   Semester   : **III**

Theory

Unit I

Application of genetic, cytogenetic and biotechnological techniques in breeding of: Wheat, triticale, rice, maize, bajra, barley, sorghum, cotton, sugarcane, important pulses, oilseeds and forage crops including their origin and germplasm sources.

Unit II

Problems and present status of crop improvement in India with emphasis on the work done in state National and International centres of crop improvement.

Unit III

Classes of seed; seed production and maintenance; seed storage; seed certification.

Practical

Emasculation and hybridization techniques; Handling of segregating generations : pedigree method, bulk method, back cross methods; Field layout of experiments; Field trials, maintenance of records and registers; Estimation of heterosis and inbreeding depression; Estimation of heritability; Parentage of released varieties/hybrids; Study of quality characters; Sources of donors for different characters; seed sampling; seed quality; seed viability; seed vigour; seed health testing; Visit to seed production plots.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
	UNIT I	
1-2	Wheat: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	6
3	Triticale: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
4-5	Rice: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	6
6-7	Maize: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	6
8	Bajra: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
9	Barley: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
10-11	Sorghum: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	6
12-13	Cotton: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	6
14	Sugarcane: Centers of origin, Distribution of species, wild relatives,	3

	application of genetic, cytogenetics and biotechnological techniques in breeding	
15	Chickpea: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
16	Pigeonpea: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
17	Green gram and Black gram: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
18	Groundnut: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
19	Soybean: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
20	Sunflower: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
21	Safflower: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
22	Linseed: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
23	Napier Grass: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding	3
24	Berseem: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding:	3
25	Lucern: Centers of origin, Distribution of species, wild relatives, application of genetic, cytogenetics and biotechnological techniques in breeding:	3
UNIT II		
26-27	Problems and present status of crop important in India. Work done in State, National and International centers of crop improvement	6
UNIT III		
28	Classes of seed : Nucleous, Breeder Foundation and Certified seed	3
29	General principles of seed production (Agronomic and Genetic)	5
30	Seed storage: General principles of storage and factors affecting seed longevity during storage	5
31-32	Seed certification, phases of certification, procedure for seed certification, field inspection.	6
	Total :	**100**

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Practical Exercise

Exercise No.	Title
1.	Study of emasculation and hybridization techniques
2.	Handling of segregating generation by pedigree method
3	Handling of segregating generation bulk method
4	Handling of segregating generation by back cross method
5	Layout of the field experimente
6	Field trials, maintenance of record and registers
7	Estimation of heterosis and inbreeding depression
8	Estimation of heritability
9	Parentages of released hybrid/verities
10	Study of quality characters
11	Sources of donors for different characters
12	Seed Sampling and testing procedure
13	Seed viability test
14.	Seed and Seedling vigour test
15	Seed health testing
16	Visit to seed production plot

Text Books:

1. Hari Har Ram. 2011. Crop Breeding and Biotechnology. Kalyani Pub. New Delhi.
2. Poehlman JM and Borthakur D. 1969. Breeding Asian Field crops: with special Reference to Crops of India. Oxford and IBH Pub. Co.
3. Singh BD. 2015. Plant Breeding Principle and Methods. Kalyani Pub. New Delhi.

Reference Books:
1. Chahal GS and Gosal SS. 2002. Principles and Procedures of Plant Breeding: Biotechnological andConventional Approach. Narosa Publishers House. New Delhi.

Course No.　　: **AS 235**　　　　Course Title　: **Animal Health Care**
Credits　　　: 3 (**2+1**)　　　　Semester　　: **III**

Theory

UNIT I

Introduction to animal health; history of disease diagnosis and medicine; classification of diseases; Introduction to fore stomach disorders in ruminants.

UNIT II

Introduction to important diseases of respiratory, urinary, musculoskeletal and cardiovascular system of domestic animals.Introduction to common metabolic, bacterial, viral, parasitic and blood protozoan diseases of domestic animals.Importance of animal health in relation to public health.

Practical

Introduction to veterinary hospital; methods of sample collection; introduction to common disease diagnostic tests in animals; vaccination schedule in domestic animals.Microscopic examination of parasites. Clinical diagnostics: urine, blood, milk, sputum, faeces examination.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightages (%)
UNIT – I		
1	**Introduction to animal health**	2
2	**History of disease diagnosis and medicine**	3
3	**Classification of diseases**	4
4-6	**Introduction to fore stomach disorders in ruminants-**Simple indigestion, Rumen impaction in sheep, Indigestion in calves fed milk replacers, ruminal lactic acidosis, rumen overload, Ruminal parakeratosis, tympany, Traumatic reticuloperitonitis, Vagus indigestion, Diaphragmatic hernia, Traumatic pericarditis, Traumatic splenitis and hepatitis, Impaction of the omasum, etc.	8
UNIT – II		
7-9	**Respiratory diseases of animals-** Diseases of the lungs-Pulmonary congestion and edema, Pulmonary hypertension, Atelectasis, Acute respiratory distress syndrome, Pulmonary hemorrhage, Pulmonary emphysema, Pneumonia- Aspiration, embolic, thrombosis, pulmonary, neoplasms, etc. Diseases of the pleura and Diaphragm- Hydrothorax and hemothorax, Pneumothorax, Diaphragmatic hernia, thump in horses, Pleuritis (pleurisy), Equine pleuropneumonia, etc. Diseases of the upper respiratory tract.	10
10-12	**Urinary diseases of animals-** diseases of the kidney, bladder	8

	ureters and urethra, Congenital defects of the urinary tract, etc.	
13-14	**Musculoskeletal diseases of animals-** Diseases of muscles, bones and joints. Congenital defects of muscles, bones, and joints, etc	5
15-16	**Cardiovascular system of domestic animals and diseases-** Arrhythmias, Diseases of the heart, pericardium, cardiac neoplasia, Diseases of the blood vessels, etc.	8
17-18	**Common metabolic diseases of domestic animals-** milk fever, Downer cow syndrome, Acute hypokalemia in cattle, Transit recumbency of ruminants, Lactation tetany of mares, Hypomagnesia tetany of animals and calves, Ketosis, acetonemia, Pregnancy toxemia in sheep, Fatty liver in cattle, Equine hyperlipemia, Steatitis, Neonatal hypoglycaemia, Postparturient hemoglobinuria, Rhabdomyolysis of horses, myonecrosis and myoglobinuria in horses, equine Cushing's disease, Disorders of thyroid function.	10
19-22	**Common bacterial diseases of domestic animals-** Diseases associated with Streptococcus, staphylococcus spp., Corynebacterium, Listeria, Erysipelothrix, Bacillus spp. Diseases associated with Clostridium spp. Diseases associated with Salmonella, Pasteurella, Brucella, Moraxella species, etc. Diseases associated with Fusobacterium and Bacteroides spp, Pseudomonas, Burkholderia spp, Campylobacter spp, Leptospira Borrelia spp. Mycoplasma spp.	12
23-26	**Common viral diseases of domestic animals-** Viral diseases with involvement of whole body; viral diseases affecting and showing signs involving different systems, viz, alimentary tract, respiratory, nervous, skin, etc.	10
27-28	**Common parasitic diseases of domestic animals-** Diseases associated with nematodes, cestodes and trematodes Diseases associated with arthropods	8
29-31	**Common blood protozoan diseases of domestic animals-** Babesiosis, Coccidiosis, Sarcocystosis/ sarcosporidiosis, Neosporosis, Cryptosporidiosis, Giardiasis, Toxoplasmosis, Equine protozoal myeloencephalitis, Theilerioses, Diseases associated with Trypanosomes- trypanosomiasis, surra, dourine, etc.	12
32	**Importance of animal health in relation to public health**	
	Total	**100**

Practical Exercise

Exercise No.	Title
1	Introduction to veterinary hospital
2	Methods of sample collection
3-5	Introduction to common disease diagnostic tests in animals
6-8	Vaccination schedule in domestic animals
9-10	Microscopic examination of parasites
11-12	Clinical diagnostics: urine for disease diagnosis
13-14	Clinical examination of blood and milk for animal disease diagnosis
15	Clinical examination of Sputum and nasal secretions for respiratory infections
16	Faecal examination for diagnosis of parasitic diseases

Text Books:

1. Blood DC & Henderson JA. 1968. *Veterinary Medicine.* Bailliere Tindall publishers.
2. Chakrabarti A. 2007. *Textbook of Clinical Veterinary Medicine.* Kalyani Publishers.

Reference Books:

1. Bradford P & Smith DVM. 2014. *Large Animal Internal Medicine.* 5th ed. Mosby Publishers.
2. Stephen J, Ettinger DVM, Edward C & Feldman DVM. 2010. *Textbook of Veterinary Internal Medicine Expert Consult.* 7th ed. Saunders Publishers.

Course No.   : **NSS 233**   Course Title   : **National Service Scheme III**
Credits   : 1 (**0+1**)   Semester   : **III**

Syllabus:

Vocational skill development
To enhance the employment potential and to set up small business enterprises skills of volunteers, a list of 12 to 15 vocational skills will be drawn up based on the local conditions and opportunities. Each volunteer will have the option to select two skill-areas out of this list

Issues related environment
Environmental conservation, enrichment and sustainability, climatic change, natural resource management (rain water harvesting, energy conservation, forestation, waste land development and soil conservations) and waste management

Disaster management
Introduction and classification of disaster, rehabilitation and management after disaster; role of NSS volunteers in disaster management.

Entrepreneurship development
Definition, meaning and quality of entrepreneur; steps in opening of an enterprise and role of financial and support service institution.

Formulation of production oriented project
Planning, implementation, management and impact assessment of project

Documentation and data reporting
Collection and analysis of data, documentation and dissemination of project reports

Practical Exercises

Exercise No.	Topic	Weightages (%)
1.	**Vocational skill development** To enhance the employment potential and to set up small business enterprises skills of volunteers,	6
2.	**Vocational skill development** A list of 12 to 15 vocational skills will be drawn up based on the local conditions and opportunities.	6
3.	**Vocational skill development** Each volunteer will have the option to select two skill-areas out of this list	6
4.	**Issues related environment** Environmental conservation, enrichment and sustainability,	6
5.	**Issues related environment** Climatic change, natural resource management (rain water harvesting, energy conservation, forestation,	6
6.	**Issues related environment** waste management	7
7.	**Issues related environment** waste land development and soil conservations)	7
8.	**Disaster management** Introduction and classification of disaster, rehabilitation	7

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No.	Topic	Marks
9.	**<u>Disaster management</u>** Management after disaster;	7
10.	**<u>Disaster management</u>** role of NSS volunteers in disaster management.	6
11.	**<u>Entrepreneurship development</u>** Definition, meaning and quality of entrepreneur;	6
12.	**<u>Entrepreneurship development</u>** Steps in opening of an enterprise and role of financial and support service institution.	6
13.	**<u>Formulation of production oriented project</u>** Planning, implementation,	6
14.	**<u>Formulation of production oriented project</u>** Management and impact assessment of project	6
15.	**<u>Documentation and data reporting</u>** Collection and analysis of data,	6
16.	**<u>Documentation and data reporting</u>** documentation and dissemination of project reports	6
Total		100

SEMESTER-IV

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Course No: **EDBM-241**   Course Title: **EntrepreneurshipDevelopment & Business Management**
Credits: **2(1+1)**   Semester: **IV**

Theory

Entrepreneurship Development and Business Communication

Entrepreneur- Meaning and definition of Entrepreneur, Characteristics of entrepreneurs; Entrepreneurship Development- Concept and process of entrepreneurship development; Achievement motivation and entrepreneurship development, Government policy and programs and institutions for entrepreneurship development,SWOT Analysis, Marketing Management for Agri Business-Agricultural Marketing, meaning and the objectives of marketing & marketing Management, market promotion techniques, Rural Marketing- The meaning and the objectives of rural marketing, Characteristics of rural markets, Procurement- Procurement Objective, Importance of Procurement, Constraints of Procurement- Agricultural commodities, Types of Purchasing, Supply chain management and Total quality management,Project Planning Formulation and report preparation; Financing of enterprise, Opportunities for agri-entrepreneurship and rural enterprise, Developing different skills for entrepreneurship-Managerial skills, Business Leadership Skills(Communication, direction and motivation Skills), Problem solving skill, Writing skill- Business letter, letters of enquiry, quotation, orders and tenders, complaint letter and success story

Practical

Assessing entrepreneurial traits, problem solving skills, managerial skills and achievement motivation, exercise in creativity, time audit through planning, monitoring and supervision, identification and selection of business idea, preparation of business plan and proposal writing, visit to entrepreneurship development institute and entrepreneurs.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
1-2	Entrepreneur- Meaning and definition of Entrepreneur, Characteristics of entrepreneurs; Entrepreneurship Development- Concept and process of entrepreneurship development	12
3-4	Achievement motivation and entrepreneurship development Entrepreneurship development programmes- concept and objectives	10
5	Government policies, programmes and institutions for entrepreneurship development	06
6	SWOT Analysis: Generation, incubation and commercialization of ideas and innovations Entrepreneurial behaviour – Concept, dimensions, factors affecting entrepreneurial behaviour	06
7-8	Marketing Management for Agri Business- Agricultural Marketing,	14

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	meaning and the objectives of marketing & marketing Management, market promotion techniques. Opportunities and challenges in Agribusiness. Communication. Good communication qualities of successful entrepreneur and effective treatment of message for successful business communication Advertisements – Meaning, types, forms, functions	
9	Rural Marketing- The meaning and the objectives of rural marketing, Characteristics of rural markets	08
10- 11	Procurement- Procurement Objective, Importance of Procurement, Constraints of Procurement- Agricultural commodities, Types of Purchasing, Supply chain management, Time management and Total quality management	12
12- 13	Project Planning Formulation and report preparation; Financing of enterprise, Opportunities for agri-entrepreneurship and rural enterprise	12
14- 15	Developing different skills for entrepreneurship- Managerial skills, Business Leadership Skills (Communication, direction and motivation Skills), Problem solving skill	12
16	Writing skill- Business letter, letters of enquiry, quotation, orders and tenders, complaint letter and success story	8
Total:		**100**

Practical Exercise

Exercise No.	Title
1.	Assessing entrepreneur potential
2.	Assessment of problem solving ability
3.	Exercises in creativity
4.	Conducting market survey to know the demands for different products
5.	Preparing advertisements for popularization of products and news writing
6.	Time audit through planning
7.	Identification and selection of business idea
8.	Preparation of business plan and proposal writing
9.	Conduct of SWOT analysis
10.	Group discussion and debates on current topics
11.	Meetings – Purpose, procedure, participation, chairmanship, physical arrangements, recording and writing of minutes of meeting
12.	Writing skills- Write Business letter, letters of enquiry, quotation, orders and tenders, complaint letter and success story
13.	Visit to agribased industries
14.	Visit to District Small Scale Industry Development Corporation office
15.	Visit to entrepreneurship development institute
16.	Visit to entrepreneurs /case study of successful entrepreneurs (project report)

Reference Books:
1. Akhouri MMP, Mishra SP and Sengupta R. 1989. Trainers Manual on Developing Entrepreneurial Motivation. NIESBUD, New Delhi.
2. Betty GB. 1979. Entrepreneurship, Playing to Win. Taraporewala, Mumbai

3. Entrepreneurship Development Institute in India. 1987. Developing New Entrepreneurs, EDII, Ahmedabad, NISIET, Library : 338.93/EDI/87/25104.
4. Mancuso J. 1974. The Entrepreneurs Handbook, Vol.I& II, Artech House Inc. USA.
5. Patel VG. 1987. Entrepreneurship Development in India and its relevant Developing Countries, Entrepreneurship Development Institute of India. Ahmedabad, NISIET, Library : 338.93 (540)/PAT/87/25103.
6. Singh AK, Singh LR and Berman R.2006. Dimensions of Agricultural Extension. Aman Publishing House, Meerut.
7. Mondal S. and Ray GL. 2009. Text Book of Entrepreneurship and Rural Development. Kalyani Publishers, Ludhiana. ISBN 978-81-272-5599-2
8. Mohanty SK. 2009. Fundamentals of Entrepreneurship. Prentice Hall of India Pvt. Ltd. New Delhi.

9. Singh D. 1995. Effective Managerial Leadership. Deep and Deep Publications. New Delhi.
10. Desai V. 2000. Dynamics of Entrepreneurial Development and Management. Himalaya Publishing House, New Delhi.
11. Khanka SS. 1999. Entrepreneurial Development. S. Chand and Co. New Delhi.
12. Nandan H. 2011. Fundamentals of Entrepreneurship. PHI Learning Pvt Ltd India.
13. Chole RR. 2012. Entrepreneurship Development and Communication Skills. Scientific Publishers, Jodhpur.
14. Singh AK. 2009. Entrepreneurship Development and Management. Lakshmi Publications Ltd.
15. Ray GL. 2005. Extension Communication and Management. Kalyani Publication. New Delhi.
16. Chole R.R., Kapse P.S. and Deshmukh P.R. (2012)Entrepreneurship Development and Communication Skills Scientific Publishers, Jodhpur

Course No   : **BIOCHEM-241**   Course Title   : **General Biochemistry**
Credits   : **4(3+1)**   Semester   : **IV**

Theory
UNIT I
Introduction and importance; Cell structure; Bio molecules: Carbohydrates, lipids, proteins and nucleic acids-structure, functions and properties; Enzymes: Classification, factors affecting activity; Structure and role of water in biological system; Acids, bases and buffers of living systems; The pK of biomolecules; Vitamins and hormones.
UNIT II
Bioenergetics; Metabolism-basic concept: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Oxidative phosphorylation, Fatty acid oxidation; General reactions of amino acid degradation; Biosynthesis - carbohydrates, lipids, proteins, nucleic acids.
UNIT III
Secondary metabolites: Terpenoids, 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;Determination of phenols; Determination of free amino acids and proteins.

Teaching Schedule- Theory with weightage (%)

No. of lectures	Topics	Weightage (%)
1	Scope and importance of biochemistry	2
2	Cell structure: plant cell, animal cell different organelles structure function.	4
3	Structure of water, acid-base concept	4
4	Buffer and pH, hydrogen bonding, hydrophobic, electrostatic and van der Waals forces	3
5-7	Bioenergetics: Fundamentals of thermodynamic principles applicable to biological processes, bioenergetics.	4
8-10	Bio molecules: Classification, structure and functions of carbohydrates	6
11-12	Classification, structure and functions of lipids	5
13-14	Classification, structure and functions of amino acids and proteins	5
15-16	Nucleic acids-structure, functions and properties	5
17-18	Enzymes: Classification, factors affecting enzyme activity: Substrate concentration, enzyme concentration, temperature and	5
19-20	Mechanism of enzyme action : Ribonuclase A, chymotrypsin, lysozyme	4
21	Structure, biological functions and classification of vitamins	3
22	Hormones: animals, plants and insects	4
23-26	Metabolism - basic concept, catabolism, anabolism. Metabolism of carbohydrates- glycolysis, TCA cycle, pentose phosphate pathway, glyoxylate cycle.Fatty acid oxidation.	12

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27	Electron transport chain and oxidative phosphorylation	3
28-29	Classification, structure and functions of lipids Metabolism of lipids	4
30-31	Classification, structure and functions of amino acids and proteins. Metabolism of proteins	3
32-33	Metabolism of nucleic acids	3
34-35	General reactions of amino acid degradation	4
36-37	Secondary metabolites role and classification	4
38-39	Terpenoids, alkaloids, phenolics and their applications in food and pharmaceutical industries.	4
40-42	Recombinant DNA technology	3
43-45	Secondary metabolites: Terpenoids	4
46-48	Alkaloids, phenolics their applications in food and pharmaceutical industries.	2
	Total:	**100**

Practical Exercise

Exercise No.	Title
1.	Preparation of standard solutions and buffers
2.	Qualitative tests for carbohydrates
3	Qualitative tests for amino acids and proteins
4	Extraction of oil from oil seeds by Soxhlet method
5.	Determination of acid and saponification value of oil
6.	Determination of iodine value of oil.
7.	Estimation of free amino acids by ninhydrin method
8.	Estimation of protein by Folin- Lowry method
9.	Quantitative estimation of total and reducing sugars by Nelson-Somogyi method
11-12	Separation of amino acids and sugars by paper chromatography
13.	Estimation of total phenol content
14.	Estimation of ascorbic acid from fruits
15.	Isolation of DNA from plant tissue
16.	DNA quanfitication

Text Books:

1   Bhatia SC. 1984. Biochemistry in Agricultural Sciences. Shree Publication House, New Delhi.
2   Purohit SS. 2009. Biochemistry - Fundamentals and Applications. Agrobios, Jodhpur.
3   Singh M. 2011. A Textbook of Biochemistry. Dominant Publishers & Distributors, New Delhi.
4   Veerkumari L. 2007. Biochemistry. MIP Publishers, Chennai.
5   Jain JL, Jain S and Jain N. 2005. Fundamentals of Biochemistry. S. Chand & Company Ltd. New Delhi.
6   Rastogi SC. 2003. Biochemistry. Tata McGraw-Hill Education, New Delhi.
7   Rama Rao AVSS. 2002. A Textbook of Biochemistry. 9th Ed. Illustrated Publisher, Sangam Books Limited, New Delhi.

Reference Books: (Theory):

1 Conn EE and Stumpf PK. 2010. Outlines of Biochemistry. 5th Ed. John Wiley Publications.
2 Voet D and Voet JG. 2011. Biochemistry. 4th Ed. John Wiley and Sons, Inc. NY, USA.
3 Goodwin TW and Mercer EI. 1983. Introduction to Plant Biochemistry. 2nd Ed. Oxford, New York. Pergaman Press.
4 Nelson DL and Cox MM. 2012. Lehninger's Principles of Biochemisry, 6th Ed . Macmillan Learning, NY, USA.
5 Berg JM, Tymoczko JL, Stryer L and Gatto GJ. 2002. Biochemistry, 7th Ed. W.H. Freeman and Company, NY, USA
6 Jayaram T. 1981. Laboratory manual in Biochemistry, Wiley Estern Ltd. New Delhi.
7 Plummer D. 1988. An Introduction to Practical Biochemistry. 3rd ed. Tata McGraw Hill, New Delhi.
8 Nath RL. 1990. Practical Biochemistry in Clinical Medicine. Academic Pub.
9 Sen AR, Pramanik NK and Roy SK. 2001. A treatise on Analysis of Food, Fats and Oils. Oil Technologists Association of India (EZ) Kolkata.
10 Sadasivam S and Manickam A. 1996. Biochemical Methods. 2nd ed. New Age International (P) Ltd. Publisher, New Delhi.

Course No : **BT-247**   Course Title : **Introductory Bioinformatics**
Credits : **3(2+1)**   Semester : **IV**

Theory

UNIT I

Introduction to bioinformatics; Development and scope of bioinformatics; Applications of computers in bioinformatics: Operating systems, hardware, software, Internet, www resources, FTP.

UNIT II

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.

UNIT III

Introduction to sequence alignment and its applications: Pair wise and multiple sequence alignment, 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.

Practical

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.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
	UNIT I	
1	**Introduction to bioinformatics;** Definition, History	2
2	Development and scope of bioinformatics	3
3-4	Applications of computers in bioinformatics	5
5	Operating systems	2
6-7	Hardware, Software	3
8-9	Internet, www resources, FTP	5
	UNIT II	
10- 12	**Biological Databases and their classification;** Primary databases: Nucleotide sequence databases (GenBank, EMBL)	10
13-14	Protein sequence databases; Secondary databases: SwissProt/TrEMBL, conserved domain database, Pfam;	10
15-16	**Structure databases:** Protein Data Bank (PDB), MMDB, SCOP, CATH	5
17	**Structure databases:** Retrieving information from these databases.	5
18-19	File formats: Genbank, EMBL, Fasta, PDB, Flat file, ASN.1, XML.	10

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	UNIT III	
20-21	**Introduction to sequence alignment and its applications:** Pair wise and multiple sequence alignment,	6
22	Concept of local and global alignment	6
23- 25	**Algorithms:** Dot Matrix method, dynamic programming methods (Needleman–Wunsch and Smith–Waterman) application of these algorithms in different biological problems.	10
26-27	**Tools of MSA:** ClustalW, TCoffee; Use of these tools for MSA of DNA and protein sequences. Save output file in phylip format.	
28-30	**Phylogeny;** terminologies in phylogeny, applications, and methods of phylogenetic analysis	10
31-32	**Introduction to BLAST and FASTA**. Different BLAST Programmes: their application in terms of nucleic acid and protein sequence. Significance of E Value.	08
	Total:	**100**

Practical Exercise

Exercise No.	Title
01	To learn Basics computer operating System
02	To study UNIX, LINUX operating systems
03	To study the Primary nucleotide database : EMBL, GenBank, DDBJ
04	To study the protein primary database : Unigene; Protein information resource: SwissProt, TrEMBL
05	To study the protein secondary databases : Uniprot, CATCH, SCOP
06	To study the protein Structural databases: PDB, MMDB
07	To study the information retrieval System using search engines : Entrez, ARSA, SRS;
08	Blast analysis of unknown nucleotide sequence
09	Blast analysis of unknown protein sequence
10	Multiple Sequence alignment using ClustalW
11	Prediction of primary structure of protein : Translation
12	Prediction of primary structure of protein (amino-acid and atomic compositions, pI, extinction coefficient, etc.)
13	Secondary structure prediction of protein sequence using APSSP: Advanced Protein Secondary Structure Prediction Server
14	Secondary structure prediction of protein sequence Ramachandran Plot
15	Tertiary structure prediction of protein sequence using Cn3D and swissPDB viewer
16	Molecular visualization of protein structures

Text Books:
1. Baxevanis AD & Ouellette BFF.2001.Bioinformatics: A practical guide to the analysis of genes and proteins.John Wiley and Sons.
2. Mount DW. 2001. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor.
3. Xiong J.2006. Essential Bioinformatics.Cambridge University Press.

Course No   : **BT-248**   Course Title : **Plant Genetic Transformation**
Credits   : **3(2+1)**   Semester   : **IV**

Theory

UNIT I

History of plant genetic transformation; Generation of gene construct and maintenance; Genetic transformation: *Agrobacterium* mediated, biolistic, electroporation, liposome, Polyethylene glycol, *in planta*methods.

UNIT II

Selection and characterization of transgenic plants using selectable and reportable markers; PCR; qRT-PCR; Southern, Northern, ELISA and Western techniques; Application of genetic transformation: for quality, yield, biotic, and abiotic stresses; Biosafety aspects of transgenic plants and regulatory framework.

Practical

Preparation of stock solutions, Preparation of competent cells of *Agrobacterium tumefaciens*; Restriction mapping of plasmid, Construction of binary vector and its transfer to an *Agrobacterium* strain; Confirmation of transformed bacterial colonies; *Agrobacterium tumefaciens* mediated and biolistic plant transformation; Colony hybridization.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
	UNIT I	
1-3	**History of plant genetic transformation:-** History, Major Discoveries Definition and applications.	7
4	**Generation of gene construct** : Selection/ isolation/Identification of interest,	5
5	Methodology, competent cell preparation, Different Vectors used, Enzymes required, Purification , confirmation of construct	8
6	**Maintenanc**e:- Bacterial transformation	4
7	Culture maintenance method	2
8-9	*Agrobacterium* mediated Genetic transformation: Introduction, Principle, Methodology and Application	7
10	**Genetic transformation using biolistic gun and electroporation:** Introduction, Principle, Methodology and Application	5
11	**Genetic transformation using liposome, Polyethylene glycol:** Introduction, Principle, Methodology and Application	2
12	*In planta* **transformation methods :** Methodology	2
13	**Genetic transformation in Maize: I**ntroduction, Principle, Methodology and Application	2
14	**Genetic transformation in Brinjal etc.** Introduction, Principle, Methodology and Application	2
	UNIT II	
15	**Selection and characterization of transgenic plants using selectable**	5

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	and reportable markers:- Introduction and Definition	
16-18	Different markers used for characterization, Methodology, Applications	8
19	**PCR;** Introduction, Instrumentation, Principle and application.	5
20-22	**qRT-PCR :-** Introduction and Principle,Instrumentation, Application	8
23	**Southern Hybridisation:** Introduction, Instrumentation, Principle and application	3
24	**Northern Hybridisation:** Introduction, Instrumentation, Principle and application	3
25	**ELISA:** Introduction, Instrumentation, Principle and application	3
26	**Western Hybridisation:** Introduction, Instrumentation, Principle and application	3
27	**Application of genetic transformation: for quality improvement,:**	4
28-29	**Application of genetic transformation:**biotic, and abiotic stresses	3
30	**Biosafety aspects of transgenic plants and regulatory framework :-** Definition, Environmental safety.	3
31	Food safety to human and animal health, Risk Management, Biosafety Framework, Hazzard, Biosafety levels, containment.	3
32	EPA Act 1986, 1989 Rule , Recombinant DNA guidelines, Implementing agency, statutory Bodies, Grant of approvals, penalties etc.	3
Total		**100**

Practical Exercise

Exercise No.	Title
1	**Preparation of stock solutions,** CTAB, EDTA, EtBr, TAE, TBE, Tris HCL Loading dye, LB Medium/ broth etc.
2	**Preparation of competent cells of *Agrobacterium tumefaciens*;** protocol, *Agrobacterium* competent cell preparation
3-5	**Restriction mapping of plasmid,** Digestion of plasmid DNA with different restriction enzyme and visualization of bands on gel by electrophoresis.
6-8	**Construction of binary vector and its transfer to an *Agrobacterium* strain;** ligation by using ligase enzyme and transformation to *Agrobacterium.*
9-11	**Confirmation of transformed bacterial colonies;**PCR,Selective marker and scorable marker, Hybridization methods etc.
12	*Agrobacterium tumefaciens* **mediated transformation of plants**
13	**Biolistic gene gun method of plant transformation**
14	**Confirmation of transformed plantlets**
15-16	**Colony hybridization.** Probe based detection

Text Books:
1. Grierson D. 2012. Plant Genetic Engineering. Springer Netherlands.
2. Primose SB & Twyman RM. 2006. Principles of Gene Manipulation and Genomics, 7th Ed. Blackwell Publishing.
3. Sambrook J and Russel D. 2001. Molecular Cloning: A Laboratory Manual. 3rd Ed Cold Spring Harbor Laboratory Press.

Reference Books:
1. Green MR & Sambrook J. 2014. Molecular Cloning: A Laboratory Manual. 4th Ed. 3 Vol Sets. Cold Spring Harbor Laboratory Press.
2. Stewart NC Jr. 2008. Plant Biotechnology and Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc.

