Curriculum for B.Tech (Biotechnology)

Based on ICAR's 5th Dean Committee recomendation, restructuring of B.Tech. Biotechnology programme which will be effective from 2023-24 academic year with following departments and their respective course curriculum is proposed as:

Degree Nomenclature: Bachelor of Technology **(**B.Tech.) Biotechnology

Description: The B.Tech programme is full time four years Under Graduate Programme. The medium of instruction shall be English. The programme consists of Eight Semesters- Semester I and II in the First Year of the Programme, Semesters III and IV in the Second Year and V and VI Semesters in the Third Year, VII and VIII Semesters in the Fourth Year of the programme. The UG degree will have four areas of choice for elective *viz.* Plant Biotechnology, Animal Biotechnology, Microbial & Environmental Biotechnology, and Bioinformatics.

Eligibility Criteria: 10+2/Intermediate with PCM/PCMB/PCB (P - Physics, C - Chemistry,M - Mathematics and B -Biology) from a recognised Board/university with minimum 60% marks for GEN/ OBC Candidates while 55% for SC/ST candidates.

Medium of Instruction	**:**	English
Maximum Intake	**:**	**40**
Divisions/**Departments** /Section	**:**	**Five**

1. Plant Biotechnology
2. Animal Biotechnology
3. Microbial & Environmental Biotechnology
4. Bioinformatics
5. Basic Sciences (Additional department)

Course Curriculum:

- The curriculum has a total of 168 credit hours for the B.Tech Biotechnology programme.

- The students will have to opt from one of these four elective courses during their 6th semester of the degree and each students has to complete minimum 18 credit hours in selected elective course. The elective subjects are:

  1. Plant Biotechnology
  2. Animal Biotechnology
  3. Microbial & Environmental Biotechnology

4. Bioinformatics

1. Plant Biotechnology:

Laboratory facilities : Plant tissue culture lab and Biochemistry lab

Core Courses:

Course No.	Course Title	Credit hours
BTY-113	Basic Genetics	2+1
BTY-116	Cell Biology	2+0
BTY-117	Crop Production Technology	2+1
BTY-123	General Biochemistry	3+1
BTY-126	Plant Tissue Culture	2+1
BTY-128	Production Technologies for Horticultural Crops	2+1
BTY-129	Basics of Plant Breeding	2+1
BTY-214	Fundamentals of Crop Protection	2+1
BTY-216	Breeding of Field Crops	2+1
BTY-225	Plant Genetic Transformation	2+1
BTY-318	IPR, Biosafety and Bioethics	2+0

Elective Courses:

Course No.	Course Title	Credit hours
BTY-322	Plant Tissue Culture and its Applications	2+1
BTY-323	Principles and Applications of Plant Genetic Transformation	2+1
BTY-324	Applications of Genomics and Proteomics	2+1
BTY-325	Molecular Breeding in Field Crops	2+1
BTY-326	Molecular Breeding of Horticultural Crops and Forest Trees	2+1
BTY-327	Epigenetics and Gene Regulation	2+1

2. Animal Biotechnology

Laboratory facilities : Animal Tissue Culture Lab And Molecular Biology Lab

Core Courses:

Course No.	Course Title	Credit hours
BTY-114	Introduction to Biotechnology	2+1
BTY – 125	Molecular Biology	2+1
BTY -128	Anatomy and Physiology of Livestock	3+0
BTY -129	Introduction to Animal Breeding	2+1
BTY –212	Recombinant DNA Technology	2+1
BTY -213	Livestock Production and Management	2+1
BTY -214	Livestock Product Technology	2+1
BTY -215	Animal Health Care	2+1
BTY -222	Instrumentation in Biotechnology	1+1
BTY -224	Classical and Molecular Cytogenetics	2+1
BTY -313	Molecular Genetics	2+0
BTY -314	Nanobiotechnology	2+0
BTY -315	Animal Biotechnology	3+1
BTY -316	Molecular Marker Technology	2+0

Elective Courses:

Course No.	Course Title	Credit hours
BTY –322	Principles and Procedures of Animal Cell Culture	2+1
BTY –323	Animal Genomics	2+1
BTY –324	Embryo Transfer Technologies	2+1
BTY –325	Transgenic Animal Production	3+0
BTY –326	Molecular Diagnostics	2+1
BTY –327	Molecular Virology and Vaccine Production	2+1

3. Microbial & Environmental Biotechnology

Laboratory facilities : Microbiology lab and Instrumentation lab

Core Courses:

Course No.	Course Title	Credit hours
BTY-108	Environmental Studies and Disaster Management	2+1
BTY-406	Food Science and Processing	1+1
BTY-502	Immunology	2+1
BTY-207	Biodiversity and its Conservation	2+0
BTY-204	Microbiology	2+1
BTY-403	Microbial Genetics	2+1
BTY-501	Enzymology & Enzyme Technologies	2+1

Elective Courses:

Course No.	Course Title	Credit hours
BTY-631	Microbial Biotechnology	2+1
BTY-632	Bio-prospecting of Molecules and Genes	3+0
BTY-633	Molecular Ecology and Evolution	3+0
BTY-634	Fundamentals of Molecular Pharming and Biopharmaceuticals	2+1
BTY-635	Food Biotechnology	2+1
BTY-636	Green Biotechnology	2+1

4. Bioinformatics

Laboratory facilities : Bioinformatics lab

Core Courses:

Course No.	Course Title	Credit hours

BTY-308	Information and Communication Technology	1+1
BTY-508	Agricultural Informatics	2+1
BTY-401	Introductory Bioinformatics	2+1
BTY-509	Genomics and Proteomics	3+0
BTY-601	Computational Biology	2+1

Elective Courses:

Course No.	Course Title	Credit hours
BTY-641	Programming for Bioinformatics	2+2
BTY-642	Bioinformatics Tools and Biological Databases	2+1
BTY-643	Structural Bioinformatics	2+1
BTY-644	Pharmacogenomics	2+1
BTY-645	Metabolomics and System Biology	2+1
BTY-646	Computational Methods for Data Analysis	1+1

5. Basic Science

Core Courses:

Course No.	Course Title	Credit hours
BTY-101	Basic Botany	2+1
BTY-201	Basic Zoology	2+1
BTY-102	Basic Mathematics – I	3+0
BTY-202	Basic Mathematics – II	3+0
BTY-108	Communication Skills and Personality Development	1+1
BTY-407	Entrepreneurship Development and Business Management	1+1
BTY-109	Basic Statistics	1+1
BTY-309	Biostatistics	2+1

Student Ready Programme (2 Semesters)

Course No.	Course Title	Credit hours
BTY-701	In-house Skill Development Modules	20

BTY-801	Project Formulation, Execution and Presentation	10
BTY-802	Entrepreneurial Development in Biotechnology (on campus /offcampus)	10

Non Credit Courses (2)

Course Title	**Non Credit hours**
Educational Tour	0
NCC/NSO/NSS	0

Semester-wise Distribution of Courses:

Semester I		
Course No.	**Course Title**	**Cr hrs**
BTY-111/ BTY-112	Basic Botany/ Basic Mathematics – I	2+1/ 3+0
BTY-113	Basic Genetics	2+1
BTY-114	Introduction to Biotechnology	2+1
BTY-115	Basic Statistics	1+1
BTY-116	Cell Biology	2+0
BTY-117	Crop Production Technology	2+1
BTY-118	Environmental Studies and Disaster Management	2+1
BTY-119	Communication Skills and Personality Development	1+1
BTY-110	NCC/NSO/NSS	0+0 NC
Total		**21**

Semester II		
Course No.	**Course Title**	**Cr hrs**

BTY-121/ BTY-122	Basic Zoology/ Basic Mathematics – II	2+1/3+0
BTY-123	General Biochemistry	3+1
BTY-124	Microbiology	2+1
BTY-125	Molecular Biology	2+1
BTY-126	Plant Tissue Culture	2+1
BTY-127	Biodiversity and its Conservation	2+0
BTY-128-I / BTY-128-II	Production technologies for Horticultural Crops/ Anatomy and Physiology of Livestock	2+1/3+0
BTY-129-I / BTY-129-II	Basics of Plant Breeding/ Introduction to Animal Breeding	2+1
BTY-120	NCC/NSO/NSS	0+0 NC
Total		**24**

Semester III		
Course No.	**Course Title**	**Cr hrs**
BTY-211	Plant Physiology	2+1
BTY-212	Recombinant DNA Technology	2+1
BTY-213	Livestock Production and Management	2+1
BTY-214-I / BTY-214-II	Fundamentals of Crop Protection/ Livestock Product Technology	2+1
BTY-215-I / BTY-215-II	Breeding of Field Crops/ Animal Health Care	2+1
BTY-216	Information and Communication Technology	1+1
BTY-217	Biostatistics	2+1
BTY-130	NCC/NSO/NSS	0+0 NC
Total		**20**

Semester IV		
Course No.	**Course Title**	**Cr hrs**
BTY-221	Introductory Bioinformatics	2+1
BTY-222	Instrumentation in Biotechnology	1+1
BTY-223	Microbial Genetics	2+1
BTY-224	Classical and Molecular Cytogenetics	2+1
BTY-225	Plant Genetic Transformation	2+1
BTY-226	Food Science and Processing	1+1

BTY-227	Entrepreneurship Development and Business Management	1+1
BTY-140	NCC/NSO/NSS	0+0NC
Total		**18**

