UNDER GRADUATE
COURSE CATALOGUE
2025

CHAUDHARY CHARAN SINGH HARYANA AGRICULTURAL UNIVERSITY HISAR-125004

(A+ Grade NAEAB-ICAR ACCREDITED)

Foreword

It gives me immense pleasure to present the Undergraduate Academic Catalogue of Chaudhary Charan Singh Haryana Agricultural University, Hisar, developed in adherence to the academic guidelines laid down by the Indian Council of Agricultural Research (ICAR) and the holistic vision of the National Education Policy 2020 (NEP 2020).

This catalogue encompasses a wide array of undergraduate programmes-B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness Management, B.Tech. (Agricultural Engineering), B.Tech. (Biotechnology), B.Sc. (Hons.) Community Science and B.F.Sc. reflecting our institution's comprehensive and forward-looking approach to agricultural education.

Rooted in academic excellence and enriched with hands-on learning, the curriculum is crafted to develop skilled, innovative and socially responsible professionals. The NEP 2020's emphasis on multidisciplinary education, flexibility and learner-centric models is well-embedded in the structure of this catalogue. It is designed to empower students with critical thinking, entrepreneurial aptitude, ethical grounding and global awareness-traits essential for addressing the challenges and opportunities of the 21st century agri-food systems.

As we move toward a future of sustainable agriculture, climate resilience and technological integration, this academic catalogue stands as a guiding document that aligns education with employability, research with relevance and tradition with transformation.

I congratulate the all contributing faculty members, Dr. S.K. Pahuja (Dean, College of Agriculture and College of Agricultural Engineering & Technology), Dr. Beena Yadav (Dean, College of Community Science), Dr. K.D. Sharma (Dean, College of Biotechnology), Dr. Rajesh Gera (Dean, College of Basic Sciences & Humanities and College of Fisheries Science), Dr. Atul Dhingra, OSD to Vice-Chancellor and Head, Business Management and Dr. Mukesh Kumar, Associate Professor, Dept. of Genetics and Plant Breeding, College of Agriculture for their dedication, vision and hard work in preparing this catalogue. It will undoubtedly serve as a valuable academic compass for our students, educators and stakeholders.

Prof. B.R. Kamboj

Prof. B.R. Kamboj
Vice-Chancellor
CCSHAU, Hisar

Preface

I am delighted to present the Undergraduate Academic Catalogue of CCS Haryana Agricultural University, Hisar, meticulously prepared in alignment with the guidelines of the Indian Council of Agricultural Research (ICAR) and the National Education Policy 2020 (NEP 2020). This catalogue outlines the structure, curriculum and academic framework of our diverse undergraduate programs-B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness Management, B.Tech. Agricultural Engineering, B.Tech. Biotechnology, B.Sc. (Hons.) Community Science and B.F.Sc. The course catalogue and examination and evaluation system as per the recommendations of the Sixth Deans' Committee of ICAR and will be implemented from academic session 2025-26 of 4-year programme of all the colleges.

In tune with the vision of NEP 2020, this catalogue embodies a holistic and multi disciplinary approach, aiming to nurture critical thinking, practical skills, ethical grounding and entrepreneurial spirit among our students. The curriculum emphasizes experiential learning, skill development, and industry alignment, ensuring that our graduates are not only academically sound but also socially responsible and globally competent.

Each program has been thoughtfully designed to balance foundational knowledge with emerging scientific advancements, integrating local relevance with global perspectives. Special emphasis has been placed on internships, rural and industry exposure, interdisciplinary electives, and innovation-driven projects to foster creativity and real-world problem-solving abilities in our students.

This catalogue is a testament to our commitment to academic excellence, student-centric learning, and nation-building through quality education in agriculture and allied sciences. I sincerely hope it serves as a valuable guide for our students, faculty, and stakeholders, and contributes to shaping the next generation of agricultural professionals and leaders.