Course No: **BT/ECE-241**   Course Title   : **Fundamentals of Electronics &Instrumentation in Biotechnology**

Credits : **2(1+1)**   Semester   : **IV**

Theory:

UNIT I

ElectronicsPN junction diode, diode forward and reverse characteristics; Diode as a circuit element; Application of PN junction diode such as: half wave, full wave bridge rectifier, clipper, clamper and voltage multiplier circuit; Construction and working of bipolar transistor, load line concept, analysis and design of various biasing methods of NPN transistor with common emitter configuration; AC model and analysis of small signal NPN transistor with common emitter configuration; Concept of generalized instrumentation system; Transducers for the measurement of temperature using thermometer and thermocouple, linear displacement measurement using LVDT; Force measurement using the strain gauge.

UNIT II

Principles and working of laboratory equipments: Table top, refrigerated and ultra centrifuges; Laminar air flow; Autoclaves, pH meter; Fermenters; Temperature control shakers, BOD shakers; Gel electrophoresis, 2-D gel electrophoresis, gel documentation, gel driers; ELISA readers; Freeze driers/lypholizers; Spectrophotometers; Gene pulser; Particle gun; Plant growth chambers; Thermal cyclers; Realtime PCR; DNA synthesizer; DNA sequencer; Microscopes: Light, stereo, phase contrast and inverted.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
	UNIT I	
1	**PN Junction Diode:** Introduction to Semiconductors, Junction Theory, Formation of Depletion Region, Junction Potential, Working Principle, Characteristics and Applications.	6
2	**Diode as a Circuit Element:** Symbol, Forward and Reverse Biasing of Diode, Voltage drop across Diode, Breakdown Voltage, Volt-Ampere (V-I) Characteristics of a Diode.	6
3	**Diode Applications :-** DC Power Supply, Rectification, Types of Rectifiers, Half Wave Rectifier (HWR), Full Wave Rectifier (FWR), Full Wave Bridge Rectifier, Performance Parameters of Rectifiers and Inter-comparison, Clippers, Clampers, Voltage Multipliers.	7
4	**Bipolar Junction Transistor:** Introduction, Construction, Types - NPN and PNP, Operation and Working Principle, Characteristics, Regions of Operation, Transistor Configurations (CE,CB,CC), Applications.	6
5	**Load Line Concept:** DC and AC Load Lines, Load Lines for Common Configurations (CE,CB,CC), Analysis of Load Lines.	6
6	**Concept of Generalized Instrumentation System :** Definition and concept	2

	Transducers :- Resistance Temperature Detector (RTD), Thermistor, Thermocouple, Comparison of common types of Temperature Transducers, Displacement Transducer – LVDT, Strain Gauge for Force Measurement.	4
7	**PN Junction Diode:** Introduction to Semiconductors, Junction Theory, Formation of Depletion Region, Junction Potential, Working Principle, Characteristics and Applications.	6
8	**Diode as a Circuit Element:** Symbol, Forward and Reverse Biasing of Diode, Voltage drop across Diode, Breakdown Voltage, Volt-Ampere (V-I) Characteristics of a Diode.	7
UNIT II		
9	Principles and working of laboratory equipments: **Table top, refrigerated and ultra centrifuges;**Properties of dextop centrifuge Applications of table top centrifuge. Principles of working, Sedimentation.**Ultra Centrifuge :**Features, Speed and criteria of UF centrifuge. Resolution power. Process of UF. Parts of centrifuge.	6
10-11	**Laminar air flow**; Construction. Types of Laminar air flow; Vertical, Horrizontal. Uses of LAF	5
	Autoclaves: Construction operation criteria for different materials.	3
	pH meter : Definition importance of maintaining pH for culturing microbes.working of pH meter.Calibration of pH meter.	5
12	**Fermenters**: Criteria for ideal fermentors. Types of bioreactors, construction of fermentors, Applications with examples.	2
	Temperature control shakers	2
	Gel electrophoresis:Factors affecting electrophoratic mobility, Types of gels, electrophoratic mobility in gels, principle, electrophoratic procedures, Detection recovery and estimation. Applications of gel electrophoresis	2
13-14	**2-D gel electrophoresis**: SDS Agarose, gel electrophorasis, native page, Principle and procedure. Iso-electric focusing. Applications of electrophoratic techniques in detection of different bio-molecules.	3
	gel documentation, gel driers	2
	ELISA readers : Definition, Use in drug discovery and bioassay validation. Use in biotechnological industry. Absorbance, fluorscence, Time resolved fluorscence, Luminiscence.	4
	Freeze driers, BOD shakers , lypholizers; Gene pulser; Particle gun; Plant growth chambers ,Thermal cyclers; Real time PCR; DNA synthesizer; DNA sequencer: Principle and methodology	4
15-16	**Microscopes**: **Light**: Principle, types of lenses construction applications,stereo ; Magnification, illumination differences to normal compound microscope. **Phase contrast: Definition**, Working principle, Diagrammatic representation. Applications. **Inverted microscope** : Construction Principle and biological applications: Fluorscence, Ilumination etc.	6
	Spectrophotometers: Basic principles Instrumentation for UV visible, IR spectro-photometry. Application of UV visible spectro-photometry Qualitative and quantitative analysis of biomolecules.	6
Total :		**100**

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Practical Exercise

Exercise No.	Title
1-2	To familiarize laboratory equipment and its equipment working; Forward and reverse VI Characteristics of a PN junction diode;
3-4	To study half wave, full wave and bride rectifier using diode; Clipper, Clamper and Voltage multiplier circuit;
5-6	To determine input V-I Characteristics s of bipolar transistor for common emitter configuration;
7-8	To determine output V-I Characteristics s of bipolar transistor for common emitter configuration; -
9-10	To analyse a biasing circuits for CE transistor;
11-12	To design and test a biasing circuits for CE transistor;
13-14	To study the measure of temperature using the available sensor;
15-16	To measure displacement with the available sensor; To study force with the available sensor.

Text Books:
1. Gupta JB. 2009. Basic Electronics. SK Kataria & Sons.
2. Manhas P & Thakral S. 2010. Digital Electronics. SK Kataria & Sons.
3. Sharma Sanjay. 2012. Electronics Devices & Circuits. SK Kataria & Sons.

Reference Books:

1. Golding EW & Widdis FC. 1969. Electrical Measurements and Measuring Instruments. Pitman.
2. Malvino A and Bates D. 2006. Electronics Principles. Tata McGraw-Hill Education.

B.Tech. (Biotechnology)

Theory

UNIT I

Introduction and history; Mitosis and meiosis; 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.

UNIT II

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

Preparation of chromosome stains; Pollen fertility; Preparation of mitotic and meiotic slides of plant/animal cells; Preparation of karyotypes; C/G banding of the chromosomes; Genomic *in situ* hybridization; Microphotography.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
	UNIT I	
1	**Introduction and history:** Definition, scope,	3
2	Application, major discoveries and scientists.	3
3-4	**Mitosis and meiosis** Overview of mitosis and meiosis, Phases of cell cycle	6
5	Differences between mitosis and meiosis	3
6	Stages of mitosis and meosis.	3
7-8	**Structure of chromatin**:- Introduction, Chromatin structure and hierarchy, Centromere, telomere and origin of replication	6
9-10	Nucleosome: Introduction, structure and hierarchy	6
11	**Chromosome structure**:-History of discovery	3
12	Chromosome in prokaryotes and eukaryotes	3
13	Chromosome landmarks;Visible Chromosomal Landmarks: Chromosome size, Centromere position, Position of nucleolar organizers,	3
14	Chromomere patterns, Heterochromatin patterns, Banding patterns	3
15	**Specialized chromosomes;** Lampbrush chromosomes,	3
16	Polytene chromosomes, Accessory Chromosome.	4
17	**Differential staining of the chromosomes- Q-banding, G banding-** History**,** introduction, procedure and applications	2
18	**C banding, R banding:-**History**,** introduction, procedure and applications.	4
19	*In situ* **hybridization-FISH and GISH**: Probes – RNA and DNA, Introduction, principle and procedure and application	4
20	GISH: - Introduction, principle and procedure and application	3

		UNIT II	
21-22	Chromosomal aberrations: aneuploidy- monosomy, Trisomy and tetrasomy, haploidy and polyploidy		7
23	**Autopolyploidy and allopolyploidy;** with example		3
24-25	Methods of doubled haploid production; *In-vitro* Androgenesis, Gynogenesis		6
26	Parthenogenesis		3
27	**Structural aberrations of chromosomes: deletions, duplications:** Definition and diagrammatic representation.		3
28	**Inversions and translocations:** Definition and diagrammatic representation		3
29	**Locating genes on chromosomes:** identification and location of specific gene on chromosome		4
30	**Genome analysis:** Cytogenetic location**.**		3
31-32	Molecular location**:** High-throughput sequencing, Illumina (Solexa) sequencing, Ion Torrent Assembly: Assembly approaches, Finishing. AnnotationSequencing pipelines and databases		6
		Total:	**100**

Practical Exercise

Exercise No.	Title
1-2	Preparation of chromosome stains: Giosma, Acetocarmin, vital stain etc
3-4	Pollen fertilityby staining
5-6	Preparation of mitotic and meiotic slides of plant/animal cells;
7	Preparation permanent slide of all of mitotic and meiotic stage
8-9	Preparation of karyotypes; onion cells/ plant cells karyotyping staining
10-12	C/G banding of the chromosomes; by using standard protocol
13-14	Genomic *in situ* hybridization; by using standard protocol
15-16	Microphotography. Photographing of microscoping slides , crops, insects etc.

Textbook:
1. Gupta PK. 2007. Cytogenetics.Rastogi publications.
2. Khush GS. 1973. Cytogenetics of Aneuploids. Academic Press.

Reference Books:
1. Becker K, Hardin J. 2004. The World of Cell. 5th Ed. Pearson Edu.
2. Carroll M. 1989. Organelles. The Guilford Press.
3. Charles B. 1993. Discussions in Cytogenetics. Prentice Hall.
4. Mahabal Ram. 2010. Fundamentals of Cytogenetics and Genetics. PHI Learning Pvt. Ltd.
5. Yao-Shan Fan. 2002. Molecular Cytogenetics: Protocols and Applications. Humana Press.

Course No   : **MICRO-242**   Course Title   :   **Microbial Genetics**
Credits   : **3(2+1)**   Semester   :   **IV**

Theory

UNIT I

Microorganisms as tools for genetic studies; Genetic variability in microorganisms; Genetic analysis of representative groups of bacteria, fungi and viruses; Random and tetrad spore analysis; Recombination and chromosomal mapping; Complementation - intergenic and intragenic.

UNIT II

Bacterial plasmids; Structure, life cycle, mode of infection and their role in genetic engineering; Transfer of genetic material in bacteria: Conjugation, transformation and transduction; Genetics of bacteriophage: T4, lambda and M13 - fine structure of gene, life cycle, mode of infection; Mutation: types, mutagens, DNA damage and repair; Transposable elements; Lac operon; Yeast genetics.

UNIT III

Concept and application of recombinant DNA technology; Use of genetic tools to improve the microbial strains with respect to industry, agriculture and health.

Practical

Conjugation and transformation in bacteria; Spontaneous and auxotrophic mutation; Chemical and UV mutagenesis in fungi and bacteria; Complementation in fungi; Identification of mutants using replica plating technique; Isolation of genomic DNA from *E. coli*; Isolation and curing of

plasmid;Identification of plasmid by electrophoresis / antibiotic plates.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
	UNIT-I	
1	**Microorganisms as tools for genetic studies**: General description, Microbes as tools for use in molecular biology, controlled matings, genetic engineering.	5
2-3	**Genetic variability in microorganisms; Genetic analysis of representative groups of bacteria, fungi and viruses:** Genotyping methods- 1)DNA banding pattern based methods, 2) PCR amplification, (3) DNA hybridization–based methods using nucleotide probes, (4) DNA sequencing-based methods to study the polymorphism of DNA sequences, (5) differentiation of isolates on the basis of presence or absence of particular genes and (6) high resolution melting analysis–real–time monitoring of melting process of PCR amplified polymorphic DNA fragment.	10
4-5	**Random and tetrad spore analysis**	5

6-8	**Recombination and chromosomal mapping:** Crossing over,cytological basis, Holliday model of recombination, molecular mechanism of recombination in bacteria. Chromosome mapping: two factor crosses, three factor crosses, interference, ordered and unordered tetrad data, somatic cell hybridization.	10
9-11	**Complementation- intergenic and intragenic:**Introduction, Intergenicvs intragenic complementation, Complementation test, Complementation group, Complementation Studies, Complementation Analysis.	5
UNIT-II		
12-13	**Bacterial plasmids:** **Types-** i) F plasmid, ii) R plasmid, iii) Col plasmid, iv) Digredative plasmid, v) Vir plasmid **Structure:** Modular organization, **Life cycle and mode of infection of Agrobacterium:** Molecular biology of Agrobacterium infection, Ti and Ri plasmid, organization of vir region, transfer of T- DNA, integration of T-DNA to plant genome, vectors derived from pTi and their role in genetic engineering	10
14-16	**Transfer of genetic material in bacteria:** **Conjugation:** Definition, history, mechanism of DNA transfer during conjugation, high frequency recombination (Hfr) strain, Significance. **Transformation:** Definition, history, Griffith's experiment, process of transformation, Significance. **Transduction:** Definition, history, Types-generalized and specialized, process of transduction, Significance.	10
17-20	**Genetics of bacteriophage:** **T4: Fine structure of gene-**ds DNA genome **Life cycle-**Lytic **Mode of infection-** by binding OmpC porin proteins and Lipopolysaccharide (LPS) on the surface of *E. coli* cells **Lambda : Fine structure of gene**– 48,490 base pairs of dslinear DNA. **Life cycle-**, lytic or lysogenic. **M13: Fine structure of gene-**sscircular DNA **Mode of infection**	10
21-24	**Mutation:Types**- Substitution, insertion, deletion and frameshift mutation, **Mutagens**-1) Physical Mutagens- Ionizing radiations such as X-rays, gamma rays and alpha particles, 2) Chemical Mutagens- Mustard gas, Nitrous acids, Acridine dies and base analogues, 3) Biological Agents- Transposons, viruses, bacteria, **DNA damage and repair:** Introduction, Mechanism- 1) Photo reactivation, 2) excision repair, 3) Post replication recombination repair. **Transposable elements**: Genetic instability and discovery of transposable elements, transposable elements in bacteria, transposable elements in eukaryotes, genetic and evolutionary significance of transposable elements.	10
25-27	**Lac operon:** Regulatory genes, Mechanism. **Yeast genetics:** DNA ~60% A+T, histones; Transcriptional silencing, silent mating type cassettes, telomeres, and rDNA, 16 chromosomes, genome sequence, Centromeres, Telomeres $(TG_{1-3})_n$, Replication origins (ARS elements)	10
UNIT-III		
28-29	**Concept and application of recombinant DNA technology:** Introduction and application of recombinant DNA technology in agriculture,	5

	pharmaceutical, food, health industries, etc.	
30-32	**Use of genetic tools to improve the microbial strains with respect to industry, agriculture and health:** **Strain improvement:** 1) Mutant selection, selective isolation of mutant, 2) Recombination-sexual reproduction, parasexual cycle, protoplast fusion, 3) Recombinant DNA technology- Recombinant proteins, metabolic engineering.	10
	Total:	**100**

Practical Exercise

Exercise No.	Title
1	Culture techniques for isolation of single colonies of bacteria *Escherichia coli*– by streaking, serial dilution technique etc.
2	To study bacterial conjugation
3	Preparation of Competent E. coli cells and Plasmid transformation by Heat shock method
4	Induction of mutation by physical mean UV mutation
5	Induction of mutation by chemical mean
6	Induction of mutation by biological mean
7	Study of Mutation rate
8	Isolation, and production ofauxotrophic mutant.
9	Complementation in fungi
10	Identification of mutants using replica plating technique
11	Isolation of genomic DNA from *E. coli*;
12	Isolation and curing of plasmid;
13	Identification of plasmid by electrophoresis / antibiotic plates.
14-15	PCR based identification techniques
16	Bacteriophage Lambda infection and plaque study.

Text Book:
1. Gardner JE, Simmons MJ & Snustad DP. 1991. Principles of Genetics. John Wiley & Sons.
2. Maloy A & Friedfelder D. 1994. Microbial Genetics.Narosa.
3. Scaife J, Leach D & Galizzi A 1985. Genetics of Bacteria. Academic Press.
4. William Hayes 1981. Genetics of Bacteria. Academic Press.
5. Maloy SR, Cronan Jr. JE & Freifelder D. 2006. Microbial Genetics. 2nd Edition. Narosa Publishing House, New Delhi.
6. Srtickberger MW. 2005. Genetics, ' 3rd Ed. Prentice Hall of India Private Ltd. New Delhi.
7. Singh BD. 2006. Genetics, 2006, 1st Ed. Kalyani Publishers, New Delhi.
8. Lewin B. 2006. Genes IX. Pearson Prentice Hall, Pearson Education Inc., New Jersey.

Reference Books:
1. Birge EA. 1981. Bacterial and Bacteriophage Genetics. Springer Verlag.
2. Freifelder D. 2005. Molecular Biology. 2nd Ed. Narosa Publishing House, New Delhi.

Course No   : **PHY-241**   Course Title   : **Biophysics**
Credits   : **3(2+1)**   Semester   : **IV**

Theory

UNIT I

Quantum mechanics; Electronic structure of atoms; The wave particle duality, wave length of de-Broglie waves; Phase and group velocity; Some basic concepts of quantum mechanics; Schrodinger's wave equations; Particle in a box; Quantum mechanical tunneling; Ist and IInd law of thermodynamics; Enthalpy; Entropy; Statistical and thermodynamic definition of entropy; Helmholtz free energy, Equilibrium thermodynamic; Near-equilibrium thermodynamic; Gibbs free energy; Chemical potential; Thermodynamic analysis of membrane transport.

UNIT II

Hydration of macromolecules; Role of friction; Diffusion; Sedimentation; The ultracentrifuge; Viscosity; Rotational diffusion; Light scattering, Small angle x-ray scattering; Ultraviolet and visible spectroscopy; Circular dichroism(CD) and optical rotatory dispersion(ORD); Fluorescence spectroscopy; Infrared spectroscopy; Raman spectroscopy; Electron spin resonance; NMR spectroscopy; Light microscopy.

UNIT III

Electron optics; Transmission electron microscope (TEM); Scanning electron microscope(SEM); Preparation of the specimen for electron microscopy; Image reconstruction; Electron diffraction; Tunnelling electron microscope; Atomic force microscope; Crystals and symmetries, crystal systems, point group and space groups; Growth of crystals of biological molecules; X-ray diffraction.

Practical

Refractive index and dispersive power of the prism using spectrometer; Calibration of prism spectrometer; Newton's rings; Polarimeter; Diffraction grating; Resolving power of telescope and grating; Ostwald viscometer; Planck's constant using photovoltaic cell; Photospectrometer; Photoelectric effect; Stefan's constant; Thermal diffusivity in metals.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
	UNIT I	
1-2	Electronic structure of atom, Wave particle Duality, Wavelength of De-broglie wave, Phase & group velocity	5
3-4	Schrodinger's wave equations- Time Dependent & Time independent	6
5	Particle in a box, Quantum mechanical tunneling,	6
6-8	I & II Law of Thermodynamics, Enthalpy, Entropy, Helmholtz free energy, Equilibrium thermodynamic, Near equilibrium thermodynamic,	8
9-10	Gibbs Free energy, Chemical potential, Thermodynamic analysis of membrane transport.	4

	UNIT-II	
11-13	Hydration of macromolecules, Role of friction, Diffusion, sedimentation, Ultracentrifuge	8
14-15	Viscosity, Rotational diffusion, Light scattering, Small angle X-ray scattering	6
16-18	Ultraviolet & Visible spectroscopy, Circular dichroism (CD) & Optical rotary dispersion (ORD),	8
19-20	Fluorescence spectroscopy, Infrared spectroscopy, Raman spectroscopy, NMR spectroscopy	8
21	Electron spin resonance, Light microscopy.	6
	UNIT-III	
22-23	Electron optics, Transmission electron Microscope (TEM), Scanning electron microscope (SEM)	8
24	Preparation of specimen for electron microscopy, Calibration of prism spectrometer, Newton's ring	6
25-26	Polari- meter, Diffraction grating, Resolving power o Telescope & Gratting	8
27-29	Ostwald's Viscometer, Plank's constant using Photovoltaic cell	8
30-32	Photo spectrometer, Photoelectric effect, Stefan's constant, Thermal Diffusivity in metals	5
	Total:	**100**

Practical Exercises

Exercise No.	Title
1-2	Refractive index and dispersive power of the prism using spectrometer
3-5	Calibration of prism spectrometer;
6-8	Calibration of Newton's rings, Polarimeter and Diffraction grating
9-10	Resolving power of telescope and grating;
11-12	Study of Ostwald viscometer; Planck's constant using photovoltaic cell
13	Study of Photospectrometer
14	Study of Photoelectric effect
15	Study of Stefan's constant
16	Study of Thermal diffusivity in metals

Text Books:

1. Chang R. 2005. Physical Chemistry for the Biosciences. University Science Books.
2. Glaser R. 2012. Biophysics: An Introduction. Springer.
3. Pattabhi V & Gautam N. 2002.Biophysics. Narosa Publishing House.
4. Cotterill R. 2002. Biophysics: An Introduction. John Wiley & Sons.
5. Srivastava PK. 2006. Elementary Biophysics: An Introduction. Narosa Publishing House.

Course No. : **NSS 244**   Course Title : **National Service Scheme IV**
Credits : 1 (**0+1**)   Semester : **IV**

Syllabus:

Youth and crime
Sociological and psychological factors influencing youth crime, cyber crime, pear mentoring in preventing crime and awareness for juvenile justice
Civil/self defence
Civil defence services, aims and objectives of civil defence; needs and training of self defence
Resource mobilisation
Writing a project proposal of self fund units (SFUs) and its establishment
Additional life skills
Positive thinking, self confidence and esteem, setting life goals and working to achieve them, management of stress including time management.

Practical Exercises

Exercise No.	Topic	Weightages (%)
1.	**Youth and crime** Sociological and psychological factors influencing youth crime,	7
2.	**Youth and crime** Cyber crime,	7
3.	**Youth and crime** Pear mentoring in preventing crime	6
4.	**Youth and crime** Awareness for juvenile justice	6
5.	**Civil/self defence** Civil defence services,	6
6.	**Civil/self defence** Aims of civil defence;	6
7.	**Civil/self defence** Objectives of civil defence;	6
8.	**Civil/self defence** Needs and training of self defence	6
9.	**Resource mobilisation** Writing a project proposal of self fund units (SFUs)	7
10.	**Resource mobilisation** Self fund units (SFUs) establishment	7
11.	Self fund units (SFUs) Work Management	6
12.	Self fund units (SFUs) Training Programme	6
13.	**Additional life skills** Positive thinking,	6
14.	Self confidence and esteem,	6
15.	Setting life goals and working to achieve them,	6
16.	Management of stress including time management.	6
Total		**100**

B.Tech. (Biotechnology)

Suggested Reading:

i) Khwaja Ghulam Saiyidain. 1961. National Service Scheme: A Report.. Published by Ministry of Education, Govt. of India.

ii) Kaikobad NF and Kapil KK. 1971. Training and consultancy needs in national service scheme, Published by Tata Institute of Social Sciences.

iii) National Service Scheme: guide-lines to project-masters. 1971. Andhra University, Dept. of Sociology & Social Work. Published by Dept. of Sociology & Social Work, Andhra University.

iv) National Service Scheme in Gujarat: An Evaluation Report for the Year 1986-87, by Tata Institute of Social Sciences Training Orientation & Research Centre (NSS), India, India. Dept. of Youth Affairs and Sports.Published by The Centre, 1987.

v) National Service Scheme in Maharashtra: An Evaluation Report for the Year 1986-87, by Tata Institute of Social Sciences Training Orientation & Research Centre (NSS), India, India Dept. of Youth Affairs and Sports. Published by The Centre, 1988.

vi) Dilshad MB. 2001. National Service Scheme in India: A Case Study of Karnataka.. Published by Trust Pub.

SEMESTER-V

B.Tech. (Biotechnology)

Course No   : **BIOCHEM-352**   Course Title   : **Enzymology& Enzyme Technologies**
Credit   : **3(2+1)**   Semester   **: V**

Theory

<u>UNIT I</u>

Classification and nomenclature of enzymes; General characteristics of enzymes, active site, cofactors, prosthetic groups; Metalloenzymes; Isolation, purification, characterization and assays of enzyme and international units; Criteria for purity.

<u>UNIT II</u>

Enzyme kinetics: effect of pH, temperature, determination of Km and Vmax; Regulation of enzyme activity; Enzyme inhibition: competitive, non-competitive and uncompetitive; Isoenzymes, schizomers and isoschizomers; Ribozymes;   Immobilization of enzymes; Applications of enzymes: biotechnology, industry, environment, agriculture, food and medicine.

Practical

Isolation, purification and assay of enzymes;Determination of optimum pH and optimum t;emperature of enzymes; Thermostability of enzymes; Activators and inhibitors of enzyme catalysis; Determination of kinetic parameters of enzymes; Immobilization of enzymes; Isoenzymes analysis.

Teaching Schedule-Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
1	History, importance and scope of enzymes	3
2	Enzyme nomenclature, common and systemic name of enzymes	4
3	Classification of enzymes	3
4-5	Enzyme structure, specificity and concept of active sites	6
6-7	Concept of free energy, transition state, activation energy in relation to enzyme catalysis	5
8-9	Concept of cofactors, prosthetic, Metalloenzymes; group, their structures and functions	10
10-11	Basic principles of enzyme isolation, purification and measurement of enzyme activities	10
12-13	Enzyme kinetics: Michaelis- Menten equation, Lineweaver – Burk plot, effect of pH, temperature, determination of Km and Vmax and its significance.	12
14-16	Regulation of enzyme activity : regulation of enzyme activity at protein level, compartmentalization of enzymes. Covalent modification, allosteric regulation	10
17-19	Enzyme inhibition: competitive, non-competitive, un-competitive and irreversible inhibitions.	10
20-22	Isoenzymes, schizomers and isoschizomers; Ribozymes	05
23-24	Enzymes Immobilization: immobilization process, Technique for immobilization	10
25	Application of immobilization.	

26-27	Enzymes in recombinant DNA technology:	6
28-30	Applications of enzymes: biotechnology, industry	2
31	Applications of enzymes : environment, agriculture	2
32	Applications of enzymes: food and medicine	2
	Total:	**100**

Practical Exercises

Exercise No.	Title
1-2	Isolation and estimation of amylase activity from germinating seeds
3	Determination of optimum temperature of amylase enzyme
4	Determination of optimum pH of amylase enzyme
5	Determination of V max of amylase enzyme
6	Determination of Km value for amylase enzyme
7-8	Isolation and estimation of polyphenol oxidase activity from plant tissues
9-10	Isolation and estimation of peroxidase activity from plant tissues
11-12	Isolation and estimation of alkaline phosphatase from sugar cane juce
13-14	Isolation and estimation of acid phosphatase from sugar cane juce
15-16	Isolation and estimation of P5CS activity from stressed sorghum seedlings

Text Books:

1   Bhatia SC, 1984, Biochemistry in Agricultural Sciences, Shree Publication House, New Delhi.
2   Purohit SS. 2009, Biochemistry - Fundamentals and Applications, Agrobios, Jodhpur
3   Singh M. 2011, A Textbook of Biochemistry, Dominant Publishers & Distributors, New Delhi
4   Veerkumari L. 2007, Biochemistry, MIP Publishers, Chennai
5   Jain JL, Jain S and Jain N. 2005. Fundamentals of Biochemistry. S. Chand & Company Ltd. New Delhi.
6   Rastogi SC. *2003* – Biochemistry, Tata McGraw-Hill Education, New Delhi.
7   Rama Rao AVSS*, 2002*   A Textbook of Biochemistry. Edition, 9, illustrated. Publisher, Sangam Books Limited, New Delhi.

Reference Books:

1   Com EE &Stumpf PK. 2010.Outlines of Biochemistry.5th Ed. John Wiley Publications.
2   Donald Voet and Judith G. Voet. 2011. Biochemisry, 4th Ed. John Wiley and Sons, Inc., NY, USA.
3   Goodwin, TW & Mercer EI. 1983. Introduction to Plant Biochemistry. 2nd Ed. Oxford, New York.Pergaman Press.
4   David L. Nelson and Michael M. Cox.2012. Lehninger Principles of Biochemisry, 6th Ed Macmillan Learning, NY, USA
5   Jeremy M. Berg, John L. Tymoczko, LubertStryer and Gregory J. Gatto, 2002.Biochemisry, 7th Ed. W.H. Freeman and Company, NY, USA

6   Jayaram. T. 1981. Laboratory manual in biochemistry, Wiley Estern Ltd. New Delhi:

7   Plummer D. 1988. An Introduction to Practical Biochemistry. 3rd ed. Tata McGraw Hill, New Delhi.

8   Practical biochemistry: R. L. Nath. A treatise on Analysis of Food, Fats and Oils: A. R. Sen, N.K. Pramanik and S.K. Roy

9   Sadasivam *S,* Manickam *A (1996)* Biochemical methods. 2nd edition, New Age International (p) Ltd. Publisher, New Delhi.

Course No   :**BT-3510**   Course Title   : **Immunology**

Credit   :**3(2+1)**   Semester   : **V**

Theory

UNIT I

History and scope of immunology; Components of immune system: organs, tissues and cells, Immunoglobulin structure and functions; Molecular organization of immunoglobulins and classes of antibodies; Antibody diversity; antigens, haptens, antigens antibody interactions; Immuno-regulation and tolerance.

UNIT II

Allergies and hypersensitive response; Immunodeficiency; Vaccines; Immunological techniques; Immunological application in plant science, monoclonal antibodies and their uses; Molecular diagnostics.