Semester V		
Course No.	**Course Title**	**Cr hrs**
BTY-311	Enzymology and Enzyme Technologies	2+1
BTY-312	Immunology	2+1
BTY-313	Molecular Genetics	2+0
BTY-314	Nanobiotechnology	2+0
BTY-315	Animal Biotechnology	3+1
BTY-316	Molecular Marker Technology	2+0
BTY-317	Genomics and Proteomics	3+0
BTY-318	IPR, Biosafety and Bioethics	2+0
BTY-319	Agricultural Informatics	2+1
BTY-150	Yoga and Health	0+0
Total		**24**

Semester VI		
Course No.	**Course Title**	**Cr hrs**
BTY-321	Computational Biology	2+1
Optional/ Elective Courses (6)	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
BTY-160	Other Language (French/Sanskrit)	0+0
Total		**21**

Semester VII		
Course No.	**Module***	**Cr hrs**

BTY-411 Student READY - In-house Skill Development Modules	1. Plant Biotechnology 2. Animal Biotechnology 3. Microbial and Environmental Biotechnology 4. Bioinformatics *To opt only one module as per the chosen elective	0+20
BTY-412	Educational Tour	0+0NC
Total		**20**

Semester VIII		
Course No.	**Course Title**	**Cr hrs**
BTY-421	Student READY - Project Formulation, Execution and Presentation	0+10
BTY-422	Student READY - Entrepreneurial Development in Biotechnology(- On-campus/Off Campus)	0+10
Total		**20**

Academic regulations for B.Tech Biotechnology Programme

1. Academic Calendar and Schedule for Semester

The Academic Calendar and schedule for semester will be as notified by Dean, College of Biotechnology from time to time.

2. Admission to B.Tech Biotechnology degree Programme

Admission, Counselling, payment of prescribed fees and registration for 1st semester to **B.Tech Biotechnology Programme** shall be made on the basis of criteria as specified by the Academic Council. Admission shall be made in July or as specified by the University Authority.

2.1 Selection of Students

Criteria of Selection: MERIT of 10+2

To be eligible for seeking admission in B.Tech Biotechnology Programme, candidate must have passed his/her 10+2 or equivalent examination with minimum 60% marks in aggregate (55% in case of SC/ST candidates) examination with Physics, Chemistry, Biology/ Mathematics and English to appear in the merit list.

2.2 Reservation of Seats for Admission

The reservation policy of the Government of Uttar Pradesh as notified by University Registrar in prospectus issued.

2.3 Time of Admission

Admission to B.Tech Biotechnology Programme shall be made at the commencement of the first semester of each academic year, unless otherwise changed by the Academic Council.

2.4 Counselling

` Counselling of the aspirants for admission to B.Tech Biotechnology Programme shall be done on the specified date as mentioned in the prospectus notified by the University Registrar and admission fee will be deposited within seven working days after the date of counselling.

3. Enrollment, Registration and Continuance

3.1 Enrollment

Students freshly admitted to B.Tech Biotechnology Programme will be enrolled on the date of counselling as notified by the Registrar of the University.

3.2 Registration

Registration in the semesters shall consist of the following steps:

i. After getting the five registration cards signed from the concerned Instructor(s), the student shall deposit the university fees and other dues.
ii. After depositing the fee, the student shall deposit the duly filled in and signed registration cards in the office of the Dean, College of Biotechnology on the same day.
NOTE: No registration will be allowed in absentia.

3.3 Registration of Fresh Students

Registration of fresh student for the first semester of the B.Tech Biotechnology Programme is a part of admission procedure and shall be done on the prescribed date as notified by the Registrar in the prospectus. Admission of new students failing to register in the prescribed manner on the assigned date is liable to be cancelled; however, Registrar of the University can allow the student late registration up to six days only with late registration fee as prescribed.

3.4 Registration of Continuing Students

Registration of the continuing students in subsequent semester(s) shall be on the date and time notified by Dean, College of Biotechnology. However, Dean, College of Biotechnology can allow a continuing student for the late registration up to six days with a late registration fee as prescribed. Students failing to register within 6 days shall not be allowed registration in that particular semester.

3.5 Suspension of Registration

The registration of any student may be suspended by the Dean, College of Biotechnology on the recommendation of disciplinary committee. A Student whose registration has been suspended as above will have to vacate the hostel and leave the campus if such a measure is deemed necessary by the University authorities in the interest of academic discipline and peace of the campus.

3.6 Cancellation of Registration

The Dean, College of Biotechnology may cancel the registration of any student(s) who indulges in acts of indiscipline, misconduct, violation of the rules and regulations of the University, strikes, absence from class(es) without permission or without any valid reason or in cases the Dean, College Biotechnology has reasons to believe that their continuance in the institution would not be in the interest of the University.

3.7 Dropping from the University

Discontinuation of studies by any student of **B.Tech Biotechnology Programme** student will be permissible only on justified grounds after the completion of first semester examination. The student may be allowed by Dean College of Biotechnology to seek re-admission in the subsequent year(s) subject to the condition that the total period of withdrawal shall not exceed two semesters in which he/she had withdrawn.