I acknowledge the dedicated efforts of Dr. Beena Yadav (Dean, College of Community Science), Dr. K.D. Sharma (Dean, College of Biotechnology), Dr. Rajesh Gera (Dean, College of Basic Sciences & Humanities and College of Fisheries Science), Dr. Atul Dhingra, OSD to Vice-Chancellor and Head, Business Management, Dr. Mukesh Kumar, Associate Professor, Dept. of Genetics and Plant Breeding, Dr. Anil Kumar, Sr. Scientist & Head, Dept. of Nematology, Dr. Subodh Aggarwal, Assistant Professor, Dept. of Business Management, Dr. Lomash Kumar, Assistant Professor, Dept. of Entomology, Dr. Neelam M. Rose, Professor & Head, Dept. of Apparel & Textile Science , Dr. Saroj Yadav, Associate Professor, Dept. of Apparel & Textile Science, Dr. Rachna Gulati, Professor, Dept. of Aquaculture & Post harvest Technology, Dr. Anupam Anand, Assistant Professor, Dept. of Fisheries Extension, Economics & Statistics, Dr. Kavita Sharma, Assistant Professor, Dept. of Fisheries Resource Management, Dr. Rajender Kumar, Assistant Professor, Dept. of Basic Engineering, Dr. Ajeev Kumar, Assistant Professor, Dept. of Agricultural Biotechnology and Dr. Kanika Rani, Assistant Professor, Dept. of Nanobiotechnology for curriculum development, revision and compilation of under graduate course curriculum of the university.

The help extended by Registrar, Dean, PGS, Directors and Officers of the university, the Head of departments and faculty members involved in the preparation of this document is gratefully acknowledged.

Dr. S. K. Pahuja

Dr. S. K. Pahuja
Dean, College of Agriculture
&
Chairperson
Committee for finalisation
of UG Course Curriculum
CCS HAU, Hisar

ACRONYMS

AAHM	Aquatic Animal Health Management
ABM	Agricultural Business Management
ABT	Agricultural Biotechnology
AE	Agricultural Engineering
AEC	Ability Enhancement Course
AEM	Aquatic Environment Management
AGRI	Agriculture
AIA	Agro-Industrial Attachment
AM	Agribusiness Management
ANBT	Animal Biotechnology
ATS	Apparel and Textile Science
AGRON	Agronomy
AG ECON	Agricultural Economics
AGM	Agricultural Meteorology
AQC	Aquaculture
BI	Bioinformatics
BIO	Biology
BIOCHEM	Biochemistry
BIOTECH	Biotechnology
CCA	Co-curricular Activity
CE	Civil Engineering
CS	Community Science
COMP	Computer Science
EE	Electronics and Electrical Engineering
EECM	Extension Education and Communication Management
ENG	English
ENT	Entomology
EXT	Extension Education
FE	Fish Engineering
FN	Foods and Nutrition
FEES	Fisheries Extension, Economics & Statistics
FMPE	Farm Machinery & Power Engineering
FOR	Forestry
FPT	Fish Processing Technology
FRM	Fisheries Resource Management
FS	Fisheries Science
GPB	Genetics & Plant Breeding
HDFS	Human Development and Family Studies
HORT	Horticulture
IBT	Industrial Biotechnology
LPM	Livestock Production Management
MATH	Mathematics

MBB	Molecular Biology & Biotechnology
MDC	Multi-Disciplinary Course
ME	Mechanical Engineering
MEB	Microbial and Environmental Biotechnology
MICRO	Microbiology
NBT	Bio-Nanotechnology
NCC	National Cadet Corps
NEMA	Nematology
NG	Non Gradial
NSS	National Service Scheme
PBT	Plant Biotechnology
PFE	Processing and Food Engineering
PL PATH	Plant Pathology
PL PHY	Plant Physiology
RAWE	Rural Agricultural Work Experience
REE	Renewable Bio-energy Engineering
RMCS	Resource Management and Consumer Science
SEC	Skill Enhancement Course
SOC	Sociology
SOILS	Soil Science
SST	Seed Science & Technology
STAT	Statistics
SWE	Soil and Water Engineering
TUT	Tutorial
VAC	Value Added Course
VSC	Vegetable Science

CONTENTS

GENERAL INFORMATION

Chaudhary Charan Singh Haryana Agricultural University, Hisar has revised Course Curriculum for undergraduate programmes in all the colleges of the University as per the recommendations of the Sixth Deans' Committee of ICAR and implemented from academic session 2025-26.

- The B.Sc. (Hons.)/ B.F.Sc./ B.Tech. programme are of 4 years duration, covering 166-174 credits of coursework. Additionally, students engage in 16 credits of non-gradial courses and 10 credits of MOOCs/online courses. The credit distributions for the different courses have been specified for individual disciplines.