Practical

Preparation of buffers and reagents; Precipitation and agglutination test; HA, HI test; Immunoblotting, immunoelectrophoresis and fluorescent antibody test; Enzyme immunoassays including ELISA variants, western blotting; Raising of antisera in laboratory animals; Collection and preservation of antisera – separation, filtration and aliquoting.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
UNIT-I		
1	**History and scope of immunology:** Historical landmarks, Applications of immunology in medical and allied fields.	6
2-5	**Components of immune system: organs, tissues and cells,** Primary and secondary lymphoid organs T-cells B-cells NK cells, blood cells such as neutrophiles, basophiles, WBCs: structure and their role in immune response.	5
6	**Immunoglobulin structure and functions** Defination of immunoglobins ,immune sera ,structure of immunoglobulinH-chain L-chain kappa and Lambda chains, properties of immunoglobulin	8
7	**Classes of immunoglobins** Structure and function of IgG, IgA IgD IgE IgM Theories of antibody synthesis.	8
8-9	**Antibody diversity.** VDJ arrangement ,surface IgM,IgD expressing B cells Exposure to Antigen ,helper T cells	8
10-11	**Antigens, haptens,** : Defination of antigenes.Properties of antigens, functions of antigens .Classification of antigenes.concept of antigenecity.Defination of hapten	8

	antigenic specificity	
12-13	**Antigens antibody interactions;** Basis of antigen antibody reactions.,serological reactions precepitation test,immune electrophoresis, aggulutination test immune diffusion, RIA Haemagglutination	4
14-16	**Immuno-regulation and tolerance.** Balance between activator and suppressor T cells Mechanism of unresponsiveness, immunological ignorance, central tolerence of T cells and B cells, clonal deletion central and peripheral tolerence in B cells and T cells, Regulation of T cell homeostasis during immune responses	10
	UNIT II	
17-18	**Allergies and hypersensitive response** Defination and classification, IgE mediated Type I Hypersensitivity: Allergy, IgG and IgM mediated type II Hypersensitivity, Immune complex mediated Type III Hypersensitivity, Delayed type IV Hypersensitivity.	5
19	**Immunodeficiency** Primary and secondary immunodefeciency ,causes,types autoimmunity	7
20-22	**Vaccins :** Defination, Principles of vaccination, Antibody mediated protection, Cell mediated immunity, Active and passive immunization, antigenic preparation, Adjuvants .	8
22-23	**Immunological techniques;** ELISA, Flow cytometry, immune histochemistry	6
24-25	**Immunological application in plant science :** Radioimmunoassay for cytokinin determination ,immune detection of phytochrome .The Measurement of Low-Molecular-Weight, Non-Immunogenic Compounds by Immunoassay	5
28-29	**Monoclonal antibodies and their uses;** Definition, production of monoclonal antibodies,hybridoma technology, antibody heterogenecity	7
30-32	**Molecular diagnostics**: Defination, assays of molecular diagnostics, applications of molecular diagnostics .	5
	Total:	**100**

Practical Exercise

Exercise No.	Title
1-2	Preparation of buffers and reagents
3.	Study on Precipitation
4.	Study on Agglutination
5.	Study on HA Test
6.	Study on HI test
7-8	Immunoblotting
9.	Immunoelectrophoresis ;
10.	Fluorescent antibody test
11-12	Enzyme immunoassays including ELISA variants,
13-15	western blotting
16.	Raising of antisera in laboratory animals; Collection and preservation of antisera – separation, filtration and aliquoting.

Reference Books:

1. Murphy K. 2012. *Janeway's Immuno Biology*.8th Ed. Garland Science/ Taylor & Francis Group.
2. Owen JA, Punt J, Kuby J & Sharon A. 2013. *Kuby Immunology*. 7th Ed. W.H. Freeman
3. Cube Fundamentals of immunology. 7th edition. Freeman publication
4. Roitte. Essential immunology. 11th Edition, Willy Publication.
5. Thimmaiah. Practical Biochemistry.
6. Willam Paul, Fundamentals of Immunology, LWW Publication

Text Books:

1. Cube Fundamentals of immunology. 7th edition. Freeman publication
2. Roitte. Essential immunology. 11th Edition, Willy Publication.
3. Thimmaiah. Practical Biochemistry
4. Nandini Shetty, Introductory textbook of Immunology,New age publication.

Course No   : **BT-3511**   Course Title   : **Molecular Genetics**
Credit   : **2(2+0)**   Semester   : **V**

Theory

UNIT I

Structures, properties and modification of DNA; Molecular mechanisms of DNA replication, repair, mutation, and recombination; Centromere and telomere sequences and DNA packaging; Synthesis and processing of RNA and proteins; Regulation of gene expression; Mutations and DNA repair.

UNIT II

Repetitive DNA sequences and transposable elements; Promoters and their isolation; Transcription factors – their classification and role in gene expression; Epigenetic control of gene expression; Small RNAs, RNA interference and its applications.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
	UNIT-I	
1	**Structure of DNA:** Double Helical Structure of DNA (Watson and Crick Model), Different Structural Forms of DNA(A,B,Z and H)	8
2	Functions of DNAand Packaging of DNA,	2
3	**Properties of DNA:** Physical and chemical properties,Base Pairing, DNA Grooves, DNA Super coiling,	4
4	DNA Conformations, DNA Sense and Antisense.	1
5	**Modification of DNA:** DNA nicking, DNA end modification,	4
6-7	DNA repair, DNA methylation,	6
7	**Molecular mechanisms of DNA replication-** DNA polymerase, DNA ligase, Sliding clamp for DNA polymerase, Nuclease that removes RNA primers, DNA helicase, Primase.	4
8-9	**Repair**-Mismatch repair, excision repair, Base excision repair Error-Prone repair, Recombination-Repair System, Homologous recombination flawless repair	6
10	**Centromere and telomere sequences and DNA packaging:** Centromere and Telomere sequences-replication problem, G-rich repetitive sequences, DNA duplex loop formation, General structure of a telomere;	3
11	**DNA packaging**- Nucleosome, Model for packing of DNA in chromatin.	2
12-13	**Synthesis and processing of RNA and proteins:** Basic eukaryotic gene structure Exons, Introns, transcription,	5
14	Splicing pathway in GU–AG introns and translation.	5
15	**Regulation of gene expression:**	2

	General principles of gene regulation; Gene regulation in bacterial cells;	
16	Eukaryotic gene regulation- Chromatin structure and gene regulation,	2
17	Transcriptional control in eukaryotic cells,	2
18	Gene regulation through messenger RNA processing, RNA stability, RNA silencing, translational and post translational control..	4
19	**Mutations and DNA repair:** importance of mutation categories of mutations- somatic mutation, germ-line mutation, gene mutations, causes of mutation;	3
20	DNA repair- Mismatch repir, direct repair, base-excision repair, nucleotide-excision repair, other types of DNA repair	2
UNIT II		
21-22	**Repetitive DNA sequences and transposable elements:** **Repetitive DNA sequences:** Satellite DNAs, middle repetitive DNA sequences,Telomere, and Functions.	5
23	**Transposable elements:** Nature, structure and evolution of transposable element	5
24-25	Promoters and their isolation	5
26-27	**Transcription factors (TF)** –classification: functional and Structural TF eg. TFIIA, TFIID, TFIIB,TFIIF, TFIIE, TFIIH). Role of TF in gene expression.	5
28-29	Epigenetic control of gene expression:	5
30	**Small RNAs, RNA interference and its applications:Small RNAs:** siRNA, miRNA, PaciRNA- structure, mechanism and functions	5
31-32	**RNA interference and its applications:** Concept, Principle, Applications: Transient and Stable Gene Silencing, Temporal and Spatial Control of RNAi, RNAi in functional gene analysis, Insect, pest and disease resistance, weed resistance, drought tolerance, improvement of nutritional values and Limitations	5
Total:		**100**

Text Book:

1. Allison LA. 2011. Fundamental Molecular Biology. Wiley Global Education.
2. Brown TA. 1998. Genetics: A Molecular Approach. 3rd Ed. Stanley Thornes.
3. Lewin B. 2009. Genes 9. Jones & Bartlett Learning.
4. Tropp BE. 2014. Principles of Molecular Biology. Jones & Bartlett Learning.
5. Tropp BE. 2012. Molecular Biology Genes to Proteins.4th Ed. Jones & Bartlett Learning.

Reference Books:

1. Pierce BA. Genetics A Conceptual Approach, 6th Ed,.. W.H. Freeman and Company.
2. Gardner EJ, Simmons MJ, Snustad DP. 2006. Principles of Genetics. 8th Ed. John Wiley & Sons.

Course No : **BT-3512**   Course Title   : **Nanobiotechnology**
Credit   : **3(2+1)**   Semester   : **V**

Theory

UNIT I

Introduction to nanotechnology; Concepts and Terminology; Nano-Bio Interface; Biological based Nanosystems, molecular motors, biosensors and other devices.

UNIT II

Self assembly of molecules for nanotechnology applications; Biomimetics, Biotemplating and *de novo* designed nanostructures and materials; DNA-Nanotechnology; Nanomanipulations, material design, synthesis and their applications.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
UNIT I		
1	**Introduction to nanotechnology:** Milestones in Nanotechnology effect of length scale on properties.	1
2	overview of nanoscale material	1
3	top-down and bottom-up approach of nanoparticle synthesis	1
4	challenges and opportunities associated with nanoscale materials	
5	**Concepts and Terminology**: list of terms used in a field	**2**
6	**Nano-Bio Interface**: Introduction, colloidal forces as well as dynamic biophysicochemical interactions	**1**
7	Designing of nanobiointerface	2
8	Biocompatible or bioadverse outcomes and applications	2
9	**Biological based Nanosystems** : Introduction; Butterfly wings; Lotus effect;	**5**
10	**Molecular motors**: Introduction, ; Life is Motion; Cytoskeleton system,	5
11	Applications of molecular motor in Nanotechnology.	5
12	**Biosensors**: Definition, components, Principles of detection	4
13	Using Antibodies in Biosensors: Immunoassays, Cantilevers as Nano-Biosensors,	3
14	Micro- and Nanosensors and Applications of Optical Nanosensors.	3
15	**Other devices:** Types-i) solid state devices (CMOS, quantum)	2
16	ii) molecular devices (electrochemical, electromechanical, photoactive, quantum)	3
UNIT II		
17	**Self assembly of molecules for nanotechnology applications:** Introduction, mechanism of self assembly- i) Self Assembly by Molecular Interactions- intermolecular interaction, Hamaker interaction, and some examples of self assembly	5
18	ii) Externally Directed Self Assembly-electric and magnetic field,	

		flow field, microscopic viscous flow, large amplitude oscillatory shear (LAOS), combination of fields.	
19	**Biomimetics**: Biomimetic Design of Molecules, Some Key Principles of Biological Self-Assembly in nanotechnology	3
	Biomimetic Nanomaterials- nonotubes, nanofibers etc	3
20	**Biomimetic Nanoengineering-** Nano-engineering of Colloidal Particles, antigen presenting cells, Synthetic Biomimetic Blood Cells, etc.	4
21	Biotemplating-definition, mechanism, materials, advantages, limitations, future perspectives	5
22	*de novo* designed nanostructures and materials: De Novo-Designed α-Helix Coiled-Coil Nanofibers	5
23	**DNA-Nanotechnology**: Introduction; History, DNA nanostructure;	3
24	Capabilities, possibilities and limitation of DNA nanostructure;	3
25	DNA origami. Applications of DNA nanotechnology	4
26	**Nanomanipulations** : Introduction; Types-AFM, STM, In situ SEM, In situ TEM manipulation, Applications	5
27	**Material design**: Techniques	5
28	**Nanomaterial synthesis**: Physical method 1) mechanical-high energy ball milling, melt mixing 2) Vapour-physical vapour deposition, laser ablation, sputter deposition, electric arc deposition, ion implantation ,	4
29	Chemical method-collide, sol gel method	2
30	Biological method of nanomaterial synthesis-Green synthesis by microorganisms, fungi, plant extracts	2
31	Advantages and drawbacks of each method.	2
32	**Applications :** application of nanotechnology in Medical; Agriculture and food; in space, Defense and Engineering; Domestic appliances; in cosmetics; textiles; automobiles; energy	5
Total:		**100**

Text Books:

1. Hornyak GL, Moore JJ, Tibbals HF and Dutta J. 2008. Fundamentals of Nanotechnology. CRC Press.
2. Yubing Xie. 2012. The Nanobiotechnology Handbook. CRC Press.
3. Kulkarni SK. 2014. Nanotechnology: Principles and Practices. CP Publishing, New Delhi.
4. Murty BS, Shankar P, Raj B, Rath BB and Murday J. 2012. Textbook of Nanoscience and Nanotechnology. Springer.
5. Chattopadhyay KK and Banerjee AN. 2009. Introduction to Nanoscience and Nanotechnology. PHI Publication.
6. Goodshell DS. 2004. Bionanotechnology-Lessons from Nature. John Wiley Publications.

Reference Books:

1. Reisner DE. 2009. Bionanotechnology: Global Prospects. CRC Press.
2. De la Fuente JM and Grazu V. 2012. Nanobiotechnology: Inorganic nanoparticles *vs* Organic nanoparticles. Elsevier.
3. Poole Jr. CP and Owens FJ. 2003. Introduction to Nanotechnology. Wiley-Interscience; 1st ed.
4. Trivedi PC. 2008. Nanobiotechnology. Pointer Publishers.
5. Ramsden J. 2009. Essentials of Nanotechnology. Ventus Publishing APS.
6. Alarcon E. , Griffith M. and Udekwu KI. (Eds.) 2015. Silver Nanoparticles Applications:In the Fabrication and Design of Medical and Biosensing Devices. Springer.
7. Baglioni P., Chelazzi D. and Giorgi R. 2015. Nanotechnologies in the Conservation of Cultural Heritage: A compendium of materials and techniques. Springer.

B.Tech. (Biotechnology)

Course No : **BT-3513**   Course Title : **Animal Biotechnology**
Credit : **4(3+1)**   Semester : **V**
Theory

UNIT-I

History and development of animal biotechnology; Basic techniques in animal cell culture: Introduction to embryo biotechnology: oocyte collection and maturation; Sperm preparation; in vitro fertilization; Cryopreservation of oocyte, sperm and embryos; Embryo transfer technology.

UNIT II

Breeds of livestock and their characteristics; Marker assisted breeding of livestock; Introduction to animal genomics: RFLP, RAPD, SSRs, QTL, SNP, STR, Mitochondrial DNA polymorphism; Rumen and its environment: Rumen microbes- manipulation of rumen microbes for better utilization of feed; Introduction to nutrigenomics; Milk biome; Manipulation of lactation by biotechnological tools; Application of biotechnology in meat and meat products.

UNIT III

Genome and protein based diagnostics of important animal diseases: FMD, brucellosis, PPR, Mastitis, Blue tongue, Newcastle disease; Introduction to vaccinology: live attenuated vaccines, killed vaccines, cell culture based vaccines, recombinant vaccines.

Practical

Basic cell culture techniques; oocyte aspiration from ovaries; sperm preparation; In vitro fertilization; PCR based detection of animal pathogens; PCR-RFLP; Immunohistochemical localization of protein marker in tissues/cells – meat species identification by PCREDIT

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
	UNIT-I	
1-2	**History and development of animal biotechnology:** Introduction to Animal Biotechnology- Def., Contribution of various Scientist, Steps/Mile stones in development of Animal Biotechnology.	4
3	**Basic techniques in animal cell culture:** Dissociation/ Disaggregation Tech., Primary and secondary cell culture. Cell line and their types.	8
4-6	**Introduction to embryo biotechnology:** **Oocyte collection and maturation:** Collection methods and *in vitro* culture and maintenance of Oocyte.	5
7-9	**Sperm preparation:** Collection of sperms, Evaluation, Scaling up and preservation.	4
10	***In vitro* fertilization:** Causes of infertility, Fusion of sperms and *In vitro* culture Oocyte, Zygote and Embryo growth and development.	4
11	**Cryopreservation of Oocyte, sperm and embryos:** Preparation, Methods of freezing, Storage, Thawing and recultured.	4

12-14	**Embryo transfer technology**: Artificial insemination, Freezing techniques.	4
15	Selection of Donor and recipients, Super ovulation.	2
16	Estrous synchronization, Applications of ETT.	2
	UNIT-II	
17-18	**Breeds of livestock and their characteristics**: Classification, Indian and exotic breeds of Cattle, Buffalo, Sheep, Goat and Poultry Bird.	5
19	Their origin and distribution.	3
20	Distinguishing characteristics and their production.	2
21	**Marker assisted breeding of livestock**: Marker assisted selection, Advantages-limitations, Applications in Animal Breeding.	3
22	**Introduction to animal genomics**: Def., Gene isolation, Sequencing.	3
23	Applications of molecular markers such as RFLP, RAPD, SSRs.	3
24	QTL, SNP, STR.	2
25	Mitochondrial DNA polymorphism.	2
26	**Rumen and its environment**: Rumen micro flora, Rumen microbes- role of rumen microbes in digestion.	2
27	Genetic manipulation of rumen microbes for better utilization of feed.	3
28	**Introduction to nutrigenomics:** Concept Nutragenomics,Role of nutrition on gene expression and applications of nutragenomics.	3
29	**Milk biome**: Terminology, Types of microbes present in milk.	4
30	Bacterial load during different lactation stages.	2
31	Manipulation of lactation by biotechnological tools.	3
32	**Application of biotechnology in meat and meat product**: Growth factors related genes.	3
33	Transgenic animals for the meat production.	3
	UNIT-III	
34	**Genome and protein based diagnostics of important animal diseases** : FMD, Brucellosis.	3
35	PPR, Mastitis,Blue tongue.	
36	Newcastle disease: Etiology.	6
37-41	Symptoms, pathogenesis, Diagnosis and treatment for each disease.	
42-43	**Introduction to vaccinology**: History, Development of vaccines, Types of vaccines, Live attenuated vaccines.	3
44-45	Killed vaccines, Cell culture based vaccines.	2
46-48	Recombinant vaccines.	3
Total:		**100**

Practical Exercise

Exercise No.	Title
1	Study of laboratory requirements.
2-3	Design and layout of laboratory of animal biotechnology.
4	Study of laboratory rules and regulations.
5	Media requirements, preparation and sterilization.
6-7	Study of basic cell culture techniques; Isolation, dissociation and suspension culture.
8	Study of oocyte aspiration from ovaries.
9	Study of oocyte culture
10	Study of sperm preparation
11	Study of *in vitro* fertilization
12	Study of embryo culture
13-14	Detection of animal pathogens by using PCR based technique (RFLP)
15-16	Immuno histochemical localization of protein marker in tissues/cells – meat species identification by PCREDIT

Text Books:

1. Aberle ED, Forrest JC, Gerrard DE & Mills EW. 2012. Principles of Meat Science. 5th Ed. Kendall Hunt Publishing.
2. Lawrie RA & Ledward D. 2006. Lawrie's Meat Science. 7th Ed. Woodhead Publishing.
3. Sukumar De. 1997. Outlines of Dairy Technology. Oxford University Press-New Delhi.
4. Varnam A & Jane P. 1994. Milk and Milk Products: Technology, Chemistry and Microbiology. Sutherland Springer Science & Business Media.

Reference Books:

5. Sharma BD. 1999. Meat and Meat Products Technology: Including Poultry Products Technology. Jaypee Bros. Medical Publishers.

Course No   : **BT-3514**   Course Title   : **Molecular Marker Technology**
Credit   : **2(2+0)**   Semester   : **V**

Theory

UNIT I

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.

UNIT II

Application of molecular markers: Assessing genetic diversity, variety protection; Marker-assisted breeding for accelerated introgression of trait/transgene and quantitative traits; Human and animal health: Association with genetic-based diseases, Paternity determinations; Forensic studies.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
1	**Types of molecular markers-** Morphological markers, Biochemical Markers and Genetic markers.	4
2-3	Dominant and co-dominant nature of markers with their specific applications.	4
4-7	Study of different markers systems with their limitations and strengths viz. RFLP; PCR based markers like RAPD,SCAR, SSR, STS, CAPS, AFLP, SNP and their variants.	14
8-10	**Uses of molecular markers**: Applications of molecular markers in various fields with special reference to crop improvement, Application as a genetic tool for genotyping and gene mapping.	10
11-12	**Mapping populations**: Different types of mapping populations viz. F_2, DH, RILs, NILs.	4
13	Methods of development and segregation pattern in each type of population. Merits and demerits of each population.	4
14	Evaluation criteria for each type of population. Application of mapping population in molecular marker studies	2
15-16	**Bulked segregant analysis:** Analysis technique used for Bulked segregant analysis. Applications of Bulked segregant analysis.	10
17-18	**Linkage maps; Physical maps:** Construction of linkage map and physical map. Application of Linkage maps and Physical maps	10
19-20	**Application of molecular markers:** Assessing genetic diversity, variety protection.	08
21-22	**Application of molecular markers:** Marker-assisted breeding for accelerated introgression of trait/transgene	5

23-24	Marker-assisted breeding for quantitative traits	5
25-26	**Application of molecular markers:** **Human and animal health: Association with genetic-based diseases:**	04
27	Genetic variations in the human genome,	
28	Genetic testing for genetic-based diseases	
29-30	**Application of molecular markers:** Paternity determinations: Determinations of paternity by molecular genetic "fingerprinting".Advantages of DNA fingerprints for determination of correct paternity, for gentic linkage and pedigree studies.	08
31	**Application of molecular markers:** **Forensic studies:** Applications, implications	08
32	**Limitations of Molecular forensics.**	
	Total:	**100**

Text Books:

1. Huges S. & Moody A. 2007. PCR: Methods Express. Royal College of General Practitioners.
2. Chawla HS. 2002. Introduction to Plant Biotechnology. Science Pub. Inc.

Reference Books:

1. Singh BD, Biotechnology Expanding Horizon 3rd ed. Kalyani Publication.
2. Gupta PK. 1997. Elements of Biotechnology. Rastogi Publ.

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Course No   : **BT-3515**   Course title   : **Genomics and Proteomics**
Credits   : **3(3+0)**   Semester   : **V**

Theory

UNIT I

Introduction to Genomics, Functional Genomics and Proteomics; Structural genomics: Classical ways of genome analysis, BAC and YAC libraries; Physical mapping of genomes; Next generation sequencing; Genome analysis and gene annotation; Genome Projects: *E. coli*, Arabidopsis, Bovine, Human; Comparative Genomics: Orthologous and Paralogous sequences, Synteny, Gene Order, Phylogenetic footprinting.

UNIT II

Functional genomics: Differential gene expression techniques: ESTs, cDNA-AFLP, microarray, Differential display, SAGE, RNAseq, Real time PCREDIT

UNIT III

Introduction to proteomics; Analysis of proteome: Native PAGE, SDS PAGE, 2D PAGE; Edmann Degradation; Chromatographic techniques: HPLC, GC, Mass Spectrometry: MALDI-TOF, LC-MS; Post Translational modifications.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
	UNIT I	
1-2	Introduction to Genome and Genomics, terminology involved and History	2
3-6	Central dogma: Structure of genomics i.e.Functional Genomics, Structural genomics and Comparative Genomics	3
7-9	Techniques in genome analysis- DNA microarray, Nanopore technology, High -throughput sequencing, Southern hybridization, Expressed sequence tag, DNA sequencing	5
10-11	cDNA library construction and development of BAC and YAC libraries, PCR Amplifications	3
12	Gene sequencing, Principles and types of sequencing (Next generation sequencing in detail)	4
13-14	Genome mapping and different methods of mapping, Physical mapping of genomes and different techniques involved in physical mapping	4
15	Genesequence analysis and annotation by using annotation models	4
16	Case study: Genome Projects: *E. coli*	3
17	Case studies: Genome Projects: Arabidopsis, Bovine	3
18	Case study: Genome Projects: Human genome project	4
19	Brief about Comparative Genomics and techniques involved in it and Synteny	2
20	Orthologous and Paralogous sequences	2
21	Gene Order, Phylogenetic footprinting.	2
	UNIT II	

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22	Introduction to Functional genomics	2
23	Analogy for gene expression and involved techniques	3
24	Principles and procedure of ESTs, cDNA-AFLP	4
25	Principle and types of microarray and its application in functional genomics	4
26-27	Functional analysis of genome by Differential display techniques like SAGE, RNAseq, Real time PCREDIT	5
28-29	Principal, procedure and applications of SAGE RNAseq, Real time PCREDIT	3
30	Principal, procedure and applications of Real time PCREDIT	2
UNIT III		
31-32	Introduction to proteome and proteomics terminology and history, Protein synthesis i.e translation	2
33-34	Protein isolation techniques i.e Chromatographic techniques: HPLC, GC	3
35	Protein Purification techniques from crude extract	2
36-37	Protein separation by Native PAGE, SDS PAGE, 2D PAGE and its Principles and procedure	4
38	Protein staining techniques i.e Silver staining ,Coomassie blue staining, Sypro Ruby staining	2
39	Techniques of protein digestion i.e Edmann Degradation and peptide purification	2
40-41	Protein analysis by Mass Spectrometry: MALDI-TOF, LC-MS, Electrospray ionization (ESI)	4
42	Principles and procedure of MALDI-TOF	3
43	Peptide fingerprint analysis	
44	Mass Spectrometric Identification of Proteins - Mapping	3
45	Protein identification: Peptide mass fingerprint, Tandem Mass Spectrometry (MS/MS)	4
46-47	Types Post Translational modifications: Methylation of cytidine residues in the DNA, The modifications of the histones and of CpG methylation	3
48	Application of genomics and proteomics in crop development	4
	Total	**100**

Text Book:
1. Hunt S. & Livesy F. 2000. Functional Genomics: A Practical Approach. Series, 235. Oxford Univ. Press.
2. Gupta PK. 1997. Elements of Biotechnology. Rastogi Publ.
3. Lewin B. 2008. Genes IX. John Wiley & Sons.
4. Lodish H, Berk A & Zipursky SL. 2004. Molecular Cell Biology. 5th Ed. WH Freeman & Co.

Reference Books:
1. Nelson DL & Cox MM. 2005. Lehninger's Principles of Biochemistry. WH Freeman & Co.
2. Russell PJ. 1996. Essential Genetics. Blackwell Scientific Publ.
3. Schleif R.1986. Genetics and Molecular Biology. Addison-Wesley Publ.
4. Chopra VL & Nasim A. 1990. Genetic Engineering and Biotechnology: Concepts, Methodsand Applications. Oxford & IBH.

Course No   : **BT-3516**   Course Title   : **IPR, Biosafety and Bioethics**
Credits   : **2(2+0)**   Semester   : **V**
Theory

UNIT I

Introduction to Intellectual Property, concepts and types; International treaties for protection of IP's; Indian Legislations for the protection of various types of Intellectual Property; Patent search, filing process; Material transfer agreements.

 UNIT II

Biodiversity definition, importance and geographical causes for diversity; Species and population biodiversity, maintenance of ecological biodiversity hot spots in India; Convention on biological diversity; Cartagena Protocol of bio-safety, and risk management for GMO's; Bio-safety guidelines, rules and regulations and regulatory frame work for GMOs in India.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
UNIT-I		
1	Introduction to Intellectual property,	4
2	Definition, History of IPs in India, Nature and Scope	
3	Why IPR, How and Where to apply for IPR	2
4-5	Types of IPR, Copyright, Trademark, Patent, Plant Breeders Right	4
6-7	International Treaties for Protection of IPs; TRIPs, India and TRIPs, Roles	6
8-10	Indian legislations for the protection of various types of Intellectual property; Indian Copyright Act-1957, IPR Organization and Laws, Patents Act-1970	10
11	Patent Search, Sec.2(1) (j) of the patents Act-1970	2
12	Filing Process; Drafting, Application for grant of patent, IDF, IPEC	4
13-15	Material transfer agreement; Light of TRIPs agreement, Impact of TRIPs on Developing countries, FDI, Pharmaceutical Industry and TRIPs, Biopiracy, Terminator Crops	8
UNIT-II		
16-18	Biodiversity Definitions; Norse and Mc Manus (1980), Reid and Miller (1989), ICPB-1992, Factors responsible for Biodiversity, levels of Biodiversity, Types of Diversity, Importance of Diversity, Conservation of Biodiversity	10
19-21	Species Biodiversity; status of survey,endemic species, cultivated plants/Agrobiodiversity, Populationbiodiversity;Development pressure	5
22-23	Maintenance of ecological biodiversity hot spots in India; Legal instruments relevant to biological diversity in India, Endangered species Act, Federal role in wild life preservation	8
24	Convention on Biological diversity; FAO and NBA	4
25-26	Cartagena protocol of Biosafety; Definition, objectives, LMOs,	10

	Pracautionary approach, main features, applications	
27	Risk management of GMOs	5
28-30	Biosafety guidelines in India; EPA-1986, DBT, MOEF, IBC, RCGM, GEAC, Rules and Regulations of Biosafety	10
31-32	Regulatory framework for GMOs in India; GEAC, SBCC, DLC, RDAC, IBSC, RCGM	8
	Total:	**100**

Text Books:

1. Singh BD. 2007. Biotechnology: Expanding Horizon. Kalyani Publishers
2. Kumar U. and Asija M. 2009. Biodiversity: Principles and Conservation. Agrobios (India).
3. Mu Ramkumar 2008. Intellectual Property Rights Demynstified. New India Publishing Agency.

Websites
1. http;//patentoffice.nic.in
2. www.wipo.org
3. www.dbtindia.nic.in
4. www.dbtbiosafety.nic.in

Course No   : **ICT-352**   Course Title   : **Agricultural Informatics**
Credits   : **3(2+1)**   Semester   : **V**

Theory

UNIT I

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, components and creation of web; HTML & XML coding.

UNIT II

Computer programming, concepts; Documentation and programme maintenance; Debugging programmes; Introduction to Visual Basic, Java, Fortran, C/ C++, etc.; Standard input/output operations; Variables and constants; Operators and expressions; Flow of control; Inbuilt and user defined functions; Programming techniques for agriculture.

UNIT III

e-Agriculture, concepts, design and development; Application of innovative ways to use information and communication technologies (IT) in agriculture; ICT for data collection; Formation of development programmes, monitoring and evaluation; Computer models in agriculture: statistical, weather analysis and crop simulation models - concepts, structure, input-output files, limitations, advantages and application for understanding plant processes, sensitivity, verification, calibration and validation; IT application 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, concepts, techniques, components and uses for generating valuable agri-information; Decision support systems, taxonomy, components, framework, classification and applications in agriculture; Agriculture Information/Expert System; Soil Information Systems, etc. for supporting farm decisions; Preparation of contingent crop-planning and crop calendars using IT tools.

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 Power point for creating, editing and presenting a scientific document; Handling of tabular data; Animation, video tools, art tool, graphics, template and designs; MS-EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data, handling macros; MS-ACCESS: Creating database, preparing queries and reports, demonstration of agri-information system; Introduction to World Wide Web (WWW) and its components, creation of scientific website, presentation and management agricultural information through web; Introduction of programming languages - Visual Basic, Java, Fortran, C, C++, and their components; Hands-on practice on writing small programmes; Hands-on practice on Crop Simulation Models (CSM); DSSAT/Crop-Info/CropSyst/ Wofost; Preparation of input 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; Demonstration of generating information important for agriculture; Hands on practice on preparation of Decision Support System.