4. Record and Computation of class attendance

Each instructor shall maintain a record of the student's attendance in each course taught by him/her in each semester. Class attendance shall be sent to the Dean in the first week of the ensuing month by the instructor and also be notified on the notice board. The percentage attendance of a student in a course in a semester shall be computed on the basis of the total number of lectures /practical classes attended by him/her and those actually scheduled between the date of commencement of instruction and the date of closing instruction.

Each student shall be regular in attending classes and shall be required to have a minimum of 75% attendance in each course in each semester , failing which he/she will not be allowed to appear in the semester examination and he / she shall be declared failed in that subject. Such candidate will not be eligible for compartmental examination.

Dean, College of Biotechnology shall notify the eligibility of students to appear in the examination seven days before the commencement of the semester examination and notice to this effect shall be displayed on the notice board of the college.

A student who has completed attendance requirement and fails to appear in the examination shall be treated as failed and will be eligible for compartmental examination.

5. Award of degree and the maximum permissible time limit

For the award of the degree in **B.Tech Biotechnology Programme**, the minimum and

the maximum permissible time limit for the completion of degree shall be as under:

Degree	**Minimum Semester**	**Maximum semester**
B.Tech Biotechnology	8	12

The semester(s) washed out on account of withdrawal, dropping by the student on his/her own, failure to register in time, medical grounds, use of unfair means or dropped for any other reason whatsoever described above, shall be counted towards the maximum permissible time limit of semesters.

NOTE: If the student fails to complete his/her programme successfully within the maximum time limit prescribed for the programme as above, he/she shall no longer be a student of this University and degree will not be awarded to such candidate.

6. **PROGRAMME OF STUDY:** The programme of study would be as per notification by the Dean duly approved by the academic council.

7. **EXAMINATION AND EVALUATION**

- The examination shall be to assess whether the student has been able to achieve a level of competence.

- There shall be two examinations in a semester (Mid Semester and Semester End Examinations) with the ratio of marks 50:50. The mid semester examination comprising of 50% marks for each theory and practical paper shall be assessed internally by the concerned teacher/s in the college. The semester end examination comprising of 50% marks shall be assessed by external examiners and conducted by the Controller of Examinations.

- In the semester end theory examination, moderation of the question paper will be allowed 30 minutes before commencement of examination if the concerned instructor finds any portion of it beyond prescribed syllabus.

- The theory question paper shall be of 40% objective (45 mins duration) and 60% subjective (135 mins duration) total of three hour duration.

- The evaluation will be made on percentage basis. Each course will be assessed on the basis of 100 marks. The marks would be divided between internal and external assessment. There shall be one semester end external examination of each course in every semester consisting of 50% (50 marks) weightage in theory and practical courses.

7.1 Evaluation of answer sheets of mid semester examination: The answer sheets shall be evaluated by the concerned teacher. The internal examiner will evaluate the answer books and marked answer books will be shown to the students. The marks obtained will be entered in the prescribed mark sheets and will be sent to the Controller of Examinations through Dean, College of Biotechnology.

7.2 Evaluation of answer sheets of semester end examination: The answer sheets shall be evaluated by the external examiner under the directions of Controller of Examinations.

Marks in decimals 0.5-0.99 will be rounded to next higher digit.

8. Pass, Promotion and Failure Criteria

- In order to pass a subject, a student must obtain at least 50% marks in both the theory and practical exams of that subject.
- A student of first semester of the academic year, if fails in any subject(s) has to appear in the compartmental examination (in maximum of three subjects of his/her choice) of concerned subjects.
- Compartmental examination of each semester will be conducted within one month after the declaration of the result of Semester End examination. In any compartmental examination he/she has to appear in both Theory and Practical Examinations of that concerned subject.
- If a student does not pass the compartmental examination in 1st semester, he/she will be eligible for provisional promotion to second semester of that academic year with CARRY OVER as non teaching subject. If student fails in more than Three (03) subjects in first Semester of the academic year, the remaining subjects (excluding compartment) will also be carried as carry over subjects in subsequent Semester.
- The Examination of carry over subjects of first semester will be conducted along with Semester End Examination of Second semester of that Academic year.
- If any student fails in second semester subjects he/she will be allowed to appear in compartmental examinations ONLY in maximum of Three (03) subjects.
- To be promoted to the following academic year, student must PASS all the courses of odd and even semester of that year.
- If any student is unable to fulfil the above mentioned criteria, he/she will be considered as FAIL and will repeat the entire Academic Year.

9. Division and Honours

(i). **Pass** 50.00% and above
(ii). **Pass with second division** 50.00% to 59.99%
(iii). **First division** 60.00-79.99%
(iv). **First division with distinction** 80.00% and above

10.Results

- Tabulation of the results shall be done from the award list of the internal/external examiners by the office of the COE.
- Tabulation work should be completed within seven days from last date of the receipt of last award list from examiners.
- The office of COE will do the collation of the results and declare the semester results before the commencement of next semester.
- All the marks obtained in theory and practical examination(s) will be entered in the computer and hard copy will be pasted on register(s) in the office of the COE separately and the semester mark sheet of the students will be prepared by the office of COE at the end of each semester. COE will issue the semester mark sheet to all the students with a copy of the same to Dean, College of Biotechnology. The Composite Academic Transcript will be issued by COE on the completion of degree **programme** with the latest photograph of the student pasted on transcript.