General Credit Allocation Scheme of UG Programmes

Semester	Core Courses (Major+ Minor)	Multi-Disciplinary Courses (MDC)	Value Added Courses (VAC)	Ability Enhancement Courses (AEC)	Skill Enhancement Courses (SEC)	Internship/ Project/ Student READY/ RAWE & AIA	Total Credits	Non-Gradial	Online Courses/ MOOC
I	12	3(2)	-	2(3) + 2(4)	4	-	23	3(1+1a)	10
II	10	3(5)	3(6)	2(3) + 2(7)	4	-	24	2(1a+8a)	
Post-II semester	-	-	-	-	-	10(12)	-	-	
III	16	-	-	2(8)	2	-	20	3(3+1a)	
IV	12	3(9)	3(10)	-	2	-	20	2(1a+8a)	
Post-IV semester	-	-	-	-	-	10(13)	-	-	
V	21	-	-	-	-	-	21	5(3+1a+11)	
VI	21	-	-	-	-	-	21	1(1a)	
VII	20	-	-	-	-	-	20	-	
VIII	-	-	-	-	-	20	20	-	
Total	**112**	**9**	**6**	**10**	**12**	**20**	**169**	**16**	**10**

(1) Deeksharambh (Induction-cum-Foundation Course) of 2 credits (2 weeks duration)
(1a) Tutorial
(2) Farming based Livelihood systems
(3) NCC/NSS
(4) Communication Skills
(5) Entrepreneurship Development and Business Management
(6) Environmental Studies and Disaster Management
(7) Personality Development
(8) Physical Education, First Aid, Yoga Practices and Cultural Activities
(8a) Co-curricular Activity
(9) Agriculture Marketing and Trade
(10) Agriculture Informatics and Artificial Intelligence
(11) Educational Tour (10-14 days)
(12) Only for those opting for an exit with UG-Certificate
(13) Only for those opting for an exit with UG-Diploma

One multidisciplinary course in Agricultural Engineering discipline is different from the above common courses keeping in view the discipline specific requirement.

UNDERGRADUATE PROGRAMMES COLLEGE-WISE

Programme	Core Courses (Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY/ RAWE & AIA	Total Credits	Non-Gradial	Online Courses/ MOOC
B.Sc. (Hons.) Agriculture	112	9	6	10	12	20	169	17	10
B.Sc. (Hons.) Agribusiness Management	112	9	6	8	12	20	167	17	10
B.Tech. (Agricultural Engineering)	125	10	6	10	8	15	174	18	6
B.Tech. (Biotechnology)	112	9	6	8	12	20	167	16	10
B.Sc. (Hons.) Community Science	112	9	6	10	12	20	169	16	10
B.F.Sc.	117	9	6	8	12	20	172	16	10

- After the admission in the University, the students will register for *Deeksharambh* (0+2) (Non-gradial) the Foundation course of 2 weeks' duration in the 1st semester of the degree programme. It will include discussions on operational framework of academic process in the college and the university. There will be sessions with alumni, business leaders, University academic and research personnel on instilling social awareness, ethics and values, cultural heritage, folk art and craft, Indian Constitution etc. It will help to identify the strength and weakness of students, diverse potentialities and to enhance cultural integration of students from different backgrounds. It will also create a platform for students to learn from each other's life experiences.
- The first year of the degree programme comprises skill development courses/ modules along with other fundamental courses. After satisfactory completion of courses in two semesters of 1st year and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-Certificate in admitted programme on exit. The students continuing the study further, would not have to attend the internship after 1st year.
- The second year has been designed with the skill development courses as well as fundamental courses related to degree programme with adequate theory and practical components, enabling the student to get acquainted with the basic principles and applications of agricultural sciences. After satisfactory completion of the courses during first two years and subsequent satisfactory completion of 10 credits (10 weeks) of internship/industry/institute training, the student will become eligible for the award of UG-Diploma in the admitted programme on exit. The students continuing the further study, need not to attend the internship after 2nd year. However, the students of B.Tech (Agricultural Engineering) are being offered 4 weeks In-Plant training as partial credits

after 4th Semester during break for completing the degree requirement with splitting in two slots (4 weeks each).