Teaching Schedule- Theory with Weightage (%)

Lecture No.	Topic	Weightage (%)
1	Introduction to computers.	3
2	Anatomy of computers.	3
3	Memory concepts, units of memory.	6
4	Database, concepts and types, creating database.	5
5	Uses of DBMS in Agriculture.	10
6 -7	Concepts, components and creation of web.	5
8- 9	HTML & XML coding.	6
10-11	Computer programming, concepts;	5
12-13	Documentation and programme maintenance; Debugging programmers'.	5
14-16	Introduction to Visual Basic, Java, Fortran, C/ C++ Comparative study	12
17-18	Standard input/output operations.	6
19-20	Variables and constants; Operators and expressions with Examples	5
21-22	e-Agriculture, concepts, design and development; Application of innovative ways to use information and communication technologies (IT) in agriculture;	6
23	ICT for data collection; Formation of development programmes, monitoring and evaluation	3
24 -26	Computer models in agriculture: statistical, weather analysis and crop simulation models - concepts, structure, input-output files, limitations, advantages and application for understanding plant processes, sensitivity, verification, calibration and validation;	5
27-28	IT application 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;	6
29-30	Geospatial technology, concepts, techniques, components and uses for generating valuable agri-information; Decision support systems, taxonomy, components, framework, classification and applications in agriculture;	5
31-32	Agriculture Information/Expert System; Soil Information Systems, etc. for supporting farm decisions; Preparation of contingent crop-planning and crop calendars using IT tools.	4
Total:		**100**

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Practical Exercise

Exercise No.	Title
1	Study of computer components, accessories.;
2	Practice of important DOS commands
3- 4	Introduction of different operating systems such as windows, Unix, Linux; Creating files and folders; File management
5- 6	Creating a spreadsheet,
7 -8	Use of statistical tools, writing expressions, creating graphs, analysis of scientific data, handling macros
9 -10	Creating database, preparing queries and reports, demonstration of agri-information system
11	Introduction to World Wide Web (WWW) and its components, creation of scientific website, presentation and management agricultural information through web
12	Introduction of programming languages - Visual Basic, Java, Fortran, C, C++, and their components; Hands-on practice on writing small programmes
13-14	Hands-on practice on Crop Simulation Models (CSM); DSSAT/Crop-Info/CropSyst/ Wofost; Preparation of input file for CSM and study of model outputs; Computation of water and nutrient requirements of crop using CSM and IT tools;
15	Use of smart phones and other devices in agro-advisory and dissemination of market information
16	Demonstration of generating information important for agriculture; Hands on practice on preparation of Decision Support System

Text Books:

1. Singh G, Singh R & Saluja KK. 2003. Fundamentals of Computer Programming and Information Technology. Kalyani Publishers.
2. Bal HP. 2003. Perl Programming for Bioinformatics.Tata McGraw-Hill Education.
3. Kumar A. 2015. Computer Basics with Office Automation. IK International Publishing House Pvt Ltd.
4. Maidasani D. 2016. Learning Computer Fundamentals, MS Office and Internet & Web Technology. 3rd Ed. Laxmi Publications.

Course No   : **ET-351**   Course Title   : **Educational Tour**

Credits   : **1(0+1)**   Semester   : **III**

Syllabus:

Educational Tour for Maharashtra State

Identified Institutes/Universities for Maharashtra state educational tour.

1. National Chemical Laboratory (NCL), Pune
2. ICAR-National Research Centre for Grape, (NRC-Grape) Manjri, Pune
3. Vasantdada Sugar Institute (VSI), Manjri, Pune.
4. College of Agriculture, Pune.
5. ICAR- National Institute of Abiotic Stress Management, Baramati, Pune
6. Institute of Chemical Technology, Mumbai
7. Bhabha Atomic Research Centre (BARC), Trombay, Mumbai
8. Central Institute of Fisharies Education(CIFE), Andheri West
9. University of Mumbai, Mumbai
10. National Institute of Oceanography, Goa.
11. Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri
12. National Centre for Cell Science (NCCS), Pune.
13. ICAR- National Research Centre for Pomegranate (NRC-Pomegranate), Solapur

Study Tour Evaluation

Sr. No	Particulars	Marks
1.	Inquisitiveness	10
2.	Report	15
3.	Presentation	10
4.	Assignment (Leadership role, group activities during Educational Tour etc.)	10
5.	Viva	05
Total		**50**

B.Tech. (Biotechnology)

SEMESTER-VI

Course   : **BT-3617**   Course Title : **Computational Biology**
Credits   : **3(2+1)**   Semester   : **VI**

Theory

UNIT I

Introduction to computational biology; Web based servers and software for genome analysis: Ensembl, UCSC genome browser, MUMMER, BLASTZ; Sequence submission.

UNIT II

Protein interaction databases: BIND, DIP, GRID, STRING, PRIDE; Principles of Protein structure prediction; Fold Recognition (threading); Homology modeling; SCOP, CATH, PDB, PROSITE, PFAM; Methods for comparison of 3D structures of proteins.

UNIT III

Phylogenetic analysis: Evolutionary models, tree construction methods, statistical evaluation of tree methods; PHYLIP, dendroscope, MEGA; DNA barcoding database- BOLD.

Practical

Application of Genome browsers in genomic research; Exploring protein-protein interaction databases; Working with protein structural classification databases; SNP and SSR identification tools; PHYLIP.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
1	**Introduction to computational biology :** Definition and application	06
2-4	**Web based servers and software for genome analysis:** Genome Analysis an overview : approaches and methods of genome analysis, Web based servers for genome analysis : OBRC: Online Bioinformatics Resources Collection, Web based software for genome analysis : DNA Sequence Quality – Phred, EGassember, Tools at server genometools.org	08
5-6	**Ensembl**: Processing your data, Accessing Ensembl data, BLAST/BLAT, BIoMART. **UCSC genome browser** : analysis tools at server	08
7-9	**MUMMER** : Analysis genome data using this tool, components and its applications **BLASTZ;** Use of BLASTZ for analysis of genome sequences, methods and output validation. **Sequence submission** : Submission of data through BankIT and Sequin tools	06
10-12	**Protein interaction databases:** Introduction and overview of protein interaction. **BIND :** To query, view and submit records, Functional Alignment	08

	Search Tool(FAST) **DIP :** Structure of The Database, State of The Database, The JDIP Visualization Tool, **STRING**: Search Protein sequences, by protein name, search protein multiple sequences. **PRIDE**: Submit data and browse the data in PRIDE.	
13-15	**Principles of Protein structure prediction:** Primary, secondary and tertiary structure prediction, online tools for the protein structure prediction at EXPASY server	07
16-17	**Fold Recognition (threading) :** Introduction, definition, methods and software for the threading and its applications	08
18-19	**Homology modeling** : Methods and tools for homology modeling for nucleotide and protein data	08
20-23	**SCOP, CATH, PDB, PROSITE, PFAM**: Introduction to these databases, how to retrieve information from these database and pattern searching from the database.	08
24-25	**Methods for comparison of 3D structures of proteins** : Sequence-dependent vs. sequence-independent methods, Superimposition-based vs. superimposition-independent methods, Distance-based measures of protein structure similarity : Root Mean Square Deviation (RMSD)	05
26-27	**Phylogenetic analysis:** Importance, different Methods of phylogenetic analyses and their application with biological data.	06
28-29	**Evolutionary models**:Models for DNA and protein evaluation, Continuous-time Markov chains. Deriving the dynamics of substitution.Ergodicity, Time reversibility. Scaling of branch lengths, JC69 model (Jukes and Cantor, 1969), K80 model (Kimura, 1980), F81 model (Felsenstein 1981). **Tree construction methods, Statistical evaluation of tree methods**	08
30-31	**PHYLIP, dendroscope, MEGA**: introduction and its use to biological data analysis.	08
32	**DNA barcoding database-BOLD :** How to access the database and identify the species	06
	Total:	**100**

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Practical Exercises

Exercise No.	Title
1	To study the Ensembl genome browser database and their applications to understand the genome structure and functions
2	To study the PlantGDB database and their applications to understand the genome structure and functions
3	To study the Genome database and their applications to understand the genome structure and functions
4	Study of protein-protein interaction databases : String
5	Study of protein-protein interaction databases from Expasy server
6	Study of protein interaction databases : Bio GRID
7	Study of protein structural database: Access secondary protein database
8	Pattern searching using secondary databases
9	Protein family searching using secondary databases.
10	Study of SNP and SSR identification tools using genome and EST Databases
11	Multiple sequence alignment for DNA and protein sequences
12	Phylogenetic analysis of DNA sequences using PHYLIP package
13	Phylogenetic analysis of protein sequence Data using in PHYLIP package
14	Phylogenetic analysis using morphological data
15	Visualization of phylogenetic analysis results using MEGA and Tree viewer
16	Designing primers using primer 3 software

Text Books:

1. Mount D. 2001. Bioinformatics: Sequence and Genome Analysis, 2nd Ed. Cold Spring Harbor Laboratory Press.
2. Campbell MA & Heyer LJ. 2007. Discovering Genomics, Proteomics and Bioinformatics. 2nd Ed. Benjamin Cummings.

Reference books:

1. Creighton TE. 1993. Proteins: Structures and Molecular Properties. 2nd Edition. WH Freeman.
2. Stekel D. 2003. Microarray Bioinformatics. 1st Ed. Cambridge University Press.
3. Joao S & Joao M. 2004. Introduction to Computational Molecular Biology. PWS Publishing Company.

Course No   : **STAT-362**   Course Title   : **Biostatistics**
Credits   : **3(2+1)**   Semester   : **VI**

Theory

Unit I

Random variables: expected value and its variance; probability distribution of random variables; Conditional probability; Baye's theorem and its applications; Introduction to Uniform, Binomial, Poisson, Normal, Exponential and Gamma probability distributions.

Unit II

Random mating populations, Hardy-Weinberg Law; Introduction to Poisson process and Markov chains: Transition probability matrix, n-step transition probabilities, steady state. Random walk models; Sensitivity and specificity.

Unit III

Chi-square test: testing heterogeneity, use in genetic experiment, detection of linkage, linkage ratios and its estimation; Analysis of variance: One-way and two-way classification with interaction; Analysis of covariance; Incomplete block designs; Estimation and significance of genotypic and phenotypic variation.

Practical

Expected value and variance of discrete and continuous distributions; Uniform, Binomial, Poisson, Normal, Exponential and Gamma Probability distributions; Hardy-Weinberg Law; Construction of transition probability matrix in Markov Chains; Calculation of sensitivity and specificity; Detection and linkage using Chi-square test; One-way and two-way analysis of variance; Analysis of covariance; Incomplete block designs; Testing of heritability.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
1-2	Certain impossible and random events, random variable expected value and its variance.	5
3-5	Probability distribution of random variable, Conditional probability and its most elementary basic formulae, Baye's theorem and its applications.	5
6-7	Computationofposterior Probability,discrete Uniform distribution, concept, properties and its applications.	5
8-9	Bernouli trials, the law of large numbers, Definition of Binomial and Poisson distributions their properties and applications.	6
10-11	Fitting of Binomial and Poisson distribution.	5
12-13	Definition of Normal distribution, Standard Normal Distribution and its properties, numerical problems on Normal distribution.	5
14-15	Definition of Exponential and Gamma probability distributions. and its properties.	6
16-17	**Genetical statistics**: Random mating populations, Sex linked characters, selection, Hardy-Weinberg Law.	6

18-19	Introduction to Poisson process.	5
20-21	**Markov chain:** Definition, Transition probability matrix, steady states, transient chains, periodic chains.	6
22-23	Random walk models, Sensitivity and specificity.	6
24	Chi-square test: testing heterogeneity and homogeneity.	5
25-26	Detection and estimation of linkage, linkage ratios and its estimation, use in genetic experiment.	6
27-28	Estimation of component of variation due to interaction between G x E (genotypic x environment) and its significance.	7
29	**Analysis of variance**: One-way analysis.	6
30	Two-way classification.	6
31	Analysis of covariance with one auxiliary character.	6
32	Concept of incomplete block designs.	4
Total:		**100**

Practical Exercises

Exercise No.	Title
1	**Probability distribution:** Problems on Expected value and variance of discrete and continuous distributions.
2	Problems of discreteUniform distribution, Finding of Mean and Variance.
3	Fitting of Binomialdistribution.
4	Fitting of Poisson distribution.
5	Problems ofNormaldistribution.
6	Problems ofExponential distributionand Finding of Mean and Variance.
7	Problems on Gamma Probability distributions and Finding of Mean and Variance.
8	**Genetical statistics**: Computations based on Hardy-Weinberg Law.
9-10	Construction of transition probability matrix in Markov Chains.
11-12	Calculation of sensitivity and specificity, Detection and linkage using Chi-square test.
13	**Analysis of variance**: One-way analysis of variance.
14	Two-way analysis of variance.
15	Analysis of covariance with one auxiliarycharacter.
16	Testing of heritability.

Text Books

1. Narayan P, Bhatia VK & Malhotra PK. 1989. Handbook of Statistical Genetics. Indian Agricultural Statistics Research Institute, New Delhi, India.
2. Rangaswami R. 2009. A Text book of Agricultural Statistics. New Age International (P) Limited, Hyderabad.
3. Nageshwar Rao G. 2007. Statistics for Agricultural Sciences. New Delhi : BS Publications

Reference Books

1. Panse VG and Sukhatme PV. 1985. Statistical methods for Agricultural workers. Indian Council of Agricultural Research New Delhi.
2. Gupta SC and Kapoor VK. 1971. Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi.
3. Snedecor GW & Cochran WG. 1989. Statistical Methods. Iowa State University Press.
4. Biswal PC. 2009. Probability and Statistics. PHI Learning Pvt. Ltd.
5. Kaps M & Lamberson W. 2007. Biostatistics for Animal Science. CABI Publishing.
6. Pal N & Sarkar S. 2009. Statistics–Concepts and Applications. 2nd Ed. PHI Learning Pvt. Ltd.
7. Das MN and Giri NC. 1986. Design and Analysis of Experiments. Wiley Eastern Ltd., New Delhi.
8. Gomez KA and Gomez AA. 1984. Statistical Procedures for Agricultural Research. John Wiley and Sons. New York.
9. Gupta SC. 2016. Fundamentals of Statistics. Himalaya Publishing House, Mumbai, , Maharashtra, India.
10. Kapoor VK. 2007. Fundamentals of Applied Statistics.. Sultan Chand and Sons, New Delhi.

B.Tech. (Biotechnology)

Course : **PBTEL-361**   Course Title : **Plant Tissue Culture and its Applications**
Credits : **3(2+1)**   Semester : **VI**

Theory

UNIT I

Historical benchmarks of plant cell and tissue culture; Culture media components and modifications; Sterilization techniques; Various types of culture: callus, suspension, nurse, root, meristem; *In vitro* differentiation: Organogenesis and somatic embryogenesis; Plant growth regulators: mode of action, effects on *in vitro* culture and regeneration.

UNIT II

Applications: Micropropagation; Anther and microspore culture; Somaclonal variation; *In vitro* mutagenesis; Production of secondary metabolites; Synthetic seeds; *In vitro* fertilization; Embryo rescue in wide hybridization; Endosperm culture; Protoplast isolation, culture and regeneration; Somatic hybridization: cybrids, asymmetric hybrids; *In vitro* germplasm conservation.

Practical

Establishment of callus/ cell suspension cultures; Induction of plant regeneration; Micropropagation – Explant establishment, shoot multiplication, root induction, Hardening and transfer to soil; Monitoring of growth and differentiation of cells, Seed/Embryo culture; Ovary culture, Anther /pollen culture, Suspension cultures and production of secondary metabolites.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
	UNIT-I	
1	**Historical benchmarks of plant cell and tissue culture:** History of Plant tissue culture, Introduction, Scope and Importance, Applications of Plant tissue culture	4
2	**Culture media components and modifications:** Different constituents of media (Inorganic nutrients, Carbon and energy sources, Organic supplements, Growth regulators, Solidifying agents, pH of medium and their roles; MS basal medium and different types of medium	4
3	**Sterilization techniques:** Types of sterilization, Importance of sterilization	4
4-7	**Various types of culture:** callus, suspension, nurse, root, meristem: concept, principal, types, methodology and applications.	12
8-10	***In vitro* differentiation:** Organogenesis and somatic embryogenesis: Concept, Principle, types, methods and importance and applications.	10
11-12	**Plant growth regulators:** Auxins and Cytokinins their mode of action, effects on *in vitro* culture and regeneration	8
	UNIT-II	

13-14	**Applications: Micropropagation; Anther and microspore culture;**	8
15	**Somaclonal variation:** Concept, Principle, Methods	2
16	Factors affecting and causes of Somaclonal variation	2
17	Importance and applications of Somaclonal variation along with examples.	2
18-19	*In vitro* **mutagenesis:** Concept, type of mutagen, methods of *in vitro* mutagenesis, their confirmation, merit, demerits and applications.	6
20-21	**Production of secondary metabolites:** Concept, types, methods and applications.	4
22-23	**Synthetic seeds:** Concept, Principle, Method, factors affecting, Importance & Applications	4
24-25	*In vitro* **fertilization; Embryo rescue in wide hybridization:** Principle, methods with merits & demerits, Importance & Applications	6
26-27	**Endosperm culture:** Concept, principle, method, importance and applications	4
28-29	**Protoplast isolation, culture and regeneration:** concept, Principle, Methods of protoplast isolation, culture methods, culture conditions, Importance and Applications	4
30	**Somatic hybridization:** concept, methods of somatic hybridization, selection of hybrid cell and regeneration, merits, demerits and Applications.	6
31	**Cybrid and asymmetric hybrid-** concept, methodology and importance	4
32	*In vitro* **germplasm conservation:** cryopreservation, methods, limitations and applications	6
	Total:	**100**

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Practical Exercises

Exercise No.	Title
1	Establishment of callus/ cell suspension cultures
2	Induction of plant regeneration
3-5	Micropropagation – Explant establishment, shoot multiplication, root induction
6-7	Study of hardening and aftercare of tissue cultured plantlets
8-9	Monitoring of growth and differentiation of cells
10-11	Seed/Embryo culture
12	Ovary culture
13	Study of Anther culture
14	Study of pollen culture
15	Suspension cultures.
16	Production of secondary metabolites

Suggested Readings:

Text Books:

1. Bhojwani SS & Razdan MK. 1996. Plant Tissue Culture: Theory and Practice. Elsevier.
2. Debergh PC & Zimmerman RH. 1991. Micropropagation: Technology and Application. Kluwer Academic.
3. Chawla HS.2002.: Introduction to Plant Biotechnology. Science Pub. Inc.
4. De KK. 2013. Plant Tissue Culture. New Central Book Agency (P) Ltd.

Reference Books:

1. Dixon RA & Gonzales RA. 2003. Plant Cell Culture: A Practical Approach. Oxford University press.
2. George EF, Hall MA & Klerk GJD. 2007. Plant Propagation by Tissue Culture. 3rd Ed. Volume 1. Springer Science & Business Media

Theroy

UNIT I

Gene transfer methods: Direct and Indirect; Marker free transformation; *In planta*transformation; Vectors for plant transformation, molecular characterization of transgenic   plants using PCR, real time PCR, Southern, Northern and western analysis; Bioassays   with transgenic plants; Evaluation and selection of transgenic events for target trait.

UNIT II

Genetic engineering of crop plants for useful traits: Over expression, inducible, tissue specific and gene silencing systems; Biosafety concerns and regulatory mechanisms; Commercialization of transgenic products, GMO's, transgenic plants for the production of biopharmaceuticals; Molecular farming of plants for applications in medicine systems, heterologous protein production in transgenic plants; Successful case studies.

Practical

Gene isolation and gene cloning; Gene constructs and their maintenance; *Agrobacterium* mediated genetic transformation; Particle gun mediated genetic transformation. Histochemical GUS assays; PCR screening of putative transgenic plants; Raising transgenic under containment and field conditions.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
	UNIT-I	
1-2	**Gene transfer methods**: Direct and Indirect methods: principle, methodology, merits, demerits,.	9
3	Factors influencing, applications of gene transfermethods	3
4-6	**Marker free transformation:** Concept, Need, Strategies for Marker free transformation, Merits demerits and achievement's with suitable examples	6
7	*In planta* **transformation:** Concept, Types, methodology, merits, demerits, applications and future prospects	4
7-8	**Vectors for plant transformation:** Physical map, features and suitability of vector; Plasmids,binary vector,	4
9	Cosmid,	2
10	Virus vectors, Bacteriophage	2
11-14	**Molecular characterization of transgenic plants using PCR, real time PCR, Southern, Northern and Western analysis:** concepts, Methods of transgenic plant detection and characterization, Zygosity test, Copy number detection, and gene expression analysis.	10
15-16	**Bioassays with transgenic plants:** Methods and importance and prospects.	8
17-20	**Evaluation and selection of transgenic events for target trait:**	8

	Concept of event, detection methods, characterization and evaluation of event characterization and evaluation of event	
	UNIT II	
21-22	**Genetic engineering of crop plants for useful traits**: Concept, importance, Methods, merits, demerits and applications **Over expression**	4
23-24	**Over expression, Inducible expression, tissue specific expression**	8
25-26	**Gene silencing systems:** Concept, Methods, merits, demerits and applications	6
27-28-	**Biosafety concerns and regulatory mechanisms:** Guidelines, biosafety framework,regulatory process and approval mechanism	10
29-30	**Commercialization of transgenic products, GMO's, transgenic plants for the production of biopharmaceuticals:** Concept, Methods, harvesting, packaging, labeling and marketing with examples, applications and limitations	6
31-32	**Molecular farming of plants for applications in medicine systems, heterologous protein production in transgenic plants; Successful case studies:** Concept, types and Methods of molecular farming, merits, demerits, applications with successful case studies	10
Total:		**100**

Practical Exercises

Exercise No.	Title
1-2	Isolation of gene
3-4	Cloning of gene
5	Development of gene constructs
6-8	*Agrobacterium* mediated genetic transformation
9-10	Particle gun method of genetic transformation
11	Histochemical GUS assays
12-13	PCR screening of putative transgenic plants
14-16	Procedure for rising transgenic under containment & confined field trials.

Text Book:

1. Singh B.D. (2015). Biotechnology Expanding Horizon, Kalyani Publication
2. Chawla HS. 2002. Introduction to Plant Biotechnology. Science Pub. Inc.
3. Stewart NC Jr. 2008. Plant Biotechnology and Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc.

Reference Books:

1. Green MR & Sambrook J. 2014. Molecular Cloning: A Laboratory Manual. 4th Ed. Vol I, II & III. Cold Spring Harbor Laboratory Press.
2. Grierson D. 2012. Plant Genetic Engineering. Springer Netherlands.
3. Primose SB & Twyman RM. 2006. Principles of Gene Manipulation and Genomics, 7th Ed. Blackwell Publishing.
4. Sambrook J. and Russel D. 2001. Molecular Cloning: A Laboratory Manual. 3rd Ed Cold Spring Harbor Laboratory Press.

Course No   : **PBTEL-363** Course Title   : **Applications of Genomics and Proteomics**
Credits   : **3(2+1)**   Semester   : **VI**

Theory

UNIT I

Structure of genomes: *Arabidopsis*, rice, tomato, pigeon pea, wheat; DNA chips and their use in transcriptome analysis; Mutants and RNAi in functional genomics; Site directed mutagenesis; Transposon tagging; Transient gene expression: VIGS and FACS based, targeted genome editing technologies.

UNIT II

Bio-informatics in proteomics: Protein 3D structure modelling (Homology modelling and crystallography); Proteome analysis; Protein- protein interaction: FRET, yeast two hybrid and co-immunoprecipitation. Applications of genomics and proteomics in agriculture, human health and industry.Metabolomics and ionomics for elucidating metabolic pathways.

Practical

SDS_PAGE; 2D Electrophoresis; Protein characterization through HPLC; Specialized crop based genomic resourses: TAIR, Gramene, Graingenes, Maizedb, Phytozome, Cerealdb, Citrusdb; miRbase.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
	UNIT I	
1	Introduction to genomics and proteomics, terminology, History	2
2	Genomics of *Arabidopsis*	3
3	Genomics of rice,	3
4	Genomics of tomato,	3
5	Genomics of pigeon pea,	3
6	Genomics of wheat;	3
7	Introduction to Transcriptomics and techniques involved in its analysis	2
8	Principles, methods, types, procedure and application of DNA chips/Miicroarray in transcript analysis	4
9	forward and reverse genetic approaches	3
10	Types of mutation, types of mutagen, mutant and its application in functional genomics	3
11	Principal and mechanism of RNAi in functional genomics	3
12-13	Applications of RNAi Technology in crop improvement	4
14	Principle and application of Site directed mutagenesis with its mechanism	6
15	Transposon tagging its principle, procedure and mechanism and application in functional genomics	3
16	Transient gene expression by VIGS and FACS Principle, procedure and application of VIGS in genomics	4

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17	Principle, procedure and application of VIGS in genomics FACS	2
18	Introduction , components and applications of targeted genome editing technologies: CRISPR, TALLENS etc	4
UNIT II		
19	Proteomics study in relation to bioinformatics and different components of proteomics	2
20	Proteome analysis by MALDI-TOF	3
21	Proteome expasy tools study to analysis the protein	3
22	Structural analysis of protein	3
23	Protein 3D structure modeling by different modules and its procedure:Homology modelling and crystallography	4
24	Study of protein-protein interaction and techniques involved in the interactive study of protein	4
25	Principal, analysis, mechanism of FRET and its application in proteomics	3
26	yeast two hybrid system for analysis of protein-protein interaction at molecular level	4
27	Principal, mechanism and application of co-immunoprecipition in proteomics	4
28	Success case study on application of genomics and proteomics in health and industry	3
29	Introduction to Metabolomics and ionics and techniques involved in metabolite analysis	3
30	Procedure, steps, components involved in metabolite analysis	3
31	Principal and Application of Nuclear Magnetic Resonance Spectroscopy (NMR), Mass Spectrometry (MS) in metabolite analysis	3
32	Application of genomics and proteomics in crop improvement	3
Total:		**100**

Practical Exercises

Exercise No.	Title
1	Principal and procedure of SDS PAGE
2-3	Principal and procedure of 2D Electrophoresis
4-5	Protein analysis and characterization through HPLC
6	Specialized crop based genomic resources: databases and analysis of genomics and proteomics of a crops, Introduction to NCBI
7-8	TAIR, PDB, PIR,EMBL,DDBJ
9-10	Analysis using Gramene database
11	Analysis using Graingenes database
12	Analysis using Maizedb database
13	Analysis using Phytozome database
14	Analysis using Cerealdb database
15	Analysis using Citrusdb database
16	Analysis using miRbase database

Text Books:
1. Singh BD. 2005. Biotechnology, Expanding Horizons. Kalyani.
2. Gupta PK. 2013. Biotechnology and Genomics. Rastogi Publications, Meerut
3. Chahal GS & Ghosal SS. 2002. Principles and Procedures of Plant Breeding - Biotechnological and Conventional Approaches. Narosa Publ.

Reference Books:
1. Chopra VL. 1997. Plant Breeding. Oxford & IBH.
2. FAO 2001. Speciality Rices of the World - Breeding, Production and Marketing. Oxford & IBH.
3. Ghosh P. 2004. Fibre Science and Technology. Tata McGraw Hill.
4. Hay RK. 2006. Physiology of Crop Yield. 2nd Ed. Blackwell.
5. Nigam J. 1996. Genetic Improvement of Oilseed Crops. Oxford & IBH.
6. Singh RK, Singh UK & Khush GS. 2000. Aromatic Rices. Oxford & IBH.
7. Brown TA. 2002. Genomes. Wiley-LISS.
8. Hackett PB, Fuchs JA & Messing JW. 1988. An Introduction toRecombinant DNA Technology - Basic Experiments in Gene Manipulation. 2nd Ed. BenjaminPubl. Co.
9. Sambrook J & Russel D. 2001. Molecular Cloning- a Laboratory Manual. 3rd Ed. Cold Spring Harbor Lab. Press.

Course No   : **PBTEL-364**   Course Title   :**Molecular Breeding in Field Crops**
Credits   : 3(**2+1**)   Semester   : **VI**

Theory

UNIT I

Principles of plant breeding; Breeding methods for self and cross pollinated crops; Heterosis breeding; Limitations of conventional breeding; Development of specific mapping populations.

UNIT II

QTL mapping using structured populations; Fine mapping of genes/QTL; Map based gene/QTL isolation and development of gene based markers.

UNIT III

Marker assisted selection (MAS): Foreground and background selection; MAS for majorand minor genes, Marker assisted pyramiding, Marker assisted recurrent selection; Transgenic breeding; MAS for specific traits with examples; Commercial applications of MAS.

Practical

Working on some genotyping and phenotyping datasets for Linkage mapping using softwares such as Mapmaker, MapDisto and QTL mapping softwares such as WinQTL cartographer; Use of gene based and closely linked markers for foreground selection for target traits in target crops; Marker assisted detection of the transgene.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
	UNIT I	
1	**Principles of plant breeding:** Definition, introduction,Principles of plant breeding	3
2	Stages of plant breeding programme	2
3-4	**Breeding methods for self and cross pollinated crops:** different methods of breeding in self and cross pollinated crops along with examples, advantages and limitations	10
5-6	**Heterosis breeding:** introduction, definition, hybrid vigour, concept of heterosis, steps involved	5
7	**Limitations of conventional breeding:** limitations of conventional plant breeding, advantages of molecular plant breeding	5
8	**Development of specific mapping populations:** different types of mapping populations, advantages and limitations	5
	UNIT II	
9	**QTL mapping using structured populations:** introduction to QTL mapping, qualitative and quantitative traits	3

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10	Different types of molecular markers	4
11	Pre-requisites for QTL mapping, mapping populations,	2
12	Linkage mapping,	3
13	Different methods of QTL mapping,	2
14	Factors affecting QTL mapping	1
15	**Fine mapping of genes/QTL:** scope, pre-requisites for fine mapping,	6
16-17	Steps involved in fine mapping, applications	4
18	**Map based gene/QTL isolation and development of gene based markers:** steps involved,	3
19	Gene-targeted markers,	3
20	Functional markers, applications of map based cloning	4
UNIT III		
21	**Marker assisted selection (MAS):** Foreground and background selection, ,	4
22-23	MAS for major and minor genes, advantages of MAS	4
24	Stages of MAS	2
25	**Transgenic breeding:** steps involved, applications, examples	5
26-27	**Marker assisted pyramiding:** steps involved, advantages	5
28	**Marker assisted recurrent selection:** steps involved, application of MARS	5
29-30	**MAS for specific traits with examples:** MAS for disease resistance breeding in major crops, rust resistance in wheat	5
31-32	**Commercial applications of MAS:** MAS for bacterial blight resistance and sub-mergence tolerance in rice	5
Total:		**100**

Practical Exercises

Exercise No.	Title
1	Working on some genotyping and phenotyping datasets for Linkage mapping using softwares such as Mapmaker, MapDisto
2	Introduction to different databases: GrainGenes
3	Introduction to different databases: Gramene
4	Data retrieval from databases
5	Introduction to different software used for linkage mapping: Mapmaker
6	Working with MapDisto
7	QTL mapping softwares such as WinQTL cartographer
8	Introduction to WinQTL Cartographer
9	Single marker analysis
10	Simple interval mapping
11	Composite interval mapping
12	Multiple interval mapping
13	Comparison between different methods of QTL mapping
14	Use of gene based and closely linked markers for foreground selection for target traits in target crops: Case study
15-16	Marker assisted detection of the transgene

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Text Books:

1. Nagat T, Lorz H &Widholm JM. 2008. Biotechnology in Agriculture and Forestry. Springer.
2. Trivedi PC. 2000. Plant Biotechnology: Recent Advances. Panima Publishers.
3. Newbury HJ. 2003. Plant Molecular Breeding. Blackwell Publ.
4. XuYunbi 2010. Molecular Plant Breeding, CABI International
5. Singh BD & Singh AK. 2016. Marker-assisted Plant Breeding: Principles and Practices. Springer

Reference Books:

1. Gupta PK. 2013. Biotechnology and Genomics. Rastogi Publications, Meerut

Course No   : **PBTEL-365**   Course Title   : **Molecular Breeding of Horticultural**
Credits   : **3(2+1)**   **Crops and Forest Trees**
Semester   : **VI**

Theory

UNIT I

Reproductive biology of major fruit and forest crops; Basic methods of fruit crop
   improvement; Target traits in major fruit crops; Limitations of fruit crop breeding;
Breeding methods of self and cross pollinated vegetable crops; Breeding of commercial
flower crops.