11.Retotaling/Scrutiny/ Re-evaluation

Retotaling or Scrutiny of marked answer books will be allowed in the theory semester end examination. For this concerned student has to submit an application along with fee Rs.1000.00 per course.No re-evaluation of marked answer books will be allowed.

12. Character Certificate

After the completion of degree **programme**, Dean, College of Biotechnology will issue the character certificate to the concerned student.

13. Hostel Rules

Existing university hostel rules will be applicable both for boys & girls students residing in the University hostels.

Semester I

Basic Botany (2+1)

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.

Basic Mathematics-I (3+0)

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-Moivre'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; Arithmetico geometric series and special series . 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.

Basic Genetics (2+1)

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 sexinfluenced 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 of Hordeum vulgare,and meiosis; Monohybrid crosses (segregation); Dihybrid crosses (independent assortment); Probability and use of Chi-square;Isolation of Lymphocytes, Karyotyping, Mitotic Abberations,Pedigree Analysis,Enumeration of WBC and RBC.

Introduction to Biotechnology (2+1)

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.

Basic Statistics (1+1)

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.

Cell Biology (2+0)

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.

Crop Production Technology (2+1)

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 seedbed 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.

Environmental Studies and Disaster Management (2+1)

Theory

Environmental Studies

UNIT I

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

UNIT II

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.

UNIT III

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).

UNIT IV

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.

UNIT V

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

Communication Skills and Personality Development (1+1)

Theory

UNIT I

Communication skills: Structural and functional grammar; Meaning and process of communication; Verbal and nonverbal communication; Listening and note taking; Writing skills; Oral presentation skills; Field diary and lab record; Indexing, footnote and bibliographic procedures; Reading and comprehension of general and technical articles; Precise writing, summarizing, abstracting; Individual and group presentations; Impromptu presentation; Public speaking; Group discussion and interviews; Organizing seminars and conferences.

UNIT II

Voice modulation basics and their usage for meaningful impact on people; Attributes of an effective leader; Stress and conflict management; Time management: Personal organization, prioritizing and balancing; Cosmopolitan culture; Impact of non verbal communication; Science of body language; Role of team work.

Practical

Listening and note taking, writing skills, oral presentation skills; Field diary and lab record; Indexing, footnote and bibliographic procedures; Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; Individual and group presentations; Video recorded mock group discussions and interviews; Attitude management; Setting and achieving a short term goal; Creating a personal vision statement of life; Voice modulation; Practicing conscious body postures and movements; Rapport building; Video recorded practical to evaluate change in confidence level; Team work exercises; Time management.

NCC/NSO/NSS (0+0 NC)

Semester II

Basic Zoology (2+1)

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; Multiple allelism - 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.

Basic Mathematics-II (3+0)

Theory

UNIT I

Functions; Limit: Introduction, left handed and right handed limits, general rules for

calculation of limits Standard limits $\lim_{x\to a}\frac{x^n-a^n}{x-a}$, $\lim_{x\to 0}\frac{\sin x}{x}$, $\lim_{x\to 0}(1+x)^{\frac{1}{x}}$, $\lim_{x\to 0}\frac{a^x-1}{x}$, $\lim_{x\to 0}\frac{\log(1+x)}{x}$. 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, geometrical interpretation of derivative, maxima and minima, tangent and normal.

UNIT III

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

UNIT IV

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

General Biochemistry (3+1)

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.

Microbiology 3(2+1)

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.

Molecular Biology (2+1)

Theory

UNIT I

History of molecular biology; Central dogma of life; Structure of DNA and RNA; Gene structure and function; Nucleic acid as a genetic material, DNA conformations, DNA supercoiling, Denaturation and renaturation of DNA, C-value paradox, Cot value and curve, DNA replication, DNA Damage and repair mechanism; Homologous recombination and site specific recombination and transposons. Transcription in prokaryote and eukaryote; Genetic code, Translation in prokaryote and eukaryote; Structure of prokaryotic and eukaryotic nuclear and organelle genomes; Gene regulation in prokaryotes: Lac operon concept, trp 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 genes; Estimation of genetic similarities and generation of dendrograms.

Plant Tissue Culture (2+1)

Theory

UNIT I

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.

UNIT II

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.

Biodiversity and its Conservation (2+0)

Theory

UNIT I

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.

UNIT II

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.

Production Technologies for Horticultural Crops (2+1)

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.

Anatomy and Physiology of Livestock (3+0)

Theory

UNIT I

Definition of terms used in veterinary 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.