- The courses in the third year have been designed to impart in-depth knowledge of the subject to the students. There will not be an exit after 3rd year. During 5th semester, the students will have an educational tour of 10-12 days duration, which will be counted as 2 credits (Non-gradial).
- The fourth year of degree programmehas been meticulously designed not only to impart specialized knowledge to the students in the selected major disciplines but also to prepare the students to take up employment or entrepreneurship as their future career.
- During the 7th semester, the students will adequately select 20 credits from a basket of elective courses, each course giving an opportunity to gain advanced knowledge in frontier areas of science. The objective is to enable the student to acquire deeper understanding in any particular field.
- In the 8th semester of the degree programme, Student READY programme: Rural Agricultural Work Experience (RAWE), Experiential Learning, Hands-on Training, In-plant Training/ Industrial Aattachment/Internship and Project Work of 20 credits will be offered.
- In B.Tech (Agricultural Engineering) final year, the student will have the liberty to choose any three elective subjects, preferably from one or related disciplines. The objective is to enable the student to acquire deeper understanding in a particular field. In the final year, the Project-I (3 credits in 7th semester) and Project-II (4 credits in 8th semester) are meant for advanced skill development for research, employment and entrepreneurship. Under these courses, the student will have the option to take up a research project (R & D based/field study based) for developing research skills in form of project or take up incubation/ experiential learning-based activity for entrepreneurship development. The Project-I and II can also be taken up in collaboration with any organization/ industry.
- The students have to take a minimum of 10 credits of online courses (6 credits for B.Tech Agricultural Engineering) during four years as a partial requirement for the B.Sc. (Hons)/ B.F.Sc./B.Tech. programme. The online courses can be from any field such as Agriculture and allied sciences, Basic Sciences, Humanities, Psychology, Anthropology, Economics, Business Management, Languages including foreign language, Communication skills/ Music, etc. and can be taken from NPTEL, Mook IT, edX, Coursera, SWAYAM or any other such reputed portal accepted by the University. The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses. These online courses will be non-gradial and separate certificates would be issued by institute/organization offering the courses. The student must submit the list of online courses along with the content he/she intends to undertake to the Dean/Assoc. Dean/Principal of the college for a permission and records.

Entry and Exit Options

The entry and exit options for the UG programme is shown in the figure below.