UNIT II

Molecular markers for germplasm characterization and genetic diversity analysis; Pseudo
test cross mapping strategy in fruit crops; Molecular mapping in vegetable crops; Marker
assisted breeding in horticultural crops and forest plants; Micropropagation for variety
dissemination; Mutation breeding and characterization of mutants; Genomic resources for
marker development; Transgenic approaches with tree crops and utility.

Practical

Modifications in DNA extraction methods for horticultural and forest crops; Agarose gel
electrophoresis, and DNA quantification; Map maker; Diversity analysis using UPGMA;
Identifying repeat sequences using MISA; Standard Gene cloning methods including
construct making with the use of Restriction enzymes; DNA ligases and standard
molecular approaches.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
	UNIT I	
1-2	**Reproductive biology of major fruit and forest crops:** introduction, major fruit and forest crops, sexual system, flower types	5
3-4	Distribution of flower types among species, asexual as well as sexual reproductive systems	5
5-6	**Basic methods of fruit crop improvement:** introduction, stages of plant breeding programme	5
7-8	**Target traits in major fruit crops:** major fruits crops (Orange, grapes, pomegranate, mango, banana, papaya, etc), traits of importance in these crops (quality parameters)	5
9	**Limitations of fruit crop breeding:** limitations of conventional breeding, advantages of molecular breeding	5
10	**Breeding methods of self pollinated vegetable crops:** different methods along with examples, advantages and limitations	6
11-12	**Breeding methods of cross pollinated vegetable crops:** different methods, along with examples, advantages and limitations	4
13	**Breeding of commercial flower crops:** introduction, selection, domestication, polyploid for varietal development, Role of heterosis, Production of hybrids,	6
14	Male sterility, incompatibility problems, seed production of flower	4

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	crops, constraints and achievements made in commercial flowers	
	UNIT II	
15-16	**Molecular markers for germplasm characterization and genetic diversity analysis:** different types of molecular markers,	7
17	Scope and applications of molecular markers, genetic diversity	3
18-19	**Pseudo test cross mapping strategy in fruit crops:** introduction, importance, analysis of data, utility in tree species, examples	5
20	**Molecular mapping in vegetable crops:** introduction to linkage mapping, mapping populations	7
21	QTL analysis: Introduction, methodology	3
22	**Marker assisted breeding in horticultural crops and forest plants:** introduction to MAS, steps involved,	3
23	Association mapping: Introduction, advantages and limitations	4
24	Case studies in horticultural crops and forest plants, advantages of MAS	3
25	**Micropropagation for variety dissemination:** introduction, stages of micropropagation	5
26	Different methods of micropropagation	
27	**Mutation breeding and characterization of mutants:** introduction, different types of mutagens,	5
28	Scope and application of mutation breeding in horticulture and forest trees	
29	**Genomic resources for marker development**: introduction to DNA sequencing, ESTs,	5
30	Development of markers from data available in the databases	
31	**Transgenic approaches with tree crops and utility:** introduction, scope, importance,	5
32	Methods of transgenic development, examples in horticultural crops	
	Total:	**100**

Practical Exercises

Exercise No.	Title
1	Modifications in DNA extraction methods for horticultural and forest crops: Introduction to various instruments used and their working principle, laboratory safety guidelines
2	Preparation of stock solutions and buffers
3	Genomic DNA isolation using CTAB method
4	Agarose gel electrophoresis, and DNA quantification: Preparation of agarose gels, electrophoresis
5	Qualitative and quantitative analysis of DNA
6	PCR amplification using markers (RAPD/ISSR/SSR)
7	Mapmaker: Introduction to MapMaker, preparation of input files
8	Preparation of linkage map using MAPMAKER
9	Diversity analysis using UPGMA: scoring of marker data, preparation of input files
10	Different software for preparation of dendrogram, cluster analysis

11	Identifying repeat sequences using MISA: introduction to MISA, Identification of repeat sequences
12	Standard Gene cloning methods including construct making with the use of Restriction enzymes: Different Restriction enzymes
13	Digestion of plasmid DNA with different REs and visualization of bands on gel by electrophoresis
14	Vectors, different methods of cloning
15	DNA ligases and standard molecular approaches: Types of ligases
16	Application of DNA ligases in molecular biology research, mechanism

Text Books:

1. Bal JS. 2013. Fruit Growing. Kalyani Publishers.
2. Kumar N. 2006. Breeding of Horticultural crops: Principles and Practices. New India Publishing Agency.
3. Chada KL. 2012. Handbook of Horticulture. ICAR.
4. Kumar J. Prasad. 2010. Handbook of Fruit Production. Agrobios.
5. Schnell RJ & Priyadarshan PM. 2012. Genomics of Tree Crops. Springer
6. Singh Jitender. 2014. Basic Horticulture. Kalyani Publishers.
7. Singh Ranjit. 2012. Fruits. National Book Trust.
8. Spangenberg G. 2001. Molecular Breeding of Forage Crops. Kluwer Academic Publishers.
9. XuYunbi 2010. Molecular Plant Breeding, CABI International
10. Singh BD &Singh AK. 2016. Marker-assisted Plant Breeding: Principles and Practices. Springer

Reference Books:

1. Gardner VR, Braford FC &Hooker HD Jr. 1992. Fundamentals of Fruit Production. McGraw-Hill Book Company, Inc.
2. Brown TA. 1998. Genetics: A Molecular Approach. 3rd Ed. Stanley Thornes
3. Singer M & Berg P. 1991. Genes & Genome, University Science Books
4. Winnacker EL. 2003. From Genes to Clones: Introduction to Gene Technology. 4th Ed., Panima Publishers.
5. Sambrook J.F. and Russell DW, ed., Molecular Cloning: A Laboratory Manual, 3rd Ed., Vols. 1, 2 and 3 Cold Spring Harbor Laboratory Press.
6. Gupta PK. 2013. Biotechnology and Genomics. Rastogi Publications, Meerut.

Course   : **PBTEL-366**   Course Title   : **Epigenetics and Gene Regulation**
Credits   : **3(2+1)**   Semester   : **VI**

Theory

UNIT I

DNA methylation and histone modifications: DNA methylases, methyl binding proteins and histone modifiers; Epigenetic changes in response to external stimuli leading to changes in gene regulation; Role of DNA methylation in plant development: mutant case studies.

UNIT II

Introduction to small RNAs: History, biogenesis; *Insilico* predictions, target gene identification, methylation of heterochromatin by het associated siRNAs; Gene regulation by small RNA other classes of siRNAs; Role in epigenetics; Jacob Monod model; RNA editing, Genome imprinting.

Practical

In silico study of structural components of histone modifiers and DNA methylases of model plants; *In silico* prediction of siRNAs and miRNAs; Small RNAs electrophoresis using PAGE; Blotting of small RNAs on nylon membrane; miRNA target finding; Detection of small RNAs using fluorescent labelled probes; Bisulphite sequencing for methylation; qRT-PCR for quantitative analysis of small RNAs in developmental phases.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage (%)
	UNIT I	
1	Introduction to epigenetics and factors contributing to it	2
2	Epigenetics Mechanisms: interaction between DNA methylation, Histone modifications and RNA interference and there interaction with effect on gene expression	5
3	DNA, Chromatin, Histone protein	3
4	Chromatin remodeling and DNA methylation	4
5	Histone and there modifications in relation to DNA methylation	2
6	Histone acetylation and methylation and its impact on transcription activation	3
7	Reasons for DNA methylation and important enzymes participating in it; DNA methylases	4
8	Mechanism of DNA Methylation	4
9	Natural Roles of DNA Methylation in Mammalian System	3
10	Histone Phosphorylation and its modifiers	4
11	Role of DNA methylation in plant development	4
12	Transcription factors and its role in epigenetics	3
13	Epigenetic changes in response to external stimuli leading to changes in gene regulation	3
14	epigenetic processes: paramutation, bookmarking, imprinting, gene silencing, X chromosome inactivation, position effect,	4

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	reprogramming, transvection,etc.	
15	mutant case studies	3
UNIT II		
16	Introduction to all RNA and there role in gene regulation and importance of small RNAs in gene expression	2
17	History and biogenesis of small RNAs	2
18	Principle, methods and mechanism of gene prediction	3
19	Types of gene prediction and Principle and applications of *In silico* predictions	4
20	Identification of targeted gene by different genomic approaches eg. Chip technology	3
21	Heterochromatin and euchromation methylation	2
22	CpG sites	2
23	Heterochromatin methylation systems: het associated siRNAs	3
24	Gene regulation by small RNA and Other classes of siRNAs; features and characteristic and mode of action in gene regulation	4
25	Prokaryotic gene arrangement	2
26	Bacterial gene regulation: Operon model-Jacob Monod model its components and functions in gene regulation	3
27	RNA editing: editing by deletion, addition and deamination process and its mechanism	4
28	Types of RNA editing: C to U, Ato I,Alternative mRNA editing	4
29	RNA editing in eukaryotic system	3
30	RNA editing in Prokaryotic system	2
31	Genome imprinting, introduction, mechanism and imprinted gene	4
32	Role of epigenetics in crop improvements	2
Total:		**100**

Practical Exercises

Exercise No.	Title
1	*In silico* study of model pant with its structural components of histone modifiers
2	Development procedure for SiRNA
3	Development procedure for miRNA
4	*In silico* prediction of siRNAs and miRNAs and there mechanisum
5	Isolation of Small RNAs form sample
6	separation of Small RNAs by electrophoresis using PAGE
7	Principle and applications of Northern Blotting
8	miRNA targeting mechanism
9	Methods of RNA labeling
10	Procedure for development of probes
11	Detection of small RNAs using fluorescent labeled probes
12	Principles of sequencing Methods and types
13	Principal and procedure of Bisulphite sequencing method
14	Types of PCR and their use in epigenetics
15	Principal and procedure of qRT-PCR for quantitative analysis of small RNAs in developmental phases
16	Principal and procedure of Genome imprinting.

Text Books:

1. Brown TA. 1998. Genetics: A Molecular Approach. 3rd Ed. Stanley Thornes.
2. Lewin B. 2009. Genes 9. Jones & Bartlett Learning.
3. Karp G. 2004. Cell and Molecular Biology: Concepts and Experiments. John Wiley.
4. Klug WS & Cummings MR 2003. Concepts of Genetics. Scot, Foreman & Co.

Reference Books:

1. Tropp BE. 2012. Molecular Biology Genes to Proteins.4th Ed. Jones & Bartlett Learning.
2. Benjamin A Pierce. Genetics A conceptual Approach, 2nd edition. WH Freeman and Company.
3. Green MR & Sambrook J. 2014. Molecular Cloning: A Laboratory Manual. 4th Ed. Vol I, II & III Cold Spring Harbor Laboratory Press.
4. Mohanpuria P, Kumar V, Mahajan M, Mohammad H & Yadav SK. 2010. Gene Silencing: Theory, Techniques and Applications: Genetics-Research and Issues. Nova Science Publishers.
5. Lewin B, 2004. Genes VIII. Pearson Prentice Hall
6. Bruce A. 2004. Essential Cell Biology. Garland

Course No : **ABTEL-361** Course Title : **Principles and procedures of animal cell culture**
Credit : **3(2+1)** Semester : **VI**

Theory

UNIT I

History, importance and development of animal cell culture techniques; Basic requirements for animal cell culture; Sterilization procedures for cell culture work; Different types of cell culture media, growth supplements, serum free media and other cell culture reagents.

UNIT II

Different cell culture techniques including primary and secondary cultures; continuous cell lines, suspension culture, organ culture etc; Commonly used animal cell lines: CHO, HeLa, BHK-21, VERO, Sf9, C636; Their origin and characteristic, growth kinetics of cells in culture, differentiation of cells; Characterization and maintenance of cell lines; Applications of animal cell cultures.

UNIT III

Cryopreservation and revival of cells; Hybridoma technology; Scaling up methods; bioreactors; Overview of insect cell culture; Stem cell culture and its application; Common cell culture contaminants and their management.

Practical

Basic equipments used in animal cell culture laboratories; Washing, packing and sterilization of glass and plastic wares for cell culture; Preparation of media and reagents for cell culture; Primary culture technique of chicken embryo fibroblast; Culture and sub-culturing of continuous cell lines; Viability assay by trypan blue dye exclusion method; Isolation and cultivation of lymphocytes; Cryopreservation of primary cultures and cell lines; Cytopathic effect of viruses on cultured mammalian cells.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightages (%)
	UNIT – I	
1	**History and importance of animal cell culture**	2
2	**Development of animal cellculture techniques:** Primary cell culture, Secondary cell cultures,	2
3	Cell Line and Monolayer cultures	2
4	Suspension cultures. Immobilized Cultures	2
5	Culture of Primary Chick Embryo Fibroblasts (CEF): Formulations of Media and Solutions, Transfer of Cell Cultures, Preservation of Cultured Cells by Freezing	2
6	**Basic requirements for animal cell culture**: Choice of materials: Cell type, Source of tissue, Subculture,	5
7	Selection of medium, Gas phase, Culture system, Substrate,	3

	Medium, Cell culture	
8	**Sterilization procedures for cell culture work**: **Sterilization of apparatus-** Glasswares, Filter assembly **Sterilization of reagents and media-** Water, BSS, Serum, media	3
9	**Different types of cell culture media:** Introduction, Serum media, Serum free media	4
10	Complete media, Synthetic media	2
11	**Other cell culture reagents and growth supplements:** Amino acid, Hydrolysates, Embryo extracts, Conditioning medium, Antibiotics and Antimycotics.	3
UNIT – II		
12	**Different cell culture techniques including primary and secondary cultures:** **Primary culture:** Disaggregation of cells	4
13	Initiation of primary cell culture, Explant culture	3
14	Subculture of cells and secondary culture, cell lines Cell counting- viable count	3
15	Continuous cell lines, suspension culture,	3
16	Organ culture etc.	3
17	Commonly used animal cell lines: CHO, HeLa, BHK-21, VERO, Sf9, C636; their origin and characteristic	3
18	**Growth kinetics of cells in culture-** monolayer and suspension culture, Cell proliferation	3
19	**Differentiation of cells:** Expression of the *in-vivo* phenotype, stages,	3
20	Cell lineage, cell strain, Markers of differentiation, Induction of differentiation	3
21	**Characterization and maintenance of cell lines:** Need, parameters, Cell morphology, Microscopy and Chromosome content	3
22	DNA analysis, RNA and protein expression, antigenic markers	3
23	**Applications of animal cell cultures:** **Basic application-** Intracellular activity, Intracellular flux, Genomics, Proteomics, Cell-cell interaction etc.	3
24	**Appliedapplication-** Cell products, Immunology, Pharmacology, Tissue engineering, Toxicology etc.	3
UNIT III		
25	**Cryopreservation and revival of cells:** Need and consideration for freezing, Principles	4
26	Methodology for cryopreservation. Vitrification and cell banks	4
27	**Hybridoma technology:** Historical background and methodology of hybridomas	3
28	**Scaling up methods:** Scaling up in suspension, Scaling up in monolayer	2

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	Bioreactors:	
29	Controlled bioreactor- Stirred, Airlift, Hollo-fibre, Packed-bed, Fixed bed, Fluidized-bed reactor Large scale bioreactor Wave bioreactor	8
30	**Overview of insect cell culture:** Cell growth- Characteristics and media development, Small scale culture, Cell line development and its application	3
31	**Stem cell culture and its application:** Derivation, Subculture Propagation of mouse and human embryonic stem cell Passaging hES cells.	3
32	**Common cell culture contaminants and their management:** Sources and types of microbial contamination Monitoring of contamination,Disposal of contaminated culture,Eradiation of contamination,Cross contamination	3
	Total	**100**

Practical Exercises

Exercise No.	Title
1	Study of basic equipments used in animal cell culture laboratories
2	Preparation of washing, packing and sterilization of glass and plastic wares for cell culture
3	Preparation of media and filtration for cell culture
4	Preparation of chicken embryo fibroblast
5	Subculture of cell culture
6	Isolation and preparation of lymphocyte culture
7	Viability assay by trypan blue dye exclusion method
8	Preparation of inoculum for virus isolation
9	Virus inoculation: Cell culture
10	Cryopreservation of cells
11	Cytopathic effect staining
12	Preparation of buffers and reagents for cell culture
13	Extraction of RNA by Trizol method
14	Extraction of DNA by Chelax method
15	Quantitation of nucleic acid
16	Disease diagnosis by RT-PCR

Text Books:

Freshney RI. 2011. Culture of Animal Cells: A manual of basic technique and specialized applications. 6th Ed. John Wiley & Sons.

Reference Books:

Butler M. 2003. Animal Cell Culture & Technology. Garland Science.

Course No   : **ABTEL-362**   Course Title   : **Animal Genomics**

Credit   : **3(2+1)**   Semester   : **VI**

Theory

UNIT I

Genome organization in eukaryotes; Satellite DNA: VNTRs & families, LINE & SINE; Sex determination: Chomosomal basis of sex determination, Molecular markers for sexdetermination, environmental sex determination; Chromosomal aberrations: Euploidy, Chromosomal Non-disjunction and Aneuploidy, Polyploidy, Induced Polyploidy, Syndromes, Structural aberrations, Robertsonian Translocations, Position Effect, Chromosomal Mosaics, Chromosomal aberrations and evolution.

UNIT II

Molecular Markers: Markers, Genetic Markers: RAPD, STR, DNA fingerprinting, SSCP, RFLP, SNP, EST; SNP Analysis; karyotyping, Somatic cell hybridization; Radiation hybrid maps; FISH technique; Major Histocompatibility Complex: Concept and its relevance in disease resistance & immune response; Quantitative trait Loci; Marker Assisted Selection: Concept, Linkage Equilibrium, Application in Animal Sciences; Genomic Selection: Concept, Linkage Disequilibrium, Methodologies of economic Selection; Mitochondrial DNA analysis and its application in livestock; Applying DNA markers for breed characterization.

Practical

Extraction of genomic DNA from peripheral blood; Analysis of DNA by agarose or polyacrylamide gel electrophoresis; Checking the quality & quantity of genomic DNA; Restriction digestion & analysis; Sanger Sequencing data analysis; Extraction of mitochondrial DNA; Extraction of RNA from PBMC; Quality checking of total RNA; cDNA synthesis.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightages (%)
	UNIT – I	
1	Genome organization in eukaryotes; Satellite DNA	3
2	VNTRs & families	3
3	LINE & SINE	3
4-5	Sex determination: Chomosomal and molecular basis of sex determination	10
6	Molecular markers for sex determination	3
7	Environmental sex determination	3
8	Chromosomal aberrations: Introduction, Euploidy, Chromosomal Non-disjunction	6
9	Aneuploidy, Polyploidy, Induced Polyploidy	4

10	Syndromes, Structural aberrations, Robertsonian Translocations	10
11	Position Effect, Chromosomal Mosaics, Chromosomal aberrations and evolution.	7
UNIT – II		
12-14	Molecular Markers: Markers, Genetic Markers: RAPD, STR, SSCP, RFLP, SNP, EST, DNA fingerprinting;	6
15	SNP Analysis	2
16	Karyotyping,	2
17	Somatic cell hybridization	3
18	Radiation hybrid maps	3
19	FISH technique	3
20	Major Histocompatibility Complex:	5
21	Concept and its relevance in disease resistance & immune response	3
22-23	Quantitative trait Loci	3
24	Marker Assisted Selection	3
25	Concept, Linkage Equilibrium, Application in Animal Sciences	3
26	Genomic Selection: Concept	2
27-28	Linkage Disequilibrium	4
29	Methodologies of economic Selection	1
30	Mitochondrial DNA analysis and its application in livestock	2
31-32	Applying DNA markers for breed characterization	3
Total		**100**

Practical Exercises

Exercise No.	Title
1	Isolation of genomic DNA from peripheral blood
2	Analysis of DNA by agarose gel electrophoresis
3	Analysis of NA/Protein by polyacrylamide gel electrophoresis
4	Qualitative and quantitaive analysis of genomic DNA by spectrophotometric method
5	Restriction enzymes digestion of DNA
6	Polymerase Chain Reaction
7	Southern blot analysis of DNA
8	Study of DNA sequencing by Sanger's method
9	Sanger Sequencing data analysis
10	Isolation of mitochondrial DNA
11	Analysis of mt-DNA by agarose gel electrophoresis
12	Isolation of RNA from Peripheral blood mono nuclear cell (PBMC),
13	Analysis of isolated RNA from PBMC by agarose gel electrophoresis
14	Northern blot analysis of RNA
15-16	cDNA synthesis

Text Books:
1. Brown TA. 2006. Genomes. 5th Ed. Wiley-Blackwell.
2. Green MR & Sambrook J. 2014. Molecular Cloning: A Laboratory Manual.4th Ed. Vol I, II & III. Cold Spring Harbor Laboratory Press.

Reference Books:
1. Dale JW, Schantz MV & Plant N. 2012. From Genes to Genomes: Concepts and Applications of DNA Technology. John Wiley & Sons.
2. Reece RJ. 2004. Analysis of Genes & Genomes.Wiley.

Course No   : **ABTEL-363**   Course Title   : **Embryo Transfer Technologies**
Credit   : **3(2+1)**   Semester   : **VI**

Theory

UNIT I

History, advantages, limitations and scope of embryo transfer technology; Estrus cycle and its detection in animals; Methodology of super ovulation; Ovum pick up (OPU);Preparation of sperm for *in vitro* fertilization (IVF); Embryo grading and culture; Micromanipulation and immuno-modulation for enhancement of fecundity.

UNIT II

Different methods of gene transfer and their limitations; embryo splitting; embryo sexing by different methods; production of transgenic livestock by nuclear transfer and its application; regulatory issues (social, ethical, religious and environmental); Cloning of domestic animals; Conservation of endangered species; Characterization of embryonic stem cells and applications.

Practical

Demonstration of estrus detection methods; Estrus synchronization; Superovulation; Oocyte collection from slaughterhouse ovaries; Grading of oocytes from slaughterhouse ovaries; collection and preparation of semen samples; *In vitro* fertilization; Collection of embryos using non-surgical procedures; Grading and culture of embryos; Embryo sexing by different methods; Embryo splitting; Embryo freezing.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightages (%)
	UNIT – I	
1	History, advantages of embryo transfer technology	3
2	Limitations and scope of embryo transfer technology	3
3	Estrus cycle and its detection in animals;	6
4	Methodology of super ovulation; Ovum pick up (OPU);	6
5-6	Preparation of sperm for *in vitro* fertilization (IVF);	6
7	Embryo grading	6
8-9	Embryo culture	6
10-11	Micromanipulation and immuno-modulation for enhancement of fecundity.	10
	UNIT – II	
12-14	Different methods of gene transfer and their limitations	6
15	Embryo splitting	6
16-17	embryo sexing by different methods	6
18-19	Production of transgenic livestock by nuclear transfer and its application	6
20-21	Regulatory issues (social, ethical)	6
22-23	Regulatory issues (religious and environmental)	6
24-26	Cloning of domestic animals	6

27-30	Conservation of endangered species	6
31-32	Characterization of embryonic stem cells and applications	6
Total		**100**

Practical Exercises

Exercise No.	Title
1	Demonstration of estrus detection methods
2	Study of Estrus synchronization
3	Study of Superovulation
4	Oocyte collection from slaughterhouse ovaries
5	Grading of oocytes from slaughterhouse ovaries
6	Collection and preparation of semen samples
7	*In vitro* fertilization
8	Collection of embryos using non-surgical procedures
9	Grading and culture of embryos
10	Embryo sexing by different methods
11	Evaluation of embryo
12	Embryo collection in cow
13	Embryo splitting
14	Embryo freezing
15	Transfer of embryo
16	Study of managing donor and recipient herds

Text Books:

Gordon I. 2004. Reproductive Technologies in Farm Animals. CABI.

Hafez ESE. 2000. Reproduction in Farm Animals. Lippincott, Williams & Wilkins.

Reference Books:

Gwatkin RBL. 1986. Developmental Biology, Vol. 4: Manipulation of Mammalian Development. New York, Plenum Press.

Daniel JC Jr. 1978. Methods in Mammalian Reproduction. Orlando, USA, Academic Press.

Brackett BG, Seidel GE Jr. & Seidel SM. 1981. New Technologies in Animal Breeding. Orlando, USA, Academic Press.

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UNIT I

History of transgenesis; Isolation of gene, preparation of gene construct; Methods of transgenic animal production: Calcium chloride mediated transfection, lipofection,   electroporation, microinjection, nanodelivery.

UNIT II

Production of gene knockouts: cre-lox, zinc finger nucleases; CRISPR; TALENs; Production of chimeric animals; gene silencing by lentivirus system.

UNIT III

Stem cell technology: Isolation and characterization of stem cell lines from different sources: embryo, mesenchymal, induced pluripotent stem cell; Introduction to animal cloning; Application of stem cells in transgenesis and animal cloning.

UNIT IV

Fundamental assays of transgenic products: confirmation of integration of transgene; Validation of transgenic products like isolation of transgenic protein from milk and characterization; Application of transgenics in production of disease resistance models and carcinogenesis. Regulatory issues associated with transgenic animal production.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightage (%)
	UNIT I	
1	**History of transgenesis**	03
2	**Isolation of gene**	02
3	**Preparation of gene construct**	03
4-6	**Methods of transgenic animal production:-** **a.** Calcium chloride mediated transfection: **b.** Lipofection: **c.** Electroporation: **d.** Microinjection:	04
7-8	Nanodelivery:- Physico-chemical properties of the penetrant molecules (Partition coefficient, pH conditions, Penetrant concentration) Physico-chemical properties of drug delivery systems (Release characteristic, Enhancement of transdermal permeation)	04
9-10	Physiological and pathological condition of skin (Reservoir effect of horny layer, Lipid film, Skin hydration, Skin temperature, Regional variation, Pathological injuries to the skin, Cutaneous self metabolism) Routes of drug penetration through the skin	04
	UNIT II	
11-13	**Production of gene knockouts:** (1) Construction of the targeting vector. (2) Gene targeting in embryo-derived stem (ES) cells. (3) Selection of gene-targeted cells (inset).	02

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	Three outcomes are possible.	
14	**Cre-lox:** Conditional gene targeting, Cre (Cause recombination), Use in conditional gene targeting, Generation of a conditional knockout mouse using the Cre–loxP system,	02
15	Chromosomal Engineering Using the Cre–loxP System, Cre-lox technology for targeted homologous recombination of transgenes	02
16	**Zinc finger nucleases:** Definition of ZFN, consists of two functional domains, Benefits, Target Applications, ZFN-Mediated Targeted Genome Editing	02
17-18	**CRISPR:** Defination and types of CRISPR, Genome editing glossary, application of CRISPR, Targeting Efficiency and Off-target Mutations, T7 Endonuclease I Targeting Efficiency Assay	03
19-20	**TALENs:** Defination and overview of transcription activator-like effector nucleases (TALEN**s**), TALENs strategy for efficient and specific modifications of genome, *In vivo* genome editing	02
21-23	**Production of chimeric animals:** Culture of embryonic stem (ES) cells to offspring derived from the germline chimera is either derived from the genetics of the ES cells or that of the host embryo.	05
24-25	**Characterization:** -Fluorescent labeling of cell membranes. -Tracking cell contribution to the fetus or offspring. -Use of beta- galactosidase gene (beta-gal) -Transgenic reporter gene -Transgenic ES cells contribution -The final proof that these cell lines are indeed ES cells	05
26	**Gene silencing by lentivirus system:** -Vectors for somatic cell gene therapy -Advantages and Disadvantages of lentivirus	03
27-28	**Mechanism of RNA interference-** RNAi pathway triggered by the introduction into cells of either viral double stranded RNA (dsRNA).	06
UNIT III		
29-30	**Stem cell technology:-** Isolation of stem cell lines from different sources:- Embryo stem cell: Mesenchymal stem cell and its production from human bone marrow: Induced pluripotent stem cell: Characterization of stem cell lines:-	06
31-32	**Introduction to animal cloning:-** Definition of clone, Cloning by embryo splitting, case study of Dolly, Cloning by somatic cell nuclear transfer (SCNT), constraints of cloning , Safety concerns of milk or meat from cloned animals and their progenies Regulatory authorities for animal cloning	06
33	**Applications of stem cells in transgenesis and animal cloning:-** Clinical applications of cultured human stem cells, Commercial benefits of domestic animal embryonic stem cells, Commercial uses of animal cloning	06

	technology, Transgenesis in mice	
UNIT IV		
34-35	**Fundamental assays of transgenic products:** -PCR, Southern blotting, Western blotting, and Enzyme linked immunosorbant assay (ELISA) -Transgenic animal mutagenecity assays - Use of transgenic assays in the detection of gene mutations in germ cells	03
36-37	**Confirmation of integration of transgene:** • Transgene detection by PCR • Transgene copy number detection by quantitative PCR (q-PCR) Fluorescent in situ hybridization (FISH)	03
38	**Validation of transgenic products:-** **Isolation of transgenic protein from milk:**	03
39-40	**Characterization:** A. Genetic Stability B. Stability of expression Characterization of the transgenic founder (F0) animal	03
41	**Application of transgenics in production of disease resistance models and carcinogenesis:-** **Application of transgenics:** Improved growth rates (e.g., shrimp and lobster), Improved size or appearance, Improved nutrition (low cholesterol), Disease resistance,	02
42	Chemical production (bioreactors), Biomedical research models (therapy and toxicity)	02
43	**Application of Transgenic Models to Drug Development:** Disease Models- **Description-** Models to determine disease causation or therapy development	02
44	**Example-** Breast cancer, neurologic disorders, cardiac disease, Alzheimers/aging	02
45	**Carcinogenicity testing-** -Three different types of transgenic strains have been employed in the generation of transgenic mice for carcinogenicity testing:	04
46	**Regulatory issues associated with transgenic animal production:-** **Principles include:** Establishing high standards for safeguarding human health and animal health and welfare.	02
47	Developing clear technical standards and assessment guidelines, Providing a sound scientific basis for evaluating associated risk.	02
48	Consulting and involving stakeholders and the general public in the development of regulations, Building upon existing regulations and technical standards, Maintaining genetic diversity and conserving the environment.	02
Total:		**100**

Text Books:

1. Ramadass P. 2008. Animal Biotechnology: Recent Concepts and Developments. MJP, Publishers.
2. Ranga MM. 2007. Animal Biotechnology. Agrobios.