Basics of Plant Breeding (2+1)

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:, 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.

Practical

Classification of plants; Botanical description and floral biology of field crops: rice**,** sorghum, maize, wheat, bajra, sugarcane, brassicas, groundnut, sunflower, sesamum, red gram, bengal gram, green gram, soybean, black gram, cotton; Study of megasporogenesis and microsporogenesis; Fertilization and life cycle of an angiospermic plant; Hybridization techniques and precautions to be taken; selfing, emasculation and crossing techniques; Study of male sterility and incompatibility.

Introduction to Animal Breeding (2+1)

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 HWequilibrium; 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;m 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-squared 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-squared test for determining goodness of fit for HW-equilibrium; Linkage analysis from pedigree data ; Selection index.

NCC/NSO/NSS (0+0 NC)

Semester III

Plant Physiology (2+1)

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.

Recombinant DNA Technology (2+1)

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.

UNIT III

Gene Recombination and Gene Transfer: Bacterial Conjugation, Transformation, Transduction, Episomes, Plasmids, Microinjection, Electroporation, Microprojectile, Shot Gun method, Ultrasonication, Liposome fusion, Microlaser.

UNIT IV

Changing genes: site-directed mutagenesis and Protein engineering: Primer extension is a simple method for site directed mutation, PCR based site directed mutagenesis, Random mutagenesis, Use of Phage display techniques to facilitate the selection of mutant peptides, Gene shuffling, production of chimeric proteins.

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*.

Livestock Production and Management (2+1)

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;

Fundamentals of Crop Protection (2+1)

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.

Livestock Product Technology (2+1)

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.

Breeding of Field Crops (2+1)

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.

Animal Health Care (2+1)

Theory

UNIT I

Introduction to animal health; history of disease diagnoses 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.

Information and Communication Technology (1+1)

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.

Biostatistics (2+1)

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.

NCC/NSO/NSS (0+0 NC)

Semester IV

Introductory Bioinformatics (2+1)
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.

Instrumentation in Biotechnology (1+1)

Theory

UNIT I

General Principle of chromatography, Adsorption chromatography, Partition Chromatography, Planar Chromatography(Paper and TLC), Column Chromatography (Ion exchange chromatography, gel filtration and permeation chromatography, Affinity Chromatography, HPLC). Radio isotope technique; nature of radioactivity, principle of radioisotope and radiation, radioactive decay, detection and measurement of radioactivity.

UNIT II

Principles and working of laboratory equipments: Centrifugation :Principle and Types of Centrifugation.

Electrophoresis and its Principle, Gel and its types, Types of Electrophoresis (Agarose Gel Electrophoresis, SDS PAGE, 2D Gel Electrophoresis, Gel Documentation)

Laminar air flow; Autoclaves, pH meter; Fermenters; Temperature control shakers, BOD shakers;

ELISA readers.

Spectroscopy (UV-Vis, NMR, Mass Spectroscopy, IR Spectroscopy) and its Principle, Particle gun; Plant growth chambers;

Thermal cyclers(Realtime PCR, Nested PCR, Anchored PCR, Inverse PCR, RT-PCR), DNA sequencer; Microscopes: Light, stereo,phase contrast and inverted, Fluorosence, Electron Microcopes

Practical

To familiarize laboratory equipment and its equipment working Calibration of pH meter; Paper chromatography of amino acids/sugars; Paper chromatography of amino acids/sugars; TLC of sugars/amino acids; Cellular fractionation and separation of cell organelles using centrifuge; Validity of Beer's law for colorimetric estimation of creatinine; Absorption spectrum of NAD & NADH; Rocket immuno-electrophoresis;PCR Demonstration

Microbial Genetics (2+1)

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.

Classical and Molecular Cytogenetics (2+1)

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.

Plant Genetic Transformation (2+1)

Theory

UNIT I

History of plant genetic transformation; Generation of gene construct and maintenance; Genetic transformation: *Agrobacterium* mediated, biolistics, 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.

Food Science and Processing (1+1)

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.

Entrepreneurship Development and Business Management (1+1)

Theory

UNIT I

Concept of entrepreneur; Entrepreneurship development; Assessment of entrepreneurship skills; SWOT analysis and achievement motivation; Entrepreneurial behaviour; Government policy and plan for entrepreneurship development; Setting up of a new entrepreneurial venture; Environmental factors influencing entrepreneurship; Constraints in setting up of agro based industries;

UNIT II

Definition of business; Value chain concept in business; Stakeholders in business; Stages of Indian business; Importance of agribusiness in Indian economy and factors ransforming Indian agribusiness; Government as a regulatory body in agribusiness; Opportunities and challenges to Indian agribusiness.

UNIT III

Management: Definition, importance and functions; Levels of management; Planning: Definition, steps in planning, types of plan; Organizing: Meaning of organizing and organization;

Developing leadership skills; Encoding and decoding communication skills; Developing organizational and managerial skill; Problem solving skill; Supply chain management and total quality management; Project planning, formulation and report preparation.