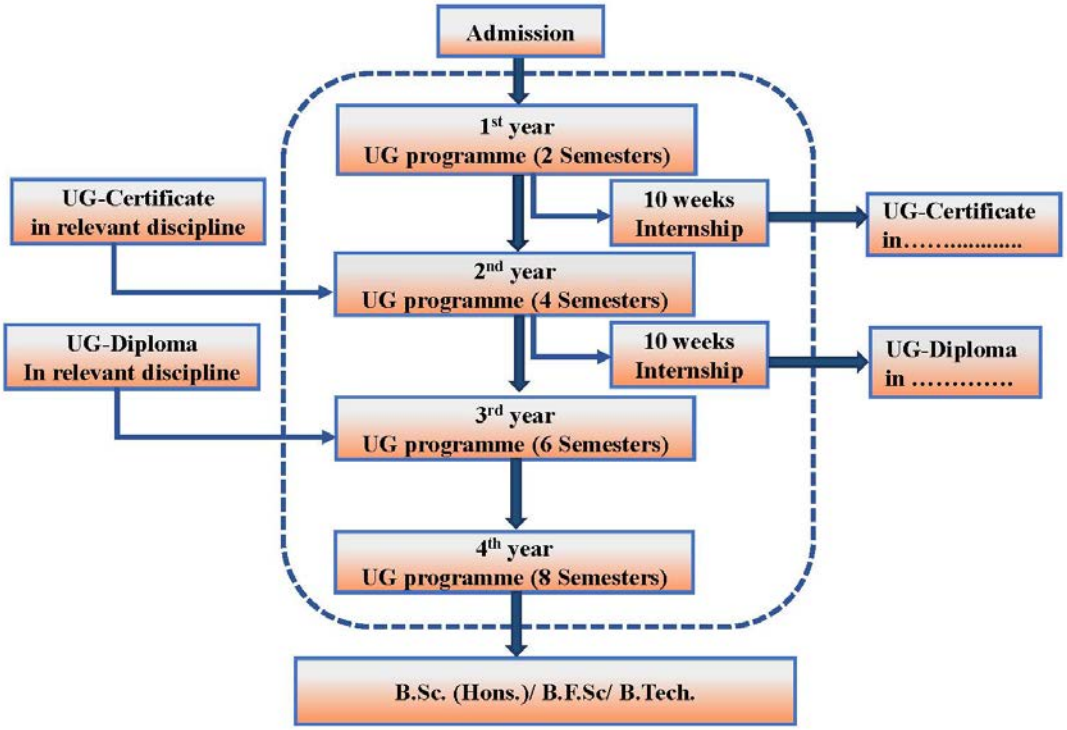


Figure 1: Entry and Exit Options for the UG Programmes

Entry Options: Students with UG-Certificate and UG-Diploma can take admission in 2nd and 3rd year, respectively of B.Sc.(Hons.)/ B.F.Sc./ B.Tech. degree programme.

Exit options

i. **UG-Certificate:** Exit after satisfactory completion of first year and 10 weeks' internship.

ii. **UG-Diploma:** Exit after satisfactory completion of second year and 10 weeks' internship.

iii. **B.Sc. (Hons.)/B.F.Sc./B.Tech.:** On successful completion of four-year degree requirements.

Examination and Evaluation System

Examination and evaluation system of under graduate programme of the University has been given below:

- External pattern of examination shall be followed only for the final theory portion to be conducted at the end of the semester for regular courses.
- External theory exam will be 50% and internal theory + practical- 50%.
- There will be mid-term examination for internal theory and evaluation will be internal.

- The question papers for non-credit courses will be set at the level of Dean/HOD concerned.
- The mid-term, practical and final-term examination shall be conducted during examination dates prescribed in the academic calendar.
- The date sheet will be provided by the Dean of the respective colleges.
- For a course with practical only, practical examination will be conducted twice during mid-term and final term.

Distribution of Marks for Various Examinations

Nature of courses Credit Hours (Theory + Practical)	**Internal (100)**				**External (100)**
	Mid-term Theory	**Assignment**	**Mid-term Practical**	**Final Practical**	
Courses with theory and practical					
1+1	30	20	NA	50	100
1+2	20	20	NA	60	100
2+1	40	20	NA	40	100
2+2	30	20	NA	50	100
3+1	50	20	NA	30	100
Courses with only theory	70	30	NA	NA	100
Courses with only practical	NA	30	70	100	NA

- After adding marks of all the examinations, the total will be divided by two for converting total marks out of 100 and combined (Theory + Practical) grade of each course will be awarded.
- The evaluation of the skill enhancement courses will be done as courses with practical only.
- Usually for any subject, there will be two assignment/quizzes within the semester, one before the midterm and one after midterm examination.
- The evaluation of internship will be done by the parent institute. The student shall submit a report to the parent institute and present the learnings before the other students and faculty after the internship programme.
- The online/MOOC courses, successfully completed by the student, will be indicated in the transcript with 'Satisfactory' grade.
- When students take deficiency course(s), they will be assessed as 'Satisfactory' or Unsatisfactory' without any grade points.

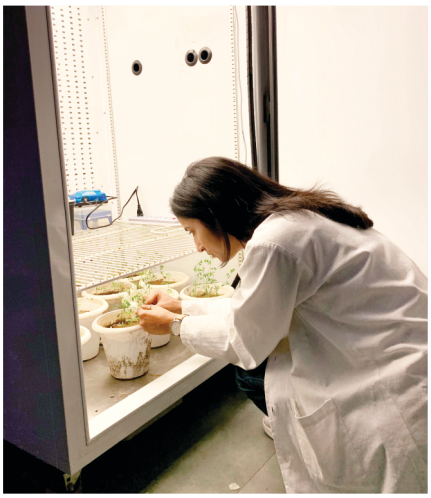
The course catalogue and examination & evaluation system as per the recommendations of Sixth Deans' committee implemented with effect from academic year 2025-26, starting from 1st year 4-year programme of all the colleges. In rest of the existing classes (2nd to 4th year 4-year programme) of all the colleges, the old course catalogue and examination system shall be followed.