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3. Singh BD. 2010. Biotechnology expanding Horizons. Kalyani Publishers.

Reference Books:
1. Singh B, Gautam SK, Chauhan MS and Singla SK. 2015. Textbook of Animal Biotechnology. The Energy and Resources Institute, TERI.

Course No   : **ABTEL-365**   Course Title   : **Molecular Diagnostics**
Credit   : **3(2+1)**   Semester   : **VI**
Theory

UNIT I

Principle and applications of molecular diagnostic tests; Nucleic acid based diagnostics for detection of pathogenic organisms: Application of restriction endonuclease analysis for identification of pathogens; Polymerase chain reaction (PCR) and its variants; Reversetranscriptase polymerase chain reaction (RT PCR); isothermal amplification (LAMP); LCR, nucleic acid sequence-based amplification (NASBA); Real-Time PCR; DNA Probes; Southern blotting; Northern blotting; Protein based assays: SDS-PAGE, Western Blot, Dot-blot, ELISA and lateral flow device.

UNIT II

Advantages of Molecular diagnostics over conventional diagnostics; serodiagnostics; DNA array technology; Protein array; tissue array; Biosensors and nanotechnology; Development and validation of diagnostic tests.

Practical

Preparations of buffers and reagents; Collection of clinical and environmental samples for molecular detection of pathogens (bacteria/virus); Extraction of nucleic acids (DNA & RNA) from the clinical specimens; Restriction endonuclease digestion and analysis using agarose gel electrophoresis; Polymerase chain reaction for detection of pathogens in blood and animal tissues; RT-PCR for detection of RNA viruses; PCR based detection of meatadulteration in processed and unprocessed meats; PCR based detection of pathogens in milk, eggs and meat; Lateral flow assay; ELISA.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightage (%)
	UNIT – I	
1	**Principle and applications of molecular diagnostic tests**	3
2	**Nucleic acid based diagnostics for detection of pathogenic organisms:** Types of nucleic acids and Target pathogens/ diseases	4
3	PCR, DNA and RNA Hybridization assays	4
4-5	Nucleic acid sequencing and NGS approaches in diagnostics	4
6	**Application of restriction endonuclease analysis for identification of pathogens:** RE enzymes, Restriction fingerprints of pathogens for diagnosis, etc.	3
7	**Polymerase chain reaction (PCR) and its variants;** Multiplex PCR, Nested, RT-PCR,	4
8	Real-time PCR, ARMS and related technologies, etc.	4
9-10	**Reverse transcriptase polymerase chain reaction (RT PCR)-** Pathogens with RNA genome, RNA isolation, cDNA synthesis and PCR, etc.	4

11	**Isothermal amplification (LAMP)** - Principle, methodology and applicationsin animal disease diagnosis, etc.	3
12	**LCR**- Principle, methodology and applications in animal disease diagnosis, etc.	4
13	**Nucleic acid sequence-based amplification (NASBA**)-Principle, mechanism/methodology and applications/ advantages, etc.	4
14	**Real-Time PCR**- Chemistries/ types of probes, Principle, methodology and applications/ advantages, etc.	4
15	**DNA Probes**- Probes, types, synthesis and applications, etc.	4
16	**Southern blotting, Northern blotting**- Principle, methodology with examples in animal disease diagnosis, etc.	4
17	**Protein based assays-** SDS-PAGE, Western Blot, Dot-blot, antibody based assays, etc.	5
18-19	**Dot-blot, ELISA** – Principle, methodology and examples/applications, etc.	5
20	**Lateral flow device**- importance, principle, methodology, applications/examples, etc.	5
UNIT II		
21	**Advantages of Molecular diagnostics over conventional diagnostics**	5
22-23	**Serodiagnostics;** Methods, importance and applications, etc.	4
24-25	**DNA array technology**; principle, methods/types, applications, etc.	4
26	**Protein array;tissue array**- principle, methods, applications, etc.	4
27- 28	**Biosensors and nanotechnology;** Principles, methods/types and applications in animal disease diagnosis, etc.	5
29-30	**Development and validation of diagnostic tests:** OIE stages/ pathway of diagnostic assay development, etc.	5
31- 32	Validation- OIE stages/ pathway of assay validation Validation status retention, etc.	5
Total		**100**

Practical Exercises

Exercise No.	Title
1-2	Preparations of buffers and reagents
3-4	Collection of clinical and environmental samples for molecular detection of pathogens (bacteria/virus)
5	Extraction of DNA from the clinical specimens
6	Extraction of RNA from the clinical specimens
7	Restriction endonuclease digestion and analysis using agarose gel electrophoresis
8	Polymerase chain reaction for detection of pathogens in blood and animal tissues
9	RT-PCR for detection of RNA viruses
10-11	PCR based detection of meat adulteration in processed and unprocessed meats
12-13	PCR based detection of pathogens in milk, eggs and meat
14-15	Lateral flow assay for disease diagnosis
16	ELISA for animal disease diagnosis

Text Books:

1. Debnath M, Prasad GBKS & Bisen PS. 2010. Molecular Diagnostics: Promises and Possibilities. Springer Science & Business Media
2. Singh BD. 2010. Biotechnology Expanding Horizons. Kalyani Publishers.

Reference Books:

1. Wilson K & Walker J. 2010. Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.
2. Viljoen GJ, Nel LH & Crowther JR. 2005. Molecular Diagnostic PCR Handbook. Springer Science & Business Media.

Course No   : **ABTEL-366**   Course Title : **Molecular Virology andVaccine Production**
Credit   : **3(2+1)**   Semester   : **VI**
Theory

UNIT I

Properties of viruses; Classification of viruses; Virus replication; Cell transformations, Cultivation of viruses, assay techniques for detection/quantification; Important Animal viruses; Virus-Host interactions; Viral infections; Immune responses to viruses: Interferon and other cytokines; Bio-safety and bio-security principles.

UNIT II

Properties of an ideal vaccine; Classification of vaccines; Methods of inactivation and attenuation of viruses; New generation vaccines: subunit, synthetic, rDNA, marker and edible; Adjuvants and vaccine delivery systems; Novel immunomodulators and vaccine delivery using nanotechnology; Vaccine preparation: Stabilizers, preservatives and vehicles; Quality control and testing of vaccines; Sero-surveillance and sero-monitoring.

Practical

Processing of clinical specimens for isolation of viruses; Cultivation of viruses in cell cultures and embryonated eggs; Harvesting of virus; Study of cytopathic effects; Titration of virus and estimation of $TCID_{50}$;Haemagglutination and Haemagglutination Inhibition test; Detection of virus by SNT, AGID and ELISA.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightages (%)
1	Properties of viruses; Classification of viruses	4
2	Virus replication	5
3-4	Cell transformations	5
5-6	Cultivation of viruses	5
7-8	Assay techniques for detection/quantification	6
9	Important Animal viruses	4
10-11	Virus-Host interactions	6
12	Viral infections	5
13	Immune responses to viruses	4
14-15	Interferon and other cytokines, Bio-safety and bio-security principles	10
16	Properties of an ideal vaccine	3
17	Classification of vaccines	5
18	Methods of inactivation and attenuation of viruses	5
19-20	New generation vaccines: subunit, synthetic rDNA, marker, edible	6
21-22	Adjuvants and vaccine delivery systems	4
23	Novel immunomodulators	3
24	Vaccine delivery using nanotechnology	5
25-26	Vaccine preparation: Stabilizers, Preservatives and vehicles	5
27-29	Quality control and testing of vaccines	5
30-32	Sero-surveillance and sero-monitoring.	5
	Total	**100**

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Practical Exercises

Exercise No.	Title
1-2	Processing of clinical specimens for isolation of viruses
3-4	Cultivation of viruses in cell cultures
5-6	Cultivation of viruses in embryonated eggs
7	Harvesting of virus
8	Study of cytopathic effects
9	Titration of virus and
10	Estimation of $TCID_{50}$
11	Study of Haemagglutination
12-3	Haemagglutination inhibition test
14	Detection of virus by SNT
15	Detection of virus by AGID
16	Detection of virus by ELISA

Text Books:
1. John CJ & Saunders V. 2007. Virology: Principles and Applications.2nd Ed. Wiley.
2. Morrow WJW, Sheikh NA, Schmidt CS and Davies DH. 2012. Vaccinology: Principles and Practice. John Wiley & Sons.
3. Sharma S & Adlakha S. 1996. Textbook of Veterinary Microbiology. Vikas Publishing House Pvt. Ltd.

Reference Books:
1. Stephenson J & Warnes R. 1998. Diagnostic Virology Protocols. Springer Science & Business Media.

ELECTIVE III: MICROBIAL AND ENVIRONMENTAL BIOTECHNOLOGY

Course No : **MEBTEL-361**   Course Title : **Microbial Biotechnology**

Credit : **3 (2+1)**   Semester : **VI**

Theory

UNIT I

Microbial biotechnology, scope and techniques; Industrially important microorganisms; Gene transfer mechanisms in microbes: Transformation, transduction, conjugation and recombination; Genetic variability in microorganisms; Biotechnological tools to improve the microbial strains with respect to industry and agriculture.

UNIT II

Biotransformation and biodegradation of pollutants, biodegradation of lignocelluloses and agricultural residues; Biotechnological treatment of waste water, sewage and sludge; Industrial production of alcohols, ethanol, acids (citric acid, acetic acid), solvents (glycerols, acetone, butanol), antibiotics (penicillin, streptomycine, tetracycline), amino acids (lysine, glutamic acid), single cell proteins; Recombinant and synthetic vaccines.

Practical

Isolation and preservation of industrially important microorganisms; Microbial fermentation, production of proteins and enzymes using bacteria, yeast and fungus; Microbial biomass production, utilization of plant biomass by recombinant microorganisms; Production of secondary metabolites from microbes.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightages (%)
1	Microbial biotechnology: Introduction	2
2	Microbial biotechnology: Scope	2
3	Techniques of microbial biotechnology	4
4	Industrially important microorganisms	4
5	Gene transfer mechanisms in microbes: Transformation, ,	2
6	Transduction	2
7	Conjugation	2
8	Gene transfer mechanisms in microbes: Recombination	2
9	Genetic variability in microorganisms	4
10	Biotechnological tools to improve the microbial strains with respect to industry	2
11	Biotechnological tools to improve the microbial strains with respect to agriculture	4
12	Biotransformation and biodegradation of pollutants	2
13	Biodegradation of lignocelluloses	4
14	Biodegradation of agricultural residues	4
15	Biotechnological treatment of waste water	4
16	Biotechnological treatment of sewage	4
17	Biotechnological treatment of sludge	2

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18	Industrial production of alcohols	4
19	Industrial production of ethanol	4
20	Industrial production of solvents i. e. butanol	2
21	Industrial production of glycerols	4
22	Industrial production of acetone	2
23	Industrial production of citric acid	4
24	Industrial production of acetic acid	4
25	Industrial production of antibiotics i. e. penicillin	4
26	Industrial production of streptomycine	4
27	Industrial production of tetracycline	4
28	Industrial production of amino acids i. e. lysine	2
29	Industrial production of glutamic acid	4
30	Industrial production of single cell proteins	4
31	Recombinant vaccines	2
32	Synthetic vaccines	2
Total		**100**

Practical Exercises

Exercise No.	Title
1	Isolation and preservation of industrially important microorganisms
2	Microbial fermentation, production of proteins and enzymes using bacteria.
3	Microbial fermentation, production of proteins and enzymes using yeast &fungus
4	Microbial biomass production
5	Utilization of plant biomass by recombinant microorganisms
6	Production of secondary metabolites from microbes
7	Production of alcohols
8	Production of ethanol
9	Production of solvents i. e. butanol
10	Production of glycerols
11	Production of acetone
12	Production of citric acid
13	Production of acetic acid
14	Production of antibiotics (penicillin and tetracycline),
15	Production of streptomycine
16	Production of amino acids (lysine, glutamic acid)

Text Books
1. Glaze AN & Nikaido H. 2007. Microbial Biotechnology: Fundamentals of Applied Microbiology. 2nd Ed. Cambridge University Press.
2. Mohapatra PK. 2006. Text Book of Environmental Biotechnology. International Publishing House Pvt. Ltd.

Reference Books
1. Shetty K, Paliyath G, Pometto A and Leven RE. 2006. Food Biotechnology. 2nd Ed.Taylor & Francis Group.
2. Peppler HJ. and Perlman D. 2004. Microbial Biotechnology. Vol.I & II.2nd Ed. Academic Press.

Course No : **MEBTEL-362** Course Title : **Bio-prospecting of Moleculesand Genes**
Credit : **3 (3+0)** Semester : **VI**

Theory:

UNIT I

Concepts and practices of bioprospecting; Traditional and modern bioprospecting; Gene prospecting; Isolation, synthesis and purification of new bioactive chemicals for laboratory.clinical and field trials; Intellectual property rights, mechanisms and the legal framework; Patenting of new genes and/or bioactive principles with novel antibiotic, insecticidal or anti-tumour properties.

UNIT II

Principles of the Convention on Biological Diversity, biodiversity conservation and biotechnology; Development and management of biological, ecological, taxonomic, and related systematic information on living species and systems.

UNIT III

Bioprospecting of microorganisms and their components; Bioprospecting of biodiversity for new medicines: Identification and collection of material by random and traditional (medicinal) approaches; Screening for particular bio-activities; Elucidation of novel molecular form, process technology; Development of techniques for large scale industrial production of the final bioactive product and its market availability and accessibility to the public.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightage (%)
Concepts and practices of bioprospecting, Traditional and modern bioprospecting:		
1	What is bioprospecting? Business in bioprospecting	1
2	Biodiversity & its importance	1
3	Indigenous knowledge and biodiversity	1
4	Role of natural products in bioprospecting: Pharmaceutical industry	1
5	Role of natural products in bioprospecting: Agriculture & other industries	1
Gene prospecting:		
6	Gene prospecting in plants and microbes: Overview	3
7	Gene prospecting approaches: Metagenomic approach, transcriptome profiling, insertional mutagenesis, allele mining	3
8	Gene prospecting approaches: Metagenomic approach, transcriptome profiling, insertional mutagenesis, allele mining	4
Isolation, synthesis and purification of new bioactive chemicals for laboratory		
9	Screening for bioactivities	1
10	Isolation of new molecules from microbes	2
11	Isolation of new molecules from plants	2
12	Synthesis of new molecules	1
13	Synthesis of new molecules	2

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14	Purification techniques for new bioactive molecules	2
Clinical and Field trials:		
15	Clinical Trials	2
16	Field Trials	3
Intellectual property rights, mechanisms and the legal framework;		
17	Intellectual property rights	1
18	Patenting of Biological material: Plant breeder rights,	2
19	Protection of plant variety	2
20	Legal frameworks, Difficulties and challenges of implementing Legal Frameworks	1
Patenting of new genes and/or bioactive principles with novel antibiotic, insecticidal or anti-tumour properties:		
21	Patenting of novel antibiotic: Case study	3
22	Patenting of novel insecticidal molecule: Case study	4
23	Patenting of novel anti-tumour molecule: Case study	2
Principles of the Convention on Biological Diversity:		
24	United Nations convention on biodiversity	1
24	Issues under convention, International bodies established by convention, parties	1
25	Global strategy for plant conservation	1
26	Cartagena protocol and Nagoya protocol	2
Biodiversity conservation and biotechnology:		
27	Conventional approaches for biodiversity conservation: In situ and Ex situ methods	3
28	Biotechnological approaches for biodiversity conservation	3
29	Tissue culture techniques used for conservation	3
30	Cryogenic techniques for conservation of biodiversity	3
31	Transgenics and biodiversity	3
Bioprospecting of microorganisms and their components:		
32	Bioprospecting for Microbial Endophytes and Their Natural Products: General considerations, rationale for plant selection	3
33	Endophyte-host interaction,	2
34	Bioprospecting for Microbial Endophytes and Their Natural Products:Endophytes and biodiversity, endophytes and phytochemistry, collection and isolation techniques of endophytes	3
35	Bioprospecting for Microbial Endophytes and Their Natural Products: Bioactive molecules from endophytes such as antimicrobial, antitumour, insecticidal, antidiabetic, etc	3
Bioprospecting of biodiversity for new medicines:		
36	Bioprospecting of medicinal plants general considerations	3
37	Medicinal plants, indigenous knowledge and ethnobotany research	2
Identification and collection of material by random and traditional (medicinal) approaches:		
38	Survey, Exploration and collection of medicinal plants with bioactivities	2
39	Bioprospecting of medicinal plants for antioxidant activity	2
40	Chemodiversity	1
Screening for particular bio-activities:		
41	Screening for antibacterial activities: Methods & One case study	2
42	Screening for antifungal activities: Methods & One case study	1
43	Screening for enzyme activities: Methods & One case study	1

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44	Screening for enzyme inhibitors: Methods & One case study	1
Elucidation of novel molecular form:		
45	Structural elucidation general approaches	1
46	Techniques used in structural elucidation: FTIR, NMR, Mass spectroscopy, XRD	2
47	Techniques used in structural elucidation: FTIR, NMR, Mass spectroscopy, XRD	2
Market availability and accessibility to the public:		
48	Marketing survey and marketing strategies	4
	Total:	**100**

Text Books:
1. Mohapatra PK. 2006. Text Book of Environmental Biotechnology. International Publishing House Pvt. Ltd.
2. Sharma PD. 2012. Ecology and Environment. 11th Ed. Rastogi Publications
3. Aravind Kumar and Govind Das. 2010. Biodiversity, Biotechnology and Traditional Knowledge: Understanding Intellectual Property Rights
4. Sarah Laird and Rachel Wynberg. 2016. Biodiversity Research, Bioprospecting and Commercialization: Science, Markets and Access and Benefit-sharing (People and Plants International Conservation). Routledge Publ.
5. Singh BD. 2015. Biotechnology Expanding Horizons. Kalyani Publ.

Course No   : **MEBTEL-363**   Course Title   : **Molecular Ecology & Evolution**

Credits   : **3 (3+0)**   **Semester**   : **VI**

Theory

UNIT I

Molecular Evolution: Concept, molecular divergence and molecular clocks; Speciation and domestication; Evolution of earth and earlier life forms; Primitive organisms,their metabolic strategies and molecular coding; New approaches to taxonomical classification including ribotypeing, Ribosomal RNA sequencing; Molecular tools in phylogeny, classification and identification.

UNIT II

Protein and nucleotide sequence analysis; Origin of new genes and proteins; Gene duplication and divergence; Genome evolution, components of genomes, whole genome duplications, chromosome rearrangements and repetitive sequence evolution.

UNIT III

Application of molecular genetics and genomics to ecology and evolution; Assessment of genetic diversity, phylogeny, inbreeding, quantitative traits using molecular tools; Mutations; Regulations of gene expression.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightage (%)
1	**Concept of molecular evolution** Population dynamics Forces in molecular evolution Gene conversion Genetic drift Selection Genome architecture Repetitive elements Chromosome number and organization Gene content and distribution Organelles The driving forces of evolution	2
2-3	**Molecular divergence** Analysis Usage Divergent species	3
4-5	**Molecular clocks** Early discovery and genetic equidistance Relationship with neutral theory Calibration Non-constant rate of molecular clock Methods Uses	3
6-7	**Speciation and domestication**	3

	Modes of speciation Artificial speciation Types of Speciation and mechanisms of Speciation Speciation via polyploidization Hybrid speciation Gene transposition Rates of speciation	
8	**Evolution of Life on Earth and earlier life forms** The Big Bang theory of the formation of the universe Formation of the solar system Early Earth Conditions Theories regarding evolution of life on earth. RNA World hypothesis	4
9-10	**Primitive organisms, their metabolic strategies and molecular coding** Prokaryotes, Eukaryotes and Archea. Multicellular organisms. The basic theories of the code nature, origin and evolution. Universality of the genetic code and collective evolution	6
11-13	**New approaches of taxonomic classification including ribotypeing** Genotypic Methods Phenotypic Methods Chemotaxonomy DNA-Based Typing Methods DNA-DNA reassociation	5
14	**Ribosomal RNA Sequencing:** Structure of r RNA Importance of rRNA Applications of Ribosomal RNA in species identification and evolution.	3
15	**Molecular tools in Phylogeny** Origins and history of Molecular Phylogenetics Phylogenetic Analysis Tools Understanding Phylogenetic Trees Distance-Matrix Methods UPGMA Method Discrete Data Methods Techniques and application	3
16	**Classification and identification** Systematic Approaches to Phylogeny Classification of phylogeny. Identification of phylogenic levels. Phenetic Cladistic Evolutionary	3
17-19	**Protein and nucleotide sequence analysis** Protein and nucleotide structure. Methods' of sequence analysis of proteins. Method's of sequence analysis of nucleotide.	6

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	Sequence Alignment Profile comparison Sequence assembly Gene prediction Protein Structure Prediction Methodology Applications.	
20-22	**Origin of new genes and proteins** Theories regarding origin of new genes and gene families. Theories regarding origin of new proteins and proteins motifs with example. Retrotransposition	6
23-24	**Gene duplication and divergence** Gene Duplication Ectopic Recombination Retrotransposition Aneuploidy Generation of duplicate genes Evolutionary fate of duplicate genes Conservation of gene function	4
25	**Genome evolution** Defination of genome Prokaryotic and eukaryotic genomes Genome size Mechanisms of genome evolution Genome evolution and speciation Composition of nucleotides (GC content) Evolving translation of genetic code	3
26	**Components of genomes** Genome Sequencing and mapping Genome compositions Proportion of non-repetitive DNA Proportion of repetitive DNA Tandem repeats Interspersed repeats Retrotransposons DNA transposons	2
27	**Whole genome duplications** Evolutionary importance, Genome diversity,Evidence of Whole-Genome Duplication Examples of different levels of ploidy, Paleopolyploidy (ancient whole genome duplications), Detecting paleopolyploidy	3
28-30	**Chromosome rearrangements and repetitive sequence evolution** Chromosomal rearrangement Impact of Chromosomal rearrangement on evolution of species. Role of repetitive sequence evolution	6
31-33	**Application of molecular genetics and genomics to ecology and evolution**	8

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	Application of Molecular markers Application of **molecular genetics in** Study of genome evolution Application of **molecular genetics in** Study of Population genetics Application of Molecular approaches in study of behavioural ecology Application of **molecular genetics in**Environmental genomics	
34-35	**Assessment of genetic diversity** Significance of Genetic Conservation of Crop Plants Erosion of Genetic Diversity due to Population Size Climate Change and Its Impact on Plant Genetic Resources Assessment of Genetic Diversity in Crop Plants Analyses of Genetic Diversity in Genomic Era Analysis of Genetic Diversity from Molecular Data Assessment of Genetic Diversity in Postgenomic Era	4
36-37	**Phylogeny** Taxonomic system Evidence for specific phylogenies Phenetics versus cladistics Evolution of land plants Animal evolution Application of phylogeny	4
38	**Inbreeding** Defination Measures of inbreeding in different organisms. Genetic disorders Examples Genetic disorders Effects of inbreeding Prevalence of inbreeding Application of inbreeding	2
39-41	**Quantitative traits using molecular tools** Quantitative traits Heritable disease and multifactorial inheritance Examples of Quantitative traits Types of QTL mapping	6
42-44	**Mutations** Defination Causes of mutation Types of mutation Application of mutation	5
45-48	**Regulations of gene expression** Control of gene expression at various stages Regulation of transcription Post-transcriptional regulation Regulation of translation Examples of gene regulation Up-regulation and down-regulation Inducible vs. repressible systems.	6
Total:		**100**

B.Tech. (Biotechnology)

Text Books:

1. Beebee T & Rowe G. 2008. An Introduction to Molecular Ecology. 2nd Ed. Oxford University Press.
2. Brown TA. 2007. Genome 3. Garlan Science Publishing.
3. Carvalho GR. 2002. Advances in Molecular Ecology. IOS Press Netherland.
4. Prakash M. 2008. Molecular Biology of Ecology (Encyclopaedia of Molecular Biology-4) Discovery Publishing House Pvt. Ltd.
5. Schierwater B, Streit B, Wagner GP and Desalle R. 1994. Molecular Ecology and Evolution: Approaches and Applications. Springer.
6. Freeland JR, Petersen SD and Kirk H. 2006. Molecular Ecology 2nd Edition. Wiley Blackwell.

Course No   : **MEBTEL-364**   Course Title: **Molecular Pharming and Biopharmacetuticals**
Credits   : **3 (2+1)**   Semester: **VI**

Theory

UNIT I

Concept of molecular pharming and production of biopharmaceuticals; Mammalian cell culture manufacturing and microbial fermentation; Fermentation and cell culture processing; Protein purification and processing; Industrial fermentation: batch and continuous cultures, production of biopharmaceuticals, immobilization techniques.

UNIT II

Biopharmaceutical analytical techniques; Biopharma drug discovery and development; production of specific vaccines and therapeutic proteins.

Practical

Isolation & purification of proteins from microbes and plants; Production of recombinant proteins in prokaryotes; Analysis of proteins by one and two dimensional gel electrophoresis; Affinity chromatography;Immunoblotting; Cell culture and immobilization techniques. Visit to biopharmaceutical industry.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightage (%)
1	Overview of molecular farming & A Top-down View of Molecular Farming from the Pharmaceutical Industry: Requirements and Expectations	2
2	Plant based expression system	5
3-4	Approaches for Increasing Heterologous Protein Accumulation in Plants	3
5	Foreign Protein Expression Using Plant Cell Suspension and Hairy Root Cultures	4
6	Production of Pharmaceutical Proteins in Plants and Plant Cell Suspension Cultures	4
7	Chloroplast Derived Antibodies, Biopharmaceuticals and Edible Vaccines	4
8	Tobacco, a platform for the production of Recombinant proteins	2
9	Edible vaccines	3
10	Biosafety Aspects of Molecular Farming in Plants	3
11	Overview, biopharmaceuticals from microbial fermentation	2
12	Inoculum development, small scale liquid fermentations, Selection of raw material for industrial scale applications	3
13	Overproduction of Metabolites of Industrial Microorganisms	4
14	Bioreactor design and Modes of operation of bioreactor	4
15	Production of Antibiotics	4
16	Production of Vaccines	4
17	Methods of immobilization of cells	4
18-19	Upstream processing: General considerations	1

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	Upstream processing: Prokaryotic and eukaryotic systems for biopharmaceutical production	2
20	Downstream processing	2
21	Cell disruption and Centrifugation	2
22	Membrane filtration	2
23	Protein purification: Salting out	2
24	Protein purification: Chromatography	2
25	Protein purification: Chromatography, ion exchange, gel filtration and affinity chromatography	3
26	Production of biopharmaceutical: vaccine	2
27	Production of biopharmaceutical: therapeutic protein	2
28	Immunoassays	5
29	Chromatography, GC & HPLC	5
30	Mass spectroscopy	5
31	Discovery process of biopharmaceutical, different stages and economics	5
32	Role of regulatory authorities in drug development	5
Total:		**100**

Practical Exercises

Exercise No.	Title
1.	General Instructions
2.	Laboratory organization & Important instruments used in Biotechnology laboratory
3.	Methods of sterilization & Preparation of buffers and solution
4-5.	Production of recombinant proteins using bioreactor
6.	Immobilization techniques
7.	Isolation of proteins using cell disruption & Centrifugation techniques
8.	Purification of proteins using ammonium sulphate: Salting out
9.	Buffer exchange using dialysis and membrane filtration
10-11	Affinity chromatography for purification of proteins
12.	Analysis of proteins by one and two dimensional gel electrophoresis
13-16.	Visit to Biopharmaceutical Industry

Text Books:

1. Brown TA. 2001. Gene Cloning and DNA Analysis and Introduction. Blackwell Publ.
2. Sambamurthy K. & Kar A. 2006. Pharmaceutical Biotechnology. New Age International Pvt Ltd Publishers.
3. Crommelin DJA,Sindelar RD and Meibohm B. 2013. Pharmaceutical Biotechnology: Fundamentals and Applications. Springer Publ.
4. Kokare CR. 2013. Pharmaceutical Biotechnology: Fundamentals And Applications. Nirali Publ.
5. Debnath M. 2005. Tools and Techniques of Biotechnology. Pointer Publ
6. Primrose SB & Twyman RM. 2013. Principles of Gene Manipulation and Genomics. John Wiley & Sons.

Course No   : **MEBTEL-365**   Course Title   : **Food Biotechnology**
Credit   : **3(2+1)**   Semester   **: VI**

Theory

<u>UNIT I</u>

Food Biotechnology: Introduction, history and importance; Applications of biotechnology in food processing: Recent developments, risk factors and safety regulations; Food spoilage and preservation process; Food and beverage fermentation: Alcoholic and non alcoholic beverages, food additives and supplements.

<u>UNIT II</u>

Industrial use of micro organisms; Commercially exploited microbes: *Saccharomyces, Lactobacillus, Penecillium, Acetobactor, Bifidobacterium, Lactococcus* and *Streptococcus*; Dairy fermentation and fermented products; Prebiotics and probiotics; Genetic engineering for food quality and shelf life improvement; Bioactive peptides; Labelling of GM foods.

Practical

Isolation, culture and maintenance of biotechnologically important micro-organisms; Use of laboratory and industrial scale shakers; Batch and continuous cultures; Use of fermentors; Detection of pathogens in food and feed; Detection of GM food; Visit to food processing industry**.**

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic to be covered	Weightage (%)
1	Food Biotechnology: Introduction,	2
2	History and importance of food biotechnology	2
3	Applications of biotechnology in food processing: Risk factors and safety regulations	2
4	Factors affecting accumulation of reducing sugars in potatoes	2
5	Sucrose metabolism in potatoes	2
6	Role of membrane in shelf life of tomatoes	2
7	Cell wall metabolism and fruit softening	4
8	Applications of biotechnology in food processing: Recent developments	4
9	Enzymes in fruit juices and brewing industries	4
10	Genes of pectin degrading enzymes	2
11	Biotechnological tools for improving processing qualities of fruits and vegetables	4
12	Food and beverage fermentation: non alcoholic beverages	2
13	Food and beverage fermentation: alcoholic beverages	4
14	Genetic engineering of wine grapes	4
15	Genetic engineering of yeast for fermentation	4
16	Biotechnology of wine yeast	4
17	Food additives and supplements	4
18	Industrial use of micro organisms	4
19	Pectinases of *Aspergillus*	2

20	Applications of microbes for Ore leaching	
21	Commercially exploited microbes: *Saccharomyces, Lactobacillus, Penicillium,* and *Acetobactor*	4
22	Commercially exploited microbes: *Bifidobacterium, Lactococcus* and *Streptococcus*;	6
23	Dairy fermentation and fermented products	4
24	Plasmid biology of dairy starter cultures	2
25	Tools for genetic manipulation of dairy starter cultures	4
26	Genomics of dairy cultures	4
27	Prebiotics	2
28	Probiotics	4
29	Genetic engineering for food quality	2
30	Genetic engineering for shelf life improvement	4
31	Bioactive peptides	4
32	GM foods and its applications	2
Total:		**100**

Practical Exercises

Exercise No.	Title
1	Isolation of biotechnologically important micro-organisms
2	Culture and maintenance of biotechnologically important micro-organisms
3	Inoculum development and maintenance
4	Sterilization
5	Strain improvement by biotechnologically applications
6	Scale up of the process
7	Study of laboratory and industrial scale shakers
8	Study of bioreactors by using batch and continuous cultures
9	Study of fermentation medias
10	Study of types of fermenters
11	Study of downstream processing
12	Production of secondary metabolites
13	Study of biocontrol agents
14	Detection of pathogens in food and feed
15	Detection of GM food
16	Visit to food processing industry like distilleries and breweries

Text Books
1. Hui YH & Khachatourians GG. 1995. Food Biotechnology: Microorganisms. Wiley-VCH.
2. Shetty K, Paliyath G, Pometto A & Levin RE. 2006. Food Biotechnology. 2nd Ed. CRC Press.