Practical

Preparation of project report for starting a new venture; Case studies of successful entrepreneurs, analysis and discussion; Preparation of complete marketing plan of selected product/service; Case

studies related to project management; Visits to industrial and agri-business houses; Numerical problems; Preparation of project report for various business ventures.

NCC/NSO/NSS (0+0 NC)

Semester V

Enzymology and Enzyme Technologies (2+1)
Theory
UNIT I
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.

UNIT II
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.

Immunology (2+1)
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.

Molecular Genetics (2+0)

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.

Nanobiotechnology (2+0)

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.

Animal Biotechnology (3+1)

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; Immuno histochemical localization of protein marker in tissues/cells – meat species identification by PCREDIT.

Molecular Marker Technology 2(2+0)

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: F2, DH, RILs, NILs; Bulked segregant analysis; Linkage maps; Physical maps.

UNIT II

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

Genomics and Proteomics (3+0)

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: MALDITOF,
LC-MS; Post Translational modifications.

IPR, Biosafety and Bioethics (2+0)

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.

Agricultural Informatics (2+1)

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 agriinput management; Smartphone mobile apps in agriculture for farm advice, market price, postharvest 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 cropplanning
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.

Yoga and Health (0+0)

UNIT I – Introduction to Yoga and Yogic Practices - I
Yoga Etymology, definition ,Aim, objective and misconception text , Yoga origin ,history and development , Rules and regulations to be followed by yoga practitioners , Introduction to Major schools of Yoga (Janan, Yoga Bhakti, Yoga Karma, Patanjali, Hatha) , Introduction to yogic practices (Sukshama Vyayama, Surya Namaskar and Asanas)

UNIT II – Introduction to Yoga Texts - I
Introduction and study of Patanjali Yoga Sutra including memorization of selected Sutra , Introduction and study of Bhagavad Gita including memorization of selected Slokas , Introduction of Hata Pradpika, Introduction and study of Gheranda Samhita.

Unit 3 – Yoga for Health Promotion – I

Brief introduction to human body, Role of yoga for health promotion, Yogic attitudes and practices, Holistic approach of yoga towards the health and diseases, Introduction to yoga diet and its relevance and importance in yoga Sadhana, Dincharya and Ritucharya with respect of yogic Lifestyle

Practical :

Practice of Sukshmavyayama, Practice of Surya Namaskar, Practice of Asanas, Practice of Halasana, Practice of Pawanmuktasana, Practice of Bhujangasana, Practice of Shalabhasana, Practice of Gomukhasana, Practice of Vakrasana, Practice of Ustrasana, Practice of Mandukasana, Practice of Sasankasana, Practice of Janusirasana, Practice of Virkshasana, Practice of Padhastasana, Practice of Nadi Shudhi, Practice of Dhyana Mudra. Meditation, Project on Patanjali Yoga Sutras, Yoga effect on Human Body, Steps of Sithaili Pranayama, Steps of Ujjayai Pranayam, Steps of Paschimottansana, Conducting Yoga project on common diseases Yoga sessions on suryanamaskar, Asanas board, Yoga for Weight loss, Improved Posture.

Semester VI

Computational Biology 2(2+1)

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.

ELECTIVE I
PLANT BIOTECHNOLOGY
1. Plant Tissue Culture and its Applications (2+1)
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; *Ivitro* 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. press.

2. Principles and Applications of Plant Genetic Transformation (2+1)
Theroy
UNIT I
Gene transfer methods: Direct and Indirect; Marker free transformation; *In planta* transformation; Vectors for plant transformation, molecular characterization of transgenicplants 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 containmentand field conditions.

3. Applications of Genomics and Proteomics (2+1)

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 twohybrid and coimmunoprecipitation.

Applications of genomics and proteomics in agriculture, human health and industry. Metabolomics and ionomics for elucidating metabolic pathways.

Practical

yy SDS-PAGE; 2D Electrophoresis; Protein characterization through HPLC; Specialized crop based genomic resourses: TAIR, Gramene, Graingenes, Maizedb, Phytozome, Ce r e a l d b, Citrusdb; miRbase.

4. Molecular Breeding in Field Crops (2+1)

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 major

and 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.

5. Molecular Breeding of Horticultural Crops and Forest Trees (2+1)

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.

6. Epigenetics and Gene regulation (2+1)

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; *In silico* 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 fluorescent labelled probes; Bisulphite sequencing for methylation; qRT-PCR for quantitative analysis of small RNAs in developmental phases.

ELECTIVE II

ANIMAL BIOTECHNOLOGY

1. Principles and Procedures of Animal Cell Culture (2+1)

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.

2. Animal Genomics (2+1)

Theory

UNIT I

Genome organization in eukaryotes; Satellite DNA: VNTRs & families, LINE & SINE; Sex determination: Chomosomal basis of sex determination, Molecular markers for sex determination,
environmental sex determination; Chromosomal aberrations: Euploidy, Chromosomal Nondisjunction
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.