COLLEGE OF BIOTECHNOLOGY


COLLEGE OF BIOTECHNOLOGY


CENTRE FOR
MICROPROPAGATION &
DOUBLED HAPLOID
PRODUCTION


Biological Safety Cabinet



COLLEGE OF BIOTECHNOLOGY

B. TECH. BIOTECHNOLOGY, 4-YEAR PROGRAMME
COURSES: SEMESTER-WISE

Course No.	Course Title	Credits
I Semester		
BIOTECH 100	*Deeksharambh* (Induction cum Foundation Course of 2 Weeks)	2 (0+2) NG
ABT 101	Introductory Cell Biology	3 (3+0)
ABT 103	Fundamentals of Genetics	3 (3+0)
ABT 105 (SEC I)	Practices in Plant Tissue Culture	2 (0+2)
MBB 101	Molecular Biology	3 (3+0)
MBB 103 (SEC II)	Laboratory Management and Instrumentation	2 (0+2)
AGRON 101 (MDC)	Farming Based Livelihood Systems	3 (2+1)
BIO 103/ MATH 103	Basic Biology/Basic Mathematics	2 (2+0)
ENG 101 (AEC)	Communication Skills	2 (1+1)
NCC I/ NSS I (AEC)	National Cadet Corps I/ National Service Scheme I	2 (0+2)
TUT	Tutorial	1 (1+0) NG
	Total Credits	**22 (14+8)**
II Semester		
ABT 102	Introduction to Biotechnology	3 (3+0)
MBB 102 (SEC III)	Basic Techniques of Molecular Biology and Biotechnology	2 (0+2)
BI 102 (SEC IV)	Bioinformatics and Bio-computation	2 (0+2)
ABM 208 (MDC)	Entrepreneurship Development and Business Management	3 (2+1)
EXT 102 (AEC)	Personality Development	2 (1+1)
GPB 202	Basics of Plant Breeding	3 (2+1)
SOILS 102 (VAC)	Environmental Studies and Disaster Management (To be taught jointly by Dept. of Soil Science, Agricultural Meteorology, Forestry and Microbiology)	3 (2+1)
MICRO 102	Elementary Microbiology	2 (1+1)
NCC II/ NSS II (AEC)	National Cadet Corps II/ National Service Scheme II	2 (0+2)
CCA 102 (AEC)	Co-curricular Activity	1 (0+1) NG
TUT	Tutorial	1 (1+0) NG
	Total Credits	**22 (11+11)**
BIOTECH 200	Student READY: Industrial Attachment/ Experiential Learning/ Hands-on Training/ Project Work/ Internship (10 weeks) Compulsory for students opting for an exit with UG-Certificate after 1st Year	10 (0+10)

III Semester		
ABT 201	Classical and Molecular Cytogenetics	3 (2+1)
MBB 201	Recombinant DNA Technology	2 (2+0)
MBB 203 (SEC V)	Methods in Recombinant DNA Technology	2 (0+2)
ENTO 201	Fundamentals of Crop Protection (To be taught jointly by Deptt. of Entomology, Plant Pathology and Nematology)	3 (2+1)
MATH 203	Biomathematics	2 (2+0)
PL PHY 201	Fundamentals of Crop Physiology	3 (2+1)
LPM 201	Livestock Production and Management	3 (2+1)
NCC III/ NSS III (AEC)	National Cadet Corps III/ National Service Scheme III	2 (0+2) NG
CCA 201 (AEC)	Physical Education, First Aid, Yoga Practices and Cultural Activities	2 (0+2)
TUT	Tutorial	1 (1+0) NG
	Total Credits	**20 (12+8)**
IV Semester		
ABT 202	Molecular Marker Technology	2 (2+0)
ABT 204 (SEC VI)	Practices in Molecular Marker Technology	2 (0+2)
ABT 206	Biodiversity and its Conservation	2 (2+0)
BI 202	Introductory Bioinformatics	4 (3+1)
AG ECON 301 (MDC)	Agricultural Marketing and Trade	3 (2+1)
BIOCHEM 202	Basic Biochemistry	4 (3+1)
COMP 202 (VAC)	Agriculture Informatics and Artificial Intelligence	3 (2+1)
SOC 202	Human Ethics	1 (1+0)
CCA 202	Co-curricular Activity	1 (0+1) NG
TUT	Tutorial	1 (1+0) NG
	Total Credits	**21 (15+6)**
BIOTECH 300	Student READY: Industrial Attachment/ Experiential Learning/ Hands-on Training/ Project Work/ Internship (10 weeks) Compulsory for students opting for an exit with UG-Diploma after 2nd Year	10 (0+10)
V Semester		
ABT 301	Genomics and Proteomics	3 (3+0)
BNT 301	Nano-biotechnology	4 (3+1)
IBT 301	Microbial Genetics	4 (3+1)
IBT 303	Enzymology and Enzyme Technologies	3 (2+1)
MBB 301	Molecular Genetics	3 (3+0)
MBB 303	Animal Biotechnology	3 (2+1)
MBB 305	Immunology	3 (2+1)
BIOTECH 351	Educational Tour	2 (0+2) NG
NCC IV/ NSS IV (AEC)	National Cadet Corps IV/ National Service Scheme IV	2 (0+2) NG