Reference Books
1. Singh BD. 2011. Biotechnology Expanding Horizons. Kalyani Publishers, New Delhi.
2. Pelczar MJ Jr., Chan ECS &Krieg NR. 2007. Microbiology, Tata McGraw Hill Publish.

Course No   : **MEBTEL-366**   Course Title   : **Green Biotechnology**
Credit   : **3 (2+1)**   Semester   : **VI**

Theory

<u>UNIT I</u>

Green biotechnology: Definition, concept and implication; Bio-fertilizers and bio-pesticides; Plant growth promoting rhizobacteria; Production of biofuels, biodiesel and bioethanol; Biomass enhancement through biotechnological interventions; Generation of alternate fuels in plants; Identification and manipulation of micro-organisms for biodegradation of plastics and polymers; GMOs for bioremediation andphytoremediation, their roles; Strategies for detection and control of soil, air and water pollutants.

<u>UNIT II</u>

Carbon sequestration; Methanogenic microbes for methane reduction; Microbes for phytic acid degaradation; Genetic Engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake efficiency; Marker-free transgenic development strategies; Development of disease resistant and pest resistant crops through biotechnological tools.

Practical

Identification and efficiency assays of micro-organisms for biodegradation and bioremediation;Isolation of *Bacillus thurigenesis* and plant growth promoting rhizobacteria; Production of biofertilizers, biopesticides and biofuel; Assays for removal of oil spillage**.**

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightage (%)
1	• Green Biotechnology: Definition, Introduction • What is green biotechnology? • History of green biotechnology	4
2	• Concept and implication of Green Biotechnology, Aims, and • Future with green biotechnology	4
3	• Agriculturally important beneficial microorganism • Bio-fertilizers and their types its importance and applications	4
4	• Bio-pesticides their types and its importance and applications • Different plant growth promoting rhizobacteria- Mechanisms of action, Pathogenic roles, Biocontrol agent, Nitrogen fixation, Symbiotic relationships	4
5	• Introduction of biofuels, biodiesel and bioethanol • Procedure for production biofuels, biodiesel and bioethanol • Engineering of plant cell walls for enhanced biofuel production	4
6	• Applications and current status of biofuels, biodiesel and bioethanol	4

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	• Biotechnological approaches for production of biofuels, biodiesel and bioethanol • Current Worldwide status of transgenic research in production of biofuels, biodiesel and bioethanol	
7	Biotechnological Approach to Enhance the Growth and Biomass	6
8	Application of Biotechnology for the Production of Biomass-Based Fuels	4
9	Production of Fuels, Chemicals, and Materials from Biomass	2
10	Anaerobic biotechnological approaches for production of liquid energy carriers from biomass	2
11	Generation of alternate fuels from -Algae-based fuels, Biodiesel from plant source, Alcohol fuels from plant source, Recycling organic waste, etc.	2
12	Identification and Screening of micro-organisms for biodegradation of plastics and polymers	2
13	Manipulation of Plastic Degrading Microbes	2
14	Genetic Engineering (GMOs) approaches to control environmental pollution.	4
15	Genetic Engineering approach forbioremediation and phytoremediation	2
16	Biotech Plants for Bioremediation	2
17	Risk mitigation of genetically modified bacteria and plants designed for bioremediation	4
18	Carbon sequestration- Biosequestration- carbon sequestration through biological processes	4
19	Methods of carbon sequestration in Ocean	2
20	Methanogenic microbes for methane reduction	2
21	Biochemistry of methanogenesis, Natural occurrence of methanogenesis	2
22	Role of methanogenesis in global warming	2
23	Microbes for phytic acid degradation in agriculture and industry	4
24	Genetic Engineering approaches to increasing crop productivity by manipulation of photosynthesis process genes	4
25	Nitrogen fixation and its improvement through genetic engineering approach	4
26-27	Concept of C_3 and C_4 carbon fixation cycle in plant	4
28-29	Marker-free transgenic concept and application	4
30	Controversy and disadvantage of use of markers in transgenic development	4

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31	Strategies for Generating Marker-Free Transgenic Plants	4
32	Biotechnological approaches for disease and pest resistant crops	4
	Total:	**100**

Practical Exercises

Lecture No.	Title
1	Do's and Dont's in Laboratory
2	Microbiology laboratory specifications and organization of equipments and their use
3	Different Sterilization techniques to reduce cross contamination in culture
4	Preparation of culture media and their composition for growth of microorganism
5	Isolation, propagation and storage of *Bacillus thurigenesis*
6	Method of Long and Short Term Storage of *Bacillus thurigenesis*
7	Isolation, propagation and storage of plant growth promoting rhizobacteria
8	Methods of production of biofertilizers
9	Types of biofertilizers formulation
10	Principle of strain selection of *Rizobium&Azotobacter*
11	Methods of production of biopesticides
12	Methods of production of biofuel
13	Isolation and Identification of Endosulfan-Degrading Bacteria
14	Isolation and identification of petroleum hydrocarbon degrading microorganisms from oil contaminated environment
15	Indole acetic acid assay
16	Siderophore production assay

Text Books:

1. Kirkosyan A & Kaufman PB. 2009. Recent Advances in Plant Biotechnology. Springer.
2. Kumar A. 2004. Environmental Biotechnology. Daya Publishing House.
3. Murray DC. 2011. Green Biotechnology. Dominant Publishers and Distributors.
4. Kirkosyan A & Kaufman PB. 2009. Recent Advances in Plant Biotechnology. Springer.
5. Kumar A. 2004. Environmental Biotechnology. Daya Publishing House.
6. Murray DC. 2011. Green Biotechnology. Dominant Publishers and Distributors.
7. Pooja. 2010. Textbook of Green Biotechnology. Discovery Publishing House Pvt. Ltd.
8. Murray DC. 1993. Green Biotechnology. Dominant Publishers and Distributors.

Course No   : **BIFEL-361**   Course Title   : **Programming for Bioinformatics**
Credit   : **4 (2+2)**   Semester   : **VI**

Theory

UNIT I

Introduction: Operating systems, programming concepts, algorithms, flow chart, programming languages, compiler and interpreter; Computer number format: Decimal, Binary, Octal and Hexadecimal.

UNIT II

C-Language: History, constant, variables and identifiers, character set, logical and relational operators, data input and output concepts; Decision making: if statement, if-else statement, for loop, while loop and do-while loop; Arrays and functions, file handling;   Programs related to arithmetic operations, arrays and file handling in C.

Practical

UNIT I

PERL-Language: Introduction, variables, arrays, string, hash, subroutines, file handling, conditional blocks, loops string operators and manipulators, pattern matching and regular   expressions in PERL; Sequence handling in PERL demonstrating string, array and hash.

UNIT II

Shell Programming: Concepts and types of UNIX shell, Linux variables, if statements, control and iteration, arithmetic operations, concepts of awk, grep and sed; Sequence manipulations using shell scripting.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightage (%)
1	Introduction to Operating System	4
2	Chronological events in the development of operating system	
3	Operating System Overview: Definitions of Memory, device, processor and file management	6
4-5	Operating System types and Services	4
6-7	Operating System properties and Processes	4
8	Introductory programming concepts	6
9-10	Introduction to algorithms and flow charts	6
11-12	Introduction to programming languages	6
13-14	Compiler and interpreter	6
15-16	Computer number format: Decimal, Binary, Octal and Hexadecimal. Problems on interconversion of number system	8
17	C-Language: History	4
18-19	Constant, variables and identifiers	4
20-21	Character set, logical and relational operators	6
22	Data input and output concepts	4

23-24	Decision making: if statement, if-else statement	6
25-26	For loop, While loop and Do-while loop	6
27-28	Arrays and Functions	6
29	File handling	6
30-31	Programs related to arithmetic operations,	4
32	Arrays and file handling in C	4
	Total:	**100**

Practical Exercises

Exercise No.	Title
1-2	Programs using simple scalar and array variables: • To transcribe DNA sequence to RNA • To concatenate sequences • To make reverse complement of sequence • To reverse transcribe RNA to DNA sequence
3-7	Programs based on conditional statements and loops: • To searchmotifs in DNA or protein • To count nucleotides from given DNA and RNA sequences • To report percentage of hydrophobic amino acid in given protein • To write PERL script to report GC content of sequence • To search a motif in DNA and Protein sequence using regular expression and print it on screen (use special variables '$&' if required) • To focus using following PERL features for above mentioned programs: (1) Open and unless calls (2) do-until loop (3) foreach loop (4) Perl built in functions like Split, Pop, Shift etc.
8-10	Programs based on Subroutines: • To write a subroutine and calling it- Scoping a subroutine- Passing arguements to subroutine- Using Pass by value and Pass by reference- • To demonstrate the Perl Debuggers Programs like starting a debugger, setting breakpoints. Usage of 'use warnings' and 'use strict' utilities.
11	Programs based on concept of randomization: • To write a program to simulate DNA mutation • To write programs calculating percent identity between pairs of random DNA sequence
12-13	Introduction to hash datatype: • To write a program to manage Genetic code and redundancy in genetic code • To write program that translate DNA into protein • To write a program that Read FASTA file and extract the sequence data • To read DNA sequence from FASTA file, translate to protein and report the formatted output • To work with reading frames. (Example: Writing programs that translate DNA in all six reading frames)
14-15	Working with Restriction Maps and Regular Expressions: • To make programs for parsing REBASE datafile and creating a subroutine • To make restriction map from user input on names of restriction enzymes

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16	Working with GenBank files
	    • To program for separating Annotation from sequences from GenBankflatfile
	    • To programs for parsing annotation using arrays
	    • To program for parsing FEATURE table data

17-19	Working with PDB files:
	    • To program to extract sequence from PDB file
	    • To program for extracting secondary structure information from PDB file. (Examples: HELIX, SHEET, TURN record types of PDB file)

20	Working with BLAST output:
	    • Parsing BLAST output. (Example : Extract annotation and Alignment)
	    • To use BIOPERL module

21-23	Getting Started with Shell Programming:
	    • How to write shell script,
	    • Variables in shell,
	    • How to define User defined variables (UDV)
	    • Rules for Naming variable name (Both UDV and System Variable)
	    • How to print or access value of UDV (User defined variables)
	    • echo Command
	    • Shell Arithmetic
	    • More about Quotes
	    • Exit Status- The read Statement-
	    • Wild cards (Filename Shorthand or meta Characters)
	    • More commands on one command line
	    • Command Line Processing
	    • Why Command Line arguments required
	    • Redirection of Standard output/input i.e. Input - Output redirection
	    • Pipes- Filter-
	    • What is Processes- Why Process required-
	    • Linux Command(s) related with Process

24-26	Shells (bash) structured Language Constructs:
	    • Decision making in shell script (i.e. if command)
	    • test command or [expr]
	    • if...else...fi- Nested ifs- Multilevel if-then-else-
	    • Loops in Shell Scripts
	    • for loop- Nested for loop- While loop-
	    • The case Statement
	    • How to de-bug the shell script?

27-30	awk Revisited:
	    • Getting Starting with awk
	    • Predefined variables of awk
	    • Doing arithmetic with awk
	    • User Defined variables in awk
	    • Use of printf statement
	    • Use of Format Specification Code
	    • if condition in awk
	    • Loops in awk

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	• Real life examples in awk
	• awkmiscellaneous
	• sed - Quick Introduction
	• Redirecting the output of sed command
	• How to write sed scripts?
	• More examples of sed-
31-32	Sequence manipulations using shell scripting-

Text Books:
1. Balagurusamy. 2008. *Programming in ANSI C*. Tata McGraw-Hill Education.
2. James Tisdall. 2003. *Mastering Perl for Bioinformatics*. O'Reilly Media.
3. Tom Christiansen, Brian D Foy, Larry Wall & Jon Orwant. 2012. *Programming Perl*.4thEd. O'Reilly Media.
4. KanetkarYashavant. 2013. *Let Us C*. BPB Publications.

Course No : **BIFEL-462** Course Title: **Bioinformatics Tools and Biological Databases**
Credit : **3(2+1)** Semester : **VI**

Theory

UNIT I

Introduction: Biological data types, collection, classification schema of biological databases; Biological databases retrieval systems; Sequence and molecular file formats.

UNIT II

Biological databases: Nucleotide database, protein database, structural database, genome databases, metabolic pathway database, literature database, chemical database, gene expression database, crop database with special reference to BTISNET databases.

UNIT III

Bioinformatics Tools: Concept of alignment, scoring matrices, alignment algorithms, heuristic methods, multiple sequence alignment, phylogenetic analysis, molecular visualization tools.

Practical

NCBI; Expasy: SwissProt; EBI; Search engines: ENTREZ and SRS; Perform local alignment using all BLAST variants; Multilple sequence alignment using ClustalW; T Coffee; phylogenetic analysis by PHYLIP; MEGA.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightage (%)
UNIT I		
1	Introduction: Biological data types	5
2-3	Collection, classification scheme of biological databases; primary and secondary databases, Nucleotide, protein, molecular etc.	5
4-5	Biological databases retrieval systems; Entrez, SRS	5
6-7	Sequence and molecular file formats :Genbank, EMBL, Fasta, PDB, Flat file, ASN.1, XML	5
UNIT II		
8-10	Biological Databases : Primary databases: Nucleotide sequence databases (GenBank, EMBL),	07
11-12	Protein sequence databases; Secondary databases: SwissProt/TrEMBL, conserved domain database, Pfam;	07
13-15	Structural databases: Protein Data Bank (PDB), MMDB, SCOP, CATH;	07
16-17	Genome databases : Model plant database Arabidopsis and Rice metabolic pathway database : KEGG, MetaCyc, PMN	05
18-19	Literature database: chemical database,crop database with special reference to BTISNET databases.	05
UNIT III		
20-21	Bioinformatics Tools: Concept of alignmentsequence alignment and its applications: Pair wise and multiple sequence alignment,	7
22	Concept of local and global alignment	7

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	Alignment Algorithms: Dot Matrix method, dynamic programming methods (Needleman–Wunsch and Smith–Waterman); heuristic methods	
23-25	Alignment Algorithms: Dot Matrix method, dynamic programming methods (Needleman–Wunsch and Smith–Waterman); heuristic methods	10
26-27	Multiple sequence alignment: Tools of MSA: ClustalW, TCoffee;	07
28-29	Phylogenetic analysis: Phylogeny and methods of phylogenetic analysis	10
30-32	Molecular visualization tools : Rasmol, Friend, Jmol	08
	Total:	**100**

Practical Exercises

Exercise No.	Practical Exercise
1	To access information from NCBI database
2	To access information from EBI database
3-4	To retrieve information using search engines: ENTREZ
5-6	To retrieve information using search engines: SRS
7-8	To study protein database : Expasy:
9-10	To study protein database : SwissProt
11	To perform Blast analysis: Blast program.
12	Multilple sequence alignment using ClustalW
13-14	Multilple sequence alignment using T Coffee
15	Phylogenetic analysis by PHYLIP
16	Sequence analysis and graphic viewer : MEGA

Text Books:
1. Baxevanis AD. & Ouellette BFF. 2001. *Bioinformatics: A practical guide to the analysis of genes and proteins.*John Wiley and Sons.
2. Mount DW. 2001. *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor.
3. Xiong J. 2006. *Essential Bioinformatics.*Cambridge University Press

Theory

UNIT I

Introduction to structural databases of macromolecules, natural and synthetic small molecules; Structure of amino acids; Protein structure classification, Ramachandran plot; Experimental structure determination methods; Motifs, domain, profiles, fingerprint and protein family databases.

UNIT II

Structural features of RNA, RNA secondary structure predictions; RNA folding; Small RNA prediction.

UNIT III

Structure prediction: Basics of protein folding, protein folding problem, molecular chaperons; Secondary structure prediction methods and algorithms: Homology, *ab initio* and folding based tertiary structure prediction; Structure validation tools, energy minimization techniques; Introduction to molecular dynamics and simulation, Monte-Carlo methods, Markov chain and HMM; Structure visualization and comparison methods.

Practical

Protein structural classification databases, 3D-Structural databases searching and retrieval, Ramchandran Plot, Structural visualization tools, Tools for protein secondary and tertiary structure prediction; RASMOL, Cn3D, CHIMERA, SWISSPDBviewer, CPH, MODELLER, SWISS Model, EasyModeler, Procheck; GROMAC; SANJIVNI; BHAGIRATH.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightage (%)
1-2	Introduction to structural databases of macromolecules, natural and synthetic small molecules	4
3	Structure and physico-chemical properties of amino acids	4
4-5	Protein structure classification (Primary, secondary, super secondary, tertiary and quaternary structure of protein)	6
6-7	Dihedral angles or Tortional angles and Ramachandran plot	6
8-9	Experimental structure determination methods: NMR and X-crystallography	6
10-11	Concept and definition of Motifs, domain, profiles and fingerprint.	6
12-13	Introduction and need of protein family databases or derived databases	6
13-14	Structural features of RNA and types of RNA	6
15-16	RNA secondary structure predictions	6
17	RNA folding	6
18-19	Small RNA prediction	6
20-21	Structure prediction: Basics of protein folding, protein folding problem, molecular chaperons	6
22-23	Secondary structure prediction methods and algorithms structure	6

24-25	Homology, *ab initio* and folding based tertiary structure prediction	6
26	Structure validation tools	4
27-28	Energy minimization techniques	6
29-30	Introduction to molecular dynamics and simulation, Monte-Carlo methods, Markov Chain and HMM	6
31-32	Visualization and Comparison methods	4
	Total:	**100**

Practical Exercises

Exercise No.	Title
1	To study protein structural classification databases (CATH and SCOP)
2	To study 3D-structural databases searching and retrieval (e.g. PDB + Nucleic acid databank, PMDB)

3	To study Structural visualization tools (SPDBV) or RASMOL, SWISSPDB viewer, Cn3D
	 • To perform following tasks on a molecule using DeepView
	    • Selecting and Displaying
	    • Colouring
	    • Measuring and labeling

4	• To apply crystallographic symmetries:
5	• To build a full multimer from a pdb file containing only a monomer (subunit) of a protein by applying non-crystallographic symmetries.
6	• To study the interactions in the subunit interface. • To compare Conformations of Proteins: (example: Deoxyhemoglobin and Oxyhemoglobin)
7	• To use Ramachandran Plot • To examine Electron Density Maps
8	• To perform *in silico* mutagenesis and analyze Side chain conformations • To alter the model (PDBID 1HEW) by changing an isoleucine residue to glutamine.
9	• To investigate whether the new residue might form an additional H-bond to inhibitor tri-NAG.
10- 11	Protein secondary structure prediction(First generation, second generation and Third generation methods) using online servers
12- 14	Protein tertiary structure prediction methods: (CPH, MODELLER, SWISS Model, EasyModeler).
15- 16	Estimation of Predicted Models: ProCheck, ERRAT, Verify3D, Prove, Prosa etc.

Text Books:
1. A.Malcolm Campbell & Laurie J.Heyer. 2007. *Discovering Genomics, Proteomics and Bioinformatics*. Benjamin Cummings.
2. Allan Hinchkliffe. 2008. *Modeling for Beginners*. Wiley.
3. Creighton TE. 1993. *Proteins: Structures and Molecular Properties*. W.H. Freeman
4. Mount DW. 2001. *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor.

Reference Book:
1. Setubal Joao &Meidanis Joao. 1997. *Introduction to Computational Molecular Biology*.PWS Publishing Company

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Course No   : **BIFEL-463**   Course Title   : **Pharmacogenomics**
Credit   : **3(2+1)**   Semester   : **VI**
Theory

UNIT I

Basic concepts of pharmacogenomics, clinical application and challenges in pharmacogenomics; Human Genome Project, genetic diseases, personalized medicine and pharmacogenomics necessity in drug designing; Prediction of structural changes among sequence variants and genetic analysis; Microsatellites for studying genetic variations; Drug databanks; Gene therapy.

UNIT II

Drug Design: Study of important drug targets and their variations; Pharmacophore designing, prediction of ADME properties; Computational tool for toxicity prediction; SAR and QSAR techniques in drug designing; Drug receptor interactions; Structural based drug design; Lipinski's rule in drug design.

Practical

Receptor-Ligand interactions, Pharmacophore development; OSDD; DrugBank; PubChem; molecular representation using SMILES; Chemsketch: 2D and 3D structure; Structure analyses using Chimera/VMD; Detection of active site of proteins using various software; bioavailability using Mol inspiration; Docking using HEX and AUTODOCK.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightage (%)
1-2	Basic concepts of pharmacogenomics: Definition and History of medical concepts in pharmacogenomics	6
3-4	Clinical application and challenges in pharmacogenomics	6
5, 6, 7	Human Genome Project, Genetic diseases, Personalized medicine and Molecular basis of personalized medicine	8
8	Pharmacogenomics necessity in drug designing	4
9-11	Prediction of structural changes among sequence variants and genetic analysis	8
12-13	Microsatellites for studying genetic variations.	6
14-15	Drug databanks:	6
16	Gene therapy:	6
17-18	Study of important drug targets and their variations:	6
19-20	Pharmacophore modelling- • Pharmocophore: Definition and classes (HBA, HBD, Aromatic etc.) • Identification of pharmacophore features	6
21-22	Prediction of ADME properties	6
23-24	Computational tools for toxicity prediction	6
25-26	SAR and QSAR techniques in drug designing	8
27-28	Drug receptor interactions:	6
29-30	Structural based drug design	6
31-32	Lipinski's rule in drug design	6
	Total:	**100**

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Practical Exercises

Exercise No.	Title
1-3	Molecular Docking Using HEX and AUTODOCK: Docking Studies: • Approaches in Target identification • Methods of Active site analysis • Ligand preparation and conformational analysis • Rigid and flexible docking • Structure based design of lead compounds • Library docking • Molecular vizualition of docked complexes • Interaction analysis • Preparing Publication quality molecular graphics and illustrations
4 5 6	Using Chemsketch: • Chemical Structure representation: 1D, 2D and 3D structures • Molecular file formats (SMILES, WLN, SDF, MOL,PDBetc). • Compound library formatting and filtering (Physicochemical and substructure filters)
7-8	Browsing and searching by DrugBank and PubChem:
9-10	Open Source Drug Discovery (OSDD): Assignment on Community Developed Resources
11	Molecular representation using SMILES
12	Structure analyses using Chimera/VMD
13-14	Detection of active site of proteins using various softwares
15-16	Bioavailability using MolInspiration

Text Books:
1. Allan Hinchkliffe. 2008. *Modeling for Beginners*. Wiley- Blackwell Publishing.
2. GerdFolkers, Wolfgang Sippl, Didier Rognan& Hans Dieter. 2003. *Molecular Modeling: Basic Principles and applications*. Science.
3. Gupta S.P. 1996. *Quantum Biology*.New Age.
4. Lisa B. *Combinatorial Library Methods and Protocols*

Course No	: **BIFEL-465**	Course Title	: **Metabolomics and System Biology**
Credits	: **3(2+1)**	Semester	: **VI**

Theory

UNIT I

Metabolomics overview, major metabolic pathways: Glycolysis, Kreb's cycle, oxidative phosphorylation, amino acid, fatty acid and nucleotide metabolism, their control and integration; Metabolic flux and metabolic profiling; Catalytic mechanisms and enzyme kinetics, Michaelis-Menton kinetics; Conformational change, allosteric regulations, regulation of metabolic pathways; Signal transduction: Inter and intra cellular communications; Receptor ligand interaction; Structural components of signal pathways: G-protein, Jak-stat, receptor tyrosine kinase.

UNIT II

Signal Flow: Pathway to networks, small scale system biology experiments; System analysis of complex diseases, system pharmacology; Assembling large data sets in genomics and proteomics, computational analysis of large data sets, building networks; Mathematical representation of cell biological system, time and space.

Practical

Metabolic pathway databases KEGG, BRENDA, Biosilico, Protein-protein interaction databases, Swiss 2D PAGE, E-PCR; Creating networks using Cytoscape, DAVID, MAS3; in silico functional annotation using GO, AGRIGO, PANTHER, BLAST2GO.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topics	Weightage (%)
1	Introduction, Definition and Overview of Metabolomics	4
2-3	Major metabolic pathways: Glycolysis, Kreb's cycle,	4
4	Oxidative phosphorylation, their control and integration.	4
5-6	Major metabolic pathways: Amino acid, Fatty acid and Nucleotide metabolism, their control and integration.	8
7	Metabolic flux and metabolic profiling	4
8-9	Catalytic mechanisms and enzyme kinetics includingMichaelis-Menton kinetics	6
10-11	Regulation of metabolic pathways by Conformational change and allosteric regulations.	6
12-13	Introduction to Signal transduction, general steps involved in Inter and intra cellular communications and classification of cell signaling based on distance travelled by the molecule.	6
14	Structural components of signal pathways: GPCR Pathway.	5
15-16	Structural components of signal pathways: RTKPathway and Jak-Stat.	5
17	Receptor-ligand interaction and receptor mediated endocytosis	4
18	Signal Flow: Pathway to networks,	5
19	Signal Flow: small scale system biology experiments	5
20-21	System analysis of complex diseases	5
22-23	System pharmacology	5
24-26	Assembling large data sets in genomics and proteomics	8

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27-29	computational analysis of large data sets, building networks	8
30-31	Mathematical representation of cell biological system, time and space-I	4
32	Mathematical representation of cell biological system, time and space-II	4
	Total:	**100**

Practical Exercises

Exercise No.	Title
1	Metabolic pathway mapping by KEGG
2	Text based queries by BRENDA
3	Structure based queries by BRENDA
4	Search and analysis of metabolic pathways by BIOSILICO
5	MIPS (Mammalian Protein-Protein Interaction Database)
6	Protein-Protein interaction databases searching
7	Swiss 2D PAGE searching and maps
8-9	E-PCR searching for sub-sequences that closely match the PCR primers and have the correct order, orientation and spacing.
10	Creating networks using Cytoscape
11-12	Database for Annotation, Visualization andIntegrated Discovery (DAVID) for functional annotation.
13	Molecule annotation system (MAS) 3.0 and GO terms
14-15	*In silico* functional annotation using AGRIGO, PANTHER,
16	*In silico* functional annotation using BLAST2GO.

Text Books:
1. Berg JM, Tymoczko JL &Stryer L. 2002.*Biochemistry*.5th Ed. W.H. Freeman and Company.
2. Fersht A. 1999. *Structure and Mechanism of protein science*. W.H. Freeman and Company.
3. Klipp E, Herwig R, Kowald A, Wierling C, Lehrach H. 2006. *Systems Biology in practice.Concepts, implementation and Application*.Wiley VCH.

Reference Books:
1. Vaidynathan S, Harrigan GG, Royston Goodacre. 2005. *Metabolome analysis: Strategies for system biology*. Springer.
2. Voet D &Voet J. 2002.*Biochemistry*3rd Ed. John Wiley and Sons.

Course No   : **BIFEL-466** Course Title   : **Computational Methods for Data Analysis**
Credits   : **3(2+1)**   Semester   : **VI**

Theory

UNIT I
Introduction to UNIX/LINUX operating system; Knowledge discovery and data mining techniques; Machine learning and pattern recognitions, hidden markov models; Artificial neural networks, Support vector machines.

UNIT II
Principal component analysis, ANOVA; AMOVA and different clustering methods; Gene Prediction algorithms and Phylogeny algorithms; Basics of R statistical package.

Practical

Gene prediction: FGENESH; R statistical package installation and configuration, GUI for R: R-commander, R-studio, RKWard; Analysis of gene expression using R; GNU PSPP, Scilab, QtiPlot.

Teaching Schedule- Theory with weightage (%)

Lecture No.	Topic	Weightage
1	Introduction to UNIX/LINUX operating system:	4
2	Introduction to structure of UNIX/LINUX, Concepts-	
3	UNIX/LINUX operating system: Commands and special features.	6
4	Processes and UNIX/LINUX file system-	
5	Knowledge discovery -	8
6-7	data mining techniques-	
8-10	Machine learning and pattern recognitions	8
11-12	Introduction to Hidden Markov models	6
13-14	Artificial neural networks	6
15-16	Support vector machines	4
17-18	Principal component analysis: Principle Component analysis procedure, How do we find the coefficients?, Interpretation of the principle component	6
19-20	Analysis of Variance (ANOVA): One way ANOVA, Two way ANOVA	6
21	Analysis of Molecular Variance (AMOVA):	4
22	Clustering methods: Sequence and character based methods UPGMA , Neighbor joining	6
24-25	Gene Prediction algorithms: Gene prediction in Eukaryotes by Neural networks and pattern discrimination method.	6
26-27	Gene Prediction in Prokaryotes by the scoring Matrix method and Reliability of Matrix Method-	6
28-29	Phylogeny algorithms: Distance, Maximum likelihood and Maximum Parsimony method-	6
29-30	Basics of R statistical package: Introduction, Objects and Arithmatic, Summaries and subscripting-	6
31	Matrices, attaching to objects, the apply function-	6
32	Statistical Computation and Simulation, Graphics, Writing Functions-	6
	Total:	**100**

Practical Exercises

Exercise No.	Title
1	Eukaryotic Gene Prediction
2	Prokaryotic Gene Prediction
3	R statistical package installation and configuration
4-5	GUI for R
6	R Data Import/ Export
7	R-Commander
8	R-Studio
9	RKWard
10-11	Analysis of Gene Expression using R
12-13	GNU PSPP
14	Scilab
15-16	QtiPlot

Text Books:
1. Gareth James, Daniela Witten, Trevor Hastie & Robert Tibshirani. 2013. An Introduction to Statistical Learning: with Applications in R. Springer
2. Mathur K Sunil. 2010. Statistical Bioinformatics with R. Elsevier.