3. Embryo Transfer Technologies (2+1)

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.

Theroy

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.

5. Molecular Diagnostics (2+1)

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; Reverse transcriptase 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 meat adulteration in processed and
unprocessed meats; PCR based detection of pathogens in milk, eggs and meat; Lateral flow assay;
ELISA.

6. Molecular Virology and Vaccine Production (2+1)

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 TCID50;Haemagglutination and Haemagglutination Inhibition test; Detection of virus by SNT, AGID and ELISA.

ELECTIVE III
MICROBIAL AND ENVIRONMENTAL BIOTECHNOLOGY
1. Microbial Biotechnology 3(2+1)
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.

2. Bio-Prospecting of Molecules and Genes (3+0)
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.

3. Molecular Ecology and Evolution (3+0)
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.

4. Fundamentals of Molecular Pharming and Biopharmaceuticals (2+1)
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.

5. Food Biotechnology (2+1)

Theory

UNIT I

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.

UNIT II

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**.**

Suggested Readings

6. Green Biotechnology 3(2+1)

Theory

UNIT I

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 and phytoremediation, their roles; Strategies for detection and control of soil, air and water pollutants.

UNIT II

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**.**

ELECTIVE IV

BIOINFORMATICS

1. Programming for Bioinformatics 4(2+2)

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.

2. Bioinformatics Tools and Biological databases (2+1)

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.

3. Structural Bioinformatics (2+1)

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, SWISSPDB viewer, CPH, MODELLER, SWISS Model, EasyModeler, Procheck; GROMAC; SANJIVNI; BHAGIRATH.

4. Pharmacogenomics 3(2+1)

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.

5. Metabolomics and System Biology 3(2+1)

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.

6. Computational Methods for Data Analysis 2(1+1)

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.

Agriculture Courses

Courses marked with double asterisk (*) with a total of 12 credit hours will be optional alternative to package of Animal Courses marked with asterisk (**)

1. Crop Production Technology 3(2+1)

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 seedbed 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.

2. Production Technologies for Horticultural Crops 3(2+1)

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.

3. Basics of Plant Breeding 3(2+1)

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.

Practical
Classification of plants; Botanical description and floral biology of field crops: rice**,** sorghum, maize, wheat, bajra, sugarcane, brassicas, groundnut, sunflower, sesamum, red gram, bengal gram,
green gram, soybean, black gram, cotton; Study of megasporogenesis and microsporogenesis; Fertilization and life cycle of an angiospermic plant; Hybridization techniques and precautions to be taken; selfing, emasculation and crossing techniques; Study of male sterility and incompatibility.

4. Breeding of Field Crops 3(2+1)
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.

5. Fundamentals of Crop Protection 3(2+1)
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.

Animal Science Courses
Courses marked with asterisk (**) with a total of 12 credit hours will be optional alternative to package of Agriculture Courses marked with double asterisk (*)
1. Anatomy and Physiology of Livestock 3(3+0)
Theory

UNIT I

Definition of terms used in veterinary 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.

281

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.

2. Introduction to Animal Breeding 3(2+1)

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 HWequilibrium;

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-squared 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-squared test for determining goodness of fit for HW-equilibrium; Linkage analysis from pedigree data ; Selection index.

3. Livestock Production and Management 3(2+1)

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;

4. Livestock Product Technology 3(2+1)

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.

5. Animal Health Care 3(2+1)

Theory

UNIT I

Introduction to animal health; history of disease diagnoses 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.

284

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.

UNIT I

Greetings in French, Understand days of the week and months of the year., Count (numbers), Spell words, Introduce yourself (give your age, your job, talk about your family, say where you are from, where you live, say the languages you speak), Ask questions (1), Learn basic

vocabulary, Understand a menu/Order at a restaurant, Ask questions (2), Understand and give directions (1), Speak about the weather, Say the time, Suggest an outing, Buy in shops. Do your grocery shopping, Indicate a quantity, Speak about the future (1), Make a positive/negative comment, Describe someone, Speak about the past (1), Talk about a duration, Talk about your studies, Give an advice, order (1).

UNIT II

Auxiliary verbs (*to be/to have*), Genders (*masculine/feminine*), Definite and indefinite articles, Plural form, Possessive adjectives (*my, your, his/her…*), Regular verbs at present tense *(-er verbs*), Plural of nouns, "on" pronoun, Negation, Prepositions of location *(in, on, next to, in front of…*), Use « Quel », « Est-ce que » and « Qu'est-ce que » in a question, Demonstrative adjectives (*this, that*). Partitive articles, Answering a negative question, Futur Proche (*future tense*), Reflexive verbs (*se lever…*), Imperative Form, Passé Composé (past tense), Présent Continu (Present continuous), Direct pronouns, Time markers.