TUT	Tutorial	1 (1+0) NG
	Total Credits	**23 (18+5)**
VI Semester		
ABT 302	Molecular Diagnostics	3 (2+1)
BI 302	Computational Biology	3 (2+1)
IBT 302	Industrial Biotechnology	3 (3+0)
IBT 304	IPR, Biosafety and Bioethics	2 (2+0)
MBB 302	Epigenetics and Gene Regulation	2 (2+0)
MBB 304	Introduction to Animal Breeding	3 (2+1)
STAT 301	Biostatistics	2 (1+1)
FST 301	Food Science and Processing	3 (2+1)
TUT	Tutorial	1 (1+0) NG
	Total Credits	21 (16+5)
VII Semester		
Students are required to choose elective courses of 20 credits out of Elective I-V		
Elective I: Plant Biotechnology		
ABT 401	Applications of Genomics and Proteomics	4 (3+1)
ABT 402	Principles of Molecular Breeding	4 (3+1)
ABT 403	Principles and Procedures of Plant Tissue Culture	3 (2+1)
ABT 404	Molecular Breeding in Field and Horticultural Crops	3 (2+1)
ABT 405	Seed Biology, Biotechnology, Production and Management	3 (2+1)
ABT 406	Plant Genetic Transformation	3 (2+1)
	Total Credits	**20 (14+6)**
Elective II: Bioinformatics		
BI 401	Programming in Bioinformatics	4 (2+2)
BI 402	Bioinformatics Tools and Biological Databases	3 (2+1)
BI 403	Structural Bioinformatics	3 (2+1)
BI 404	Pharmacogenomics	3 (2+1)
BI 405	Metabolomics and Systems Biology	4 (3+1)
BI 406	Computational Methods for Data Analysis	3 (2+1)
	Total Credits	**20 (13+7)**
Elective III: Microbial and Environmental Biotechnology		
IBT 401	Fundamentals of Molecular Pharming and Biopharmaceuticals	4 (3+1)
IBT 402	Microbial Biotechnology	4 (3+1)
IBT 403	Bioprospecting of Genes and Molecules	3 (3+0)
IBT 404	Molecular Ecology and Evolution	3 (3+0)
IBT 405	Food Biotechnology	3 (2+1)
IBT 406	Green Biotechnology	3 (2+1)
	Total Credits	**20 (16+4)**
Elective IV: Animal Biotechnology		
MBB 401	Principles and Procedures of Animal Cell Culture	4 (3+1)
MBB 402	Animal Genomics	4 (3+1)

MBB 403	Transgenic Animal Production	3 (3+0)
MBB 404	Molecular Virology and Vaccine Production	3 (2+1)
MBB 405	Embryo Transfer Technologies	3 (2+1)
MBB 406	Animal Reproductive Biotechnology	3 (2+1)
	Total Credits	**20 (15+5)**
Elective V: Fisheries Science (To be taught and offered by College of Fisheries Science)		
VIII Semester **Student READY** (Industrial Attachment/ Experiential Learning/ Hands-on Training/Project Work/Internship)		
BIOTECH 499	Industrial Attachment/ Project Work in Biotechnology	20
	Total Credits	**20**
Online Courses (MOOC)*		10
	Grand Total	**167+ 10 (MOOC)+ 16 NG**

*From SWAYAM, Diksha, NPTEL, mooKIT, edX, Coursera or any other portal under intimation to the Dean

B. TECH. BIOTECHNOLOGY, 4-YEAR PROGRAMME

FOUNDATION AND COMMON COURSES

Course No.	Course Title	Credits	Semester
FOUNDATION COURSES			
BIOTECH 100	*Deeksharambh* (Induction cum Foundation Course of 2 weeks)	2 (0+2) NG	I
BIOTECH 351	Educational Tour	2 (0+2) NG	V
	Total Credits	**4 (0+4) NG**	
COMMON COURSES			
Multidisciplinary Courses (MDC)			
AGRON 101 (MDC)	Farming Based Livelihood Systems	3 (2+1)	I
ABM 208 (MDC)	Entrepreneurship Development and Business Management	3 (2+1)	IV
AG ECON 301(MDC)	Agricultural Marketing and Trade	3 (2+1)	V
	Total Credits	**9 (6+3)**	
Value Added Courses (VAC)			
SOILS 102 (VAC)	Environmental Studies and Disaster Management	3 (2+1)	II
COMP 202 (VAC)	Agricultural Informatics and Artificial Intelligence	3 (2+1)	III
	Total Credits	**6 (4+2)**	
Ability Enhancement Course (AEC)			
ENG 101 (AEC)	Communication Skills	2 (1+1)	I
EXT 102 (AEC)	Personality Development	2 (1+1)	II
NCC I/ NSS I (AEC)	National Cadet Corps I/ National Service Scheme I	2 (0+2)	I
NCC II/ NSS II (AEC)	National Cadet Corps II/ National Service Scheme II	2 (0+2)	II
CCA 201 (AEC)	Physical Education, First Aid, Yoga Practices and Cultural Activities	2 (0+2)	III
	Total Credits	**10 (2+8)**	

B. TECH. BIOTECHNOLOGY, 4-YEAR PROGRAMME

CORE COURSES: DEPARTMENT-WISE

Course No.	Course Title	Credits	Semester
Agricultural Biotechnology			
ABT 101	Introductory Cell Biology	3 (3+0)	I
ABT 103	Fundamentals of Genetics	3 (3+0)	I
ABT 105	Practices in Plant Tissue Culture	2 (0+2)	I
ABT 102	Introduction to Biotechnology	3 (3+0)	II
ABT 201	Classical and Molecular Cytogenetics	3 (2+1)	III
ABT 202	Molecular Marker Technology	2 (2+0)	IV
ABT 204	Practices in Molecular Marker Technology	2 (0+2)	IV
ABT 206	Biodiversity and its Conservation	2 (2+0)	IV
ABT 301	Genomics and Proteomics	3 (3+0)	V
ABT 302	Molecular Diagnostics	3 (2+1)	VI
ABT 304	Fundamentals of Agricultural Biotechnology (For B.Sc. (Hons.) Agriculture and B.Sc. (Hons.) Agribusiness Management)	3 (2+1)	VI
	Total Credits	**29 (22+7)**	
Bioinformatics and Computational Biology			
BI 102	Bioinformatics and Bio-computation	2 (0+2)	II
BI 202	Introductory Bioinformatics	4 (3+1)	IV
BI 302	Computational Biology	3 (2+1)	VI
	Total Credits	**9 (5+4)**	
Bio-Nanotechnology			
BNT 301	Nano-biotechnology	4 (3+1)	V
	Total Credits	**4 (3+1)**	
Industrial Biotechnology			
IBT 301	Microbial Genetics	4 (3+1)	V
IBT 303	Enzymology and Enzyme Technologies	3 (2+1)	V
IBT 302	Industrial Biotechnology	3 (3+0)	VI
IBT 304	IPR, Biosafety and Bioethics	2 (2+0)	VI
	Total Credits	**12 (10+2)**	
Molecular Biology and Biotechnology			
MBB 101	Molecular Biology	3 (3+0)	I
MBB 103	Laboratory Management and Instrumentation	2 (0+2)	I
MBB 102	Basic Techniques of Molecular Biology & Biotechnology	2 (0+2)	II
MBB 201	Recombinant DNA Technology	2 (2+0)	III
MBB 203	Methods in Recombinant DNA Technology	2 (0+2)	III
MBB 301	Molecular Genetics	3 (3+0)	V
MBB 303	Animal Biotechnology	3 (2+1)	V
MBB 305	Immunology	3 (2+1)	V
MBB 304	Epigenetics and Gene Regulation	2 (2+0)	VI
MBB 306	Introduction to Animal Breeding	3 (2+1)	VI
	Total Credits	**25 (16+9)**	

SKILL ENHANCEMENT COURSES

Course No.	Course Title	Credits	Semester
ABT 105 (SEC I)	Practices in Plant