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SEMESTER-VII

B.Tech. (Biotechnology)

Course No   : **ET-472**   Course Title   : **Educational Tour**

Credits   : **1(0+1)**   Semester   : **V**

Syllabus:

Educational Tour for South/North India

Identified Institutes/Universities for South/North India educational tour.

1. Central Food Technology Research Institute (CFTRI), Mysore.
2. Indian Institute of Science(IISC), Bangalore.
3. National Centre for Biological Science (NCBS), Banglore.
4. University of Agricultural Sciences (UAS), GKVK Campus, Banglore.
5. University of Agricultural Sciences (UAS), Dharwad.
6. Tamilnadu Agricultural University (TNAU), Coimbatore.
7. Kerla Agricultural University,(KAU) Thrisur, Kerla.
8. International Crop Research Institute for Semi-Arid Tropics (ICRISAT), Hyderabad.
9. Centre for Cellular and Molecular Biology (CCMB), Hyderabad.
10. National Institute of Nutrition(NIN), Hyderabad.
11. Professor Jayshankar Telangana State Agricultural University, Telangana.
12. Anand Agricultural University (AAU), Anand, Gujrat.
13. Navsari Agricultural University, Navsari, Gujrat.
14. Indian Agricultural Research Institute (IARI), New Delhi.
15. ICAR-National Research Centre for Plant Biotechnology (NRCPB), New Delhi.
16. ICAR- National Bureau of Plant Genetic Resources (NBPGR), New Delhi.
17. International Centre For Genetic Engineering And Biotechnology (ICGEB), New Delhi.
18. Punjab Agricultural University (PAU), Ludhiana.
19. Central Potato Research Institute (CPRI), Shimla.

Study Tour Evaluation

Sr. No	Particulars	Marks
1.	Inquisitiveness	10
2.	Report	15
3.	Presentation	10
4.	Assignment (Leadership role, group activities during Educational Tour etc.)	10
5.	Viva	05
Total		**50**

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Four Modules (Only one module to be opted as per chosen elective)

1. Plant Biotechnology

2. Animal Biotechnology

3. Microbial and Environmental Biotechnology

4. Bioinformatics

STUDENT READY Programme

SEMESTER VII

MODULES *
1. PLANT BIOTECHNOLOGY**
  i. **Course No.**   : READY-PB-471
     Course Title   : Micro-propagation of field, horticultural and
                          Medicinal plants
     Credits   : 0+20

  ii. **Course No.**   : READY-PB-472
      Course Title   : DNA Fingerprinting and hybridity testing
      Credits   : 0+20

2. ANIMAL BIOTECHNOLOGY**
  i. **Course No.**   : READY-AB-471
     Course Title   : Dissemination of *Elite* germplasm of any species by frozen
                          Semen technology
     Credits   : 0+20

  ii. **Course No.**   : READY-AB-472
      Course Title   : Molecular diagnostics for diseased/disordered animals
      Credits   :0+20

3. MICROBIAL AND ENVIRONMENTAL BIOTECHNOLOGY**
  i. **Course No.**   : READY-MEB-471
     Course Title   : Production of Probiotics/ Fermented Milk Products
     Credits   : 0+20

  ii. **Course No.**   : READY-MEB-472
      Course Title   : Mushroom Production and Processing Technology
      Credits   : **0+20**

  iii. **Course No.**   : READY-MEB-473
       Course Title : Liquid Biofertilizer Production Technology
       Credits   : 0+20

4. BIOINFORMATICS**

    i. **Course No.** **:** READY-BIF-471
       Course Title **:** Biological database creation and its management
       Credits **:** 0+20

    ii. **Course No.** **:** READY-BIF-472
       Course Title **:** Bioinformatics: Gene to genome
       Credits **:** 0+20

    iii. **Course No.** **:** READY-BIF-473
       Course Title **:** Drug designing and pharmacogenomics
       Credits **:** 0+20

    iv. **Course No.** **:** READY-BIF-474
       Course Title **:** AgriSciences utility tool designing
       Credits **:** 0+20

(*****To be opted only one module as per the chosen electives)
(****** To be opted only one module as per the interest of the student and expertise available)

Objectives

- To promote professional skills and knowledge
- To build confidence and to work in project mode
- To provide an opportunity to the students for practical learning in agro-biotech based industries
- To develop competence, capability, capacity building, acquiring skills, expertise and built up confidence among the students to start their own enterprise and turn job creators instead of job seekers.

MODULES ON PLANT BIOTECHNOLOGY

Course No. : READY-PB-471
Course Title : Micro-propagation of field, horticultural and medicinal plants
Credits : 0+20
Semester : VII

Sr. No.	Activities	Week(s)
Stage 0 : Preparative stage		
1.	Orientation, book keeping and records, market survey to estimate the demand and source, Cleaning and fumigation of laboratory rooms *viz.,* working, transfer, culture rooms and *in vivo* transfer area; washing and sterilization of glassware's and plastic-wares, handling of laboratory equipments and chemicals, preparation of stock solution.	1st week
Stage 1 : Initiation of culture		
2.	Preparation of establishment media for field crops e.g. sugarcane; horticultural e.g. banana, pomegranate and ornamental flowers and medicinal plants; choice/selection of explant and its virus indexing, sterilization of explant, maintenance of environmental parameters in culture room, inoculation of explant, observations on growth and contamination of explant.	2nd and 3rd week
Stage 2 : Shoot multiplication		
3.	Preparation of shooting media, sub-culturing of shoots for multiplication, maintenance of environmental parameters in culture room, observations on growth and contamination of explant, shoot elongation.	4th to 12th week
Stage 3 : Root induction and development		
4.	Preparation of rooting media, culturing of elongated shoots for rooting, maintenance of environmental parameters in culture room, observations on growth and contamination of explant	13th to 16th week
Stage 4 : Hardening and marketing aspects		
5.	Primary and secondaryhardening, estimation of costs and returns, operation costs, investment capital requirement and feasibility analysis, identification of market channels and estimation of marketing costs and margins,	17th to 20th week
6.	Preparation of project proposal for establishments of commercial units, Entrepreneurship development in field crops e.g. sugarcane; horticultural e.g. banana, pomegranate and ornamental flowers and medicinal plants.	17th to 20th week
7.	Report writing and examination.	1st to 24th week

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Course No. : READY- PB-472
Course Title :DNA Fingerprinting and hybridity testing
Credits :0+20
Semester : VII

Sr. No.	Activity	Week(s)
1.	Preamble, book keeping and records, market survey to estimate the demand and source, sterilization of glassware's, and plastic wares and some reagents by autoclaving and ultra filtration, handling of laboratory equipments and chemicals, selection of the crop for DNA Fingerprinting of the released varieties and hybridity testing of newly developed hybrids.	1st to 2nd week
2.	Preparation of stock solution for DNA isolation, preparation of extraction buffer and crushing sample in liquid nitrogen (LN), DNA isolation by suitable reported method.	3rd and 6th week
3.	Qualitative and quantitative analysis of the isolated DNA by spectrophotometer.	7th week
4.	Preparation of 0.8% agarose gel, resolution of isolated DNA by agarose gel electrophoresis, documentation of gel under UV Trans-illuminator for quantification and checking of the quality of the isolated DNA	7th week
5.	Selection/designing of primers for fingerprinting or hybridity testing (RAPD, SSR, ISSR, SNP, SCAR, candidate gene specific primers etc.,), standardization of annealing temperature for primers, PCR amplification of DNA with particular primers at standardized annealing temperature.	8th to 12th week
6.	Preparation of appropriate conc. of agarose gel, resolution of amplified DNA by agarose gel electrophoresis, documentation of gel under UV Trans-illuminator, analysis of data with appropriate software.	13th to 15th week
7.	Estimation of costs and returns, operation costs, investment capital requirement and feasibility analysis, Identification of market channels and estimation of marketing costs and margins	16th to 19th week
8.	Preparation of project proposal for establishments of commercial units, Entrepreneurship development in DNA Fingerprinting and hybridity testing.	16th to 19th week
9.	Report writing and examination.	1st to 24th week

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B.Tech. (Biotechnology)

Course No. : READY-AB-471
Course Title : Dissemination of Elite germplasm of any species by frozen semen technology
Credits : 0+20
Semester : VII

Sr. No.	Activities	Week(s)
1.	Orientation, book keeping and records, market survey to estimate the demand and source,	1st week
2.	Identification of frozen semen straws of species to be manufactured Analysis of the existing status of the identified product and targeted market and customer. Innovativeness and creativity Preparation of the project proposal	2nd and 3rd week
3.	Organization of resources Organizing utility Sequential grouping of activities Packaging and storage Frozen semen straws pricing-physical inputs, man hands, delectation.	4th to 10th week
4.	Regularity in production SOP QC testing Maintenance of production records Team work	11th to 18th week
5.	Strategy Sales volumes Assessment of sale performance Profit generated including C/B ------ pay back period etc.	18th to 20th week
6.	Preparation of project proposal for establishments of commercial units, Entrepreneurship development in Elite Germplasm of any species by Frozen Semen Technology	18th to 20th week
7.	Report writing and examination.	1st to 24th week

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Course No. : READY-AB-472
Course Title : Molecular diagnostics for diseased animals
Credits : 0+20
Semester : VII

Module III.Molecular diagnostics for diseased animals

Sr. No.	Activity	Week(s)
1	Preamble, book keeping and records,market survey to estimate the demand and source, sterilization of glassware's, and plastic wares and some reagents by autoclaving and ultra filtration, handling of laboratory equipments and chemicals	1st to 2nd week
2	Preparation of stocksolution for DNA isolation, preparation of extraction buffer, sample collection and DNA isolation by suitable reported method.	3rd and 6th week
3	Qualitative and quantitative analysis of the isolated DNA by spectrophotometer.	7th week
4	Preparation of 0.8% agarose gel, resolution of isolated DNA by agarose gel electrophoresis, documentation of gel under UV Trans-illuminator for quantification and checking of the quality of the isolated DNA	7th week
5	Selection/designing of primers for diagnosis of diseased animals, standardization of annealing temperature for primers, PCR amplification of DNA with particular primers at standardized annealing temperature.	8th to 12th week
6	Preparation of appropriate conc. ofagarose gel, resolution of amplified DNA by agarose gel electrophoresis, documentation of gel under UV Trans-illuminator, analysis of data with appropriate software.	13th to 15th week
7	Estimation of costs and returns, operation costs, investment capital requirement and feasibility analysis, Identification of market channels and estimation of marketing costs and margins	16th to 19th week
8	Preparation of project proposal for establishments of commercial units, Entrepreneurship development inmolecular diagnostics for diseased animals.	16th to 19th week
9	Report writing and examination.	1st to 24th week

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B.Tech. (Biotechnology)

MODULES ON MICROBIAL AND ENVIRONMENTAL BIOTECHNOLOGY

Course No.   : READY-MEB-471
Course Title : Production of Probiotics/ Fermented Milk Products
Credits   : 0+20
Semester   : VII

Sr. No.	Activities	Week(s)
1	Orientation, book keeping and records,market survey to estimate the demand and source, Cleaning and fumigation of laboratory rooms *viz.,* working, transfer, culture rooms; washing and sterilization of glassware's and plastic-wares, handling of laboratory equipments and chemicals, preparation of stock solution.	1st 2nd & 3rd week
2	Culture activation	4th & 5th week
3	Culture preparation : Isolate the best culture and inoculate the same and store as a stock culture	6th, 7th & 8th week
4	Preparation of various fermented milk products or probiotics.	9th, 10th, 11th, 12th, & 13th week
5	Packaging ofvarious fermented milk products or probiotics in proper packaging material with proper label.	14th, 15th & 16th week
6	Preparation of project proposal for establishments of commercial units, Entrepreneurship development in Production of Probiotics/ Fermented Milk Products	17th &20th week
7	Report writing and examination.	1st to 24th week

Course No. : READY-MEB-472
Course Title : Mushroom Production and Processing Technology
Credits   : 0+20
Semester : VII

Sr. No.	Activities	Week(s)
1.	Orientation, book keeping and records,market survey to estimate the demand and source, Cleaning and fumigation of laboratory rooms *viz.,* working, transfer, culture rooms; washing and sterilization of glassware's and plastic-wares, handling of laboratory equipments and chemicals, preparation of stock solution.	1st & 2nd week
2.	Preparation & sterilization of media; Isolation of culture and maintenance of pure culture	3rd week
3.	Substrate sterilization and preparation: sterilisation/pasteurisation; Spawn production : Spawn produced on sterilized wheat grains.	4th & 5th week
4.	Substrate inoculation and spawn run : Fermentation and composting, filling of the beds in plastic bags; perforation of the plastic bags	6th & 7th week
5.	Casing of mushroom bed; formation of pinhead	8th week
6.	Harvesting and Packaging : Harvest crop after 3-4 days of pinhead initiation and packed in proper packaging material with proper label. Store at 4^oC in cold storage rooms and processed (drying).	9th to15th week
7.	Sales and marketing: Simultaneously sale will be continue throughout the production period as fresh, dry mushroom or as mushroom products.	16th &17th week
8.	Preparation of project proposal for establishments of commercial units, Entrepreneurship development in Mushroom Production and Processing Technology	18th &20th week
9.	Report writing and examination.	1st to 24th week

Course No.   : READY-MEB-473
Course Title : Liquid Biofertilizer Production Technology
Credits   : 0+20
Semester   : VII

Sr. No.	Activities	Week(s)
1	Orientation, book keeping and records,market survey to estimate the demand and source, Cleaning and fumigation of laboratory rooms *viz.,* working, transfer, culture rooms; washing and sterilization of glassware's and plastic-wares, handling of laboratory equipments and chemicals, preparation of stock solution.	1st & 2nd week
2	Isolation of beneficial microorganism from plant & soil	3rd to 6th week
3	Preparation of mother or starter cultures	7th &8th week
4	Preparation of broth cultures and preparation of liquid biofertilizer with cell protectants and aduvants	9th to12th week
5	Filling and packaging of bottleswith proper labels	13h to16th week
6	Preparation of project proposal for establishments of commercial units, Entrepreneurship development in Liquid Biofertilizer Production Technology	17th & 20th week
7	Report writing and examination.	1st to 24th week

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B.Tech. (Biotechnology)

Course No. : READY-BIF-471
Course Title : Biological database creation and its management
Credits : 0+20
Semester : VII

Sr. No.	Activities	Week(s)
1	Orientation, Market survey and industrial potential of bioinformatics, Introduction to operating system, Introduction to bioinformatics and the internet - Internet Basics - Connecting to the Internet - Electronic Mail - File Transfer Protocol - The World Wide Web Overview of Bioinformatics resources on the web Example: NCBI/EBI/EXPASY etc.	1st week
2	Biological databases retrieval systems - ENTREZ - SRS Exploring sequence databases - Biological literature databases (PubMed, Agricola) - Nucleic acid sequence databases (NCBI's GenBank + the European Nucleotide Archive [ENA] + the DNA Data Bank of Japan [DDBJ], RefSeq database, dbEST) - Protein sequence databases (UniProtKb) - RNA sequence databases (miRBase, lncRNAdb)	2nd and 3rd week
3	Study of Derived databases - Interpro and its constituent databases like Prosite, PIR, Prodom, Prints,Hamap, Gene3D etc., Exploring Structural database - PDB, Nucleic acid databank Specialized databases - Genome database - Metabolic pathway database (KEGG, BioCyc, BRENDA) - Chemical database - Gene expression database - Crop databases	4th to 7th week
4	Introduction: Biological data types, collection, classification schema of biological databases Sequence and molecular file formats	8th to 10th week

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	Introduction to database management system
	   • Database designing, data acquisition
	   • Data Abstraction, Data Models, Instances & Schemes
	   • 5E-R Model
	      o Entity and entity sets
	      o Relations and relationship sets
	      o E-R diagrams
	   • Reducing E-R Diagrams to tables
	   • Relational Algebra and relational Calculus
	   • Data Normalization
	   • Basic concepts and applications of Network Data Model, Hierarchical Data
	   • Model, Multimedia Database, Textual Databases	

5	Introduction to WAMP
	   • Windows Apache MySQL PHP
	
	Databases & Computational Biology
	      o MySQL database architecture (basics).
	      o The Client/Server architecture
	      o Server Application Programming concept
	   • Parsing large scale data
	   • Various file formats
	   • Perl Advance Modules
	      ▪ LWP
	      ▪ Mechanize
	      ▪ HTML/XML parsing
	   • MySQL Advance programming
	   • Loading database by parsing all parsable file
	   • Web based front-end designing
	      ▪ HTML introduction
	   • Server side communication with web based front end.
	      ▪ CGI & PHP
	      ▪ MySQL-PHP Connectivity, Querying
	      ▪ MySQL-PERL Connectivity, Querying
	   • Server Development using available packages WAMP/XAMPP/LAMP
		11th to 13th week

6	Creation of web page(s)- HTML Creation of web page(s)- HTML Case study and analysis on any one biological database IPR related issues regarding biological database creation and management Market survey Industrial potential of biological database(s) Entrepreneurship development in the field of biological database	14th to 19th week
7	Preparation of project proposal	19th to 20th week
8	Report writing and examination.	1st to 24th week

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B.Tech. (Biotechnology)

Course No. : READY-BIF-472
Course Title : Bioinformatics: Gene to genome
Credits : 0+20
Semester : VII

Sr. No.	Activities	Week(s)
1.	Orientation, Market survey and industrial potential of bioinformatic Introduction to operating system Introduction to bioinformatics and the internet • Internet Basics • Connecting to the Internet • Electronic Mail • File Transfer Protocol • The World Wide Web Overview of Bioinformatics resources on the web. Example: NCBI/EBI/EXPASY etc., Biological databases retrieval systems • ENTREZ • SRS	1st week
2.	Sequence validation and submission to public database Biomolecular sequence analysis: Overview and Concepts Pairwise sequence alignment algorithms (Dot Matrix analysis, Needleman &Wunsch, Smith & Waterman) Scoring matrices for Protein and Nucleotide sequences (PAM series and BLOSUM series) Database Similarity Searches (BLAST & FASTA) Multiple sequence alignment algorithms (CLUSTAL,T-Coffee)	2nd and 3rd week
3.	Nucleotide sequence analysis using EMBOSS Protein sequence analysis using ExPasy Molecular phylogenetics: Overview, Concepts in molecular evolution 1. Molecular Phylogeny: Concept & overview 2. Distance-based methods: Neighbour joining 3. Character-based methods: Maximum Parsimony 4. Reliability of trees: Bootstrap	4th to 6th week
4.	Structural Bioinformatics 1. Protein structural classification databases (CATH and SCOP) 2. 3D-Structural databases searching and retrieval (PDB + Nucleic acid databank, PMDB) Structural visualization tools (SPDBV) • To perform following tasks on a molecule using DeepView o Selecting and Displaying o Colouring o Measuring and labeling • Apply crystallographic symmetries: • To build a full multimer from a pdb file containing only a monomer (subunit) of a protein by applying non-crystallographic symmetries.	7th to 9th week

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	• Study the interactions in the subunit interface.
	• Comparing Conformations of proteins: example Deoxyhemoglobin AND Oxyhemoglobin Using Ramachandran Plot
	• Examining Electron density maps
	• Performing in silico mutagenesis and analyzing Side chain conformations
	   • Alter the model (PDBID 1HEW) by changing an isoleucine residue to glutamine.
	   • Investigate whether the new residue might form an additional H-bond to inhibitor tri-NAG.	

5.	Protein secondary and tertiary structure prediction
	   • protein secondary prediction using online servers
	Protein tertiary structure prediction
	   • tertiary structure prediction (CPH, MODELLER, SWISS Model, EasyModeleretc)
	   • Estimation of predicted models: ProCheck, ERRAT, Verify3D, Prove, Prosa etc.,
	ProteinMotifs and Domain Prediction
		10th to 11th week

6.	Gene Prediction Promoter and Regulatory Element Prediction RNA Structure Prediction Genome Mapping, Assembly, and Comparison	12th to 14th week
7.	Bioinformatics in functional genomics, Primer designing and e-PCR, Marker databases and its utility Assembling large data sets in genomics and proteomics Computational analysis of large data sets, building networks Next generation sequencing analysis (NGS)	

8.	Practicals using CellDesigner and Gepasi/Copasi,
	1. Getting to Know CellDesigner
	   • Starting the program
	   • Navigation
	2. Creating a new Model
	   • Species
	   • Add a Protein on the Canvas
	   • Add Protein Residues
	   • Change the Residue/Region Status
	   • Create Reaction
	   • Tidy up your diagram layout
	   • Export Images / Print Images
	   • Customizing Properties
	   • Add Notes (e.g. literature references) and MIRIAM to Proteins/Reactions
	   • Refer to the databases
	3. Running the simulation
	   • Set the Kinetic Laws / Parameters
		15th to 17th week

	• Set the values of the Species • Using Control Panel for simulation 4. Import / Export SBML file 5. Conducting knock-out, knock-down prediction 6. Practical's using Metexplore/Cell Designer • Constraint based modeling - Flux balance analysis • Analysis of Topological properties of network- choke point analysis 7. Cytoscape based practicals • Topological properties of biochemical networks		
9.	Principal component analysis, ANOVA; AMOVA and different clustering methods;Gene Prediction algorithms and Phylogeny algorithms; Basics of R statistical package, Case study and analysis of any DNA/Protein sequence using existing tools, Entrepreneurship development in the field of bioinformatics : Gene to genome	18th&19th week	
10.	Preparation of project proposal	19th to 20th week	
11.	Report writing and examination.	1st to 24th week	

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Course No. : READY-BIF-473
Course Title : Drug designing and pharmacogenomics
Credits : 0+20
Semester : VII

Sr. No.	Activities	Week(s)
1.	Orientation,Market survey and industrial potential of bioinformatics Introduction to operating system, Introduction to bioinformatics and the internet, • Internet Basics • Connecting to the Internet • Electronic Mail • File Transfer Protocol • The World Wide Web Overview of Bioinformatics resources on the web. Example: NCBI/EBI/EXPASY etc., Biological databases retrieval systems • ENTREZ • SRS	1st and 2nd week
2.	Pharmacogenomics Chemoinformatics • Chemical Structure representation: 1D, 2D and 3D structures • Molecular file formats (SMILES, WLN, SDF, MOL,PDB etc) • Compound library formatting and filtering (Physicochemical and substructure filters) Pharmacophore modelling • Pharmocophore: Definition and classes (HBA, HBD, Aromatic etc.) • Identification of pharmacophore features	3rd to 5th week
3.	Molecular Docking Docking Studies • Approaches in Target identification • Methods of Active site analysis • Ligand preparation and conformational analysis • Rigid and flexible docking • Structure based design of lead compounds • Library docking • Molecular vizualition of docked complexes • Interaction analysis Preparing Publication quality molecular graphics and illustration	6th to 8th week
4.	Molecular Dynamics (MD) • Concept of Molecular dynamics MD using NAMD Basic steps in preparing MD system (Generating PDB+PSF pair, Solvation, Ionization, creating and editing configuration files and	9th to 12th week

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	other required scripts in MD system preparation) Conventional Molecular Dynamics (Energy Minimization, Heating, Equilibration, Production)	
5.	Trajectory Analysis: RMSD, RMSF, SASA, hydrogen bonding analysis, distance based analysis etc. preparing Movie for trajectories MD using GROMACS • Generate Topology (pdb2gmx commands) • Define box and solvate (editconf and solvate commands) Add ions (grompp, genion commands)	13th to 15th week
6.	Energy Minimization, Heating, Equilibration, Production and Trajectory Analysis: Same as NAMD Parametrizing novel residues and using it in MD (ParamChem, swissparam, prodrgetc)	16th week
7.	Free Energy calculations using NAMD/Gromacs: Linear interaction energy (LIE) method/ Theromdynamic integration method/ Alchemical method for estimating free energies for calculation of Free energy of Protein Ligand System (any one of these) Case study and analysis of known drug using Docking and/or MD Entrepreneurship development in the field of bioinformatics : Drug designing and Pharmacogenomics	17th to 19th week
8.	Preparation of project proposal	19th to 20th week
9.	Report writing and examination.	1st to 24th week

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Course No. : READY-BIF-474
Course Title : AgriSciences utility tool designing
Credits : 0+20
Semester : VII

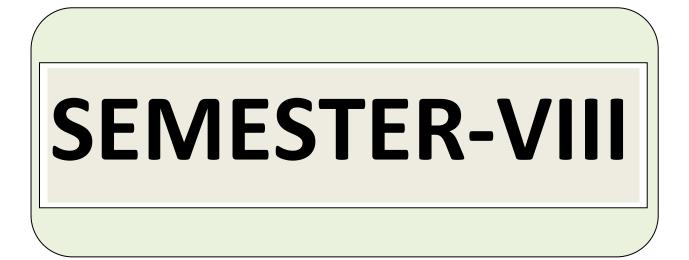| Sr. No.	Activities	Week(s)
1.	Orientation,Market survey and industrial potential of bioinformatics Introduction to operating system, Introduction to bioinformatics and the internet, - Internet Basics - Connecting to the Internet - Electronic Mail - File Transfer Protocol - The World Wide Web Overview of Bioinformatics resources on the web. Example: NCBI/EBI/EXPASY etc., Biological databases retrieval systems - ENTREZ - SRS	1stand 2ndweek
2.	Programming in C language Basics of C - History, constant, variables and identifiers, character set, logical and relational operators, data input and output concepts; - Decision making: if statement, if else statement, - for loop, while loop and do-while loop; - Arrays and functions, Structures, Pointers; - Programs related to arithmetic operations, arrays and file handling in C. Writing C programs for Bioinformatics applications - Determining the base composition in a nucleic acid sequence and amino acid composition in a protein sequence. - Generating the complimentary sequence of a DNA sequence - Pattern search algorithms - Search for a specific oligonucleotide pattern (eg. GAACATCC) in a given DNA sequence. - Find the position where a specific sequence say "GGTCCCGAC" will hybridize a given DNA sequence. - Find the restriction enzyme cleavage sites eg. where PVUZ, ECORI etc. will cut the DNA. - Locate palindromic sequence stretches in a DNA sequence. - Count the number of Open Reading frames (ORF's) in a DNA sequence. - Calculate the codon usage in a nucleic acid sequence. - Translate a DNA sequence into protein sequence in the forward and reverse frames.	3rdto 10thweek

		Programming in Scripting Language (Perl)	
		PERL-Language: Introduction, variables, arrays, string, hash, subroutines, file handling, conditional blocks, loops string operators and manipulators, pattern matching and regular expressions in PERL; Sequence handling in PERL demonstrating string, array and hash.	

3.		Bioinformatics Applications in Perl. Write scripts of regular bioinformatics tasks
		
		1. Programs using simple scalar and array variables
		   • Transcribe DNA sequence to RNA
		   • Concatenate sequences
		   • Make reverse complement of sequence
		   • Reverse transcribe RNA to DNA sequence
		2. Programs based on conditional statements and loops
		   • Search motifs in DNA or protein
		   • Counting nucleotides from given DNA and RNA sequences
		   • Reporting percentage of hydrophobic amino acid in given protein
		   • Write perl script to report GC content of sequence
		   • Search a motif in DNA and Protein sequence using regular expression and print it on screen (use special variables '$&' if required)
		   • Focus using following PERL features for above mentioned programs (1) Open and unless calls (2) do-until loop (3) foreach loop (4) Perl built in functions like Split, Pop, Shift etc.
		3. Programs based on subroutines
		   • Writing a subroutine and calling it. Scoping a subroutine. Passing arguements to subroutine. Using Pass by value and Pass by reference.
		   • Programs demonstrating Perl Debuggers like starting a debugger, setting breakpoints. Usage of 'use warnings' and 'use strict' utilities.
		4. Programs based on concept of randomization
		   • Write a program to simulate DNA mutation
		   • Write programs calculating percent identity between pairs of random DNA sequence
		5. Introduction to hash datatype
		   • Write a program to manage Genetic code and redundancy in genetic code
		   • Write program that translate DNA into protein
		   • Write a program that Read FASTA file and extract the sequence data
		   • Read DNA sequence from FASTA file, translate to protein and report the formatted output
		   • Working with reading frames.Example: writing progtams that translate DNA in all six reading frames
		6. Working with Restriction Maps and regular expressions
			11th to 16th week

	• Program for parsing REBASE datafile and creating a subroutine • Making restriction map from user input on names of restriction enzymes 7. Working with GenBank files • Program for separating Annotation from sequences from GenBankflatfile • Programs for parsing annotation using arrays • Program for parsing FEATURE table data 8. Working with PDB files • Program to extract sequence from PDB file • Program that extract secondary structure information from PDB file. Example HELIX, SHEET, TURN record types of PDB file 9. Working with BLAST output • Parsing BLAST output. Example : extract annotation and alignment Using BIOPERL module	
4.	Creation of web page(s)- HTML Creation of a tool based upon simple biological processes Entrepreneurship development scope in the field of bioinformatics : AgriSciences utility Tool Designing	17thto 19thweek
5.	Preparation of project proposal	19th to 20th week
6.	Report writing and examination.	1st to 24th week

Evaluation Criteria:

Activity within each Module	Marks Distribution (%)
Attendance	10
Mid-term	25
Practical Assignments	15
Final Exam for Practical Skill Assessment	40
Oral Examination	10
Total	**100**

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SEMESTER-VIII

B.Tech. (Biotechnology)

Semester VIII		
Course No.	**Course Title**	**Credit hours**
READY-482	Student READY- Project Formulation, Execution and Presentation	0+10
READY-483	Student READY- Entrepreneurial Development in Biotechnology (On-campus/Off Campus)	0+10
Total		**0+20 =20**

Course No : **READY-482** Course Title : **Student READY - Project Formulation, Execution and Presentation**

Credits : **10(0+10)** Semester : **VIII**

Evaluation Criteria:

Parameter	Marks Distribution (%)
Project Formulation and Implementation	20
Work Performance	30
Regularity, General Conduct and Discipline	10
Initiative and Creativity	10
Final Presentation	15
Final Project Report	15
Total:	**100**

Course No   : **READY-483**   Course Title   : **Student READY-Entrepreneurial Development in Biotechnology (On campus/Off Campus)**

Credits   : **10 (0+10)**   Semester   : **VIII**

Syllabus:

Micropropagation; DNA fingerprinting; Genetic purity for maintenance breeding; Marker assisted selection; Haploid production; Database Management skills; Molecular Diagnostics; Recombinant protein production; Animal cell culture and maintenance; Fermentation, Biopharma production; Bioprocess enrichment; Bioremediation; Biofules, etc.

Evaluation Criteria:

Parameter	Marks Distribution (%)
Project Planning, Writing and Presentation	20
Regularity	10
Monthly Assessment	10
Output Delivery	15
Technical Skill Development	15
Entrepreneurial and Business Networking Skills	10
Report Writing	10
Final Presentation	10
Total	**100**

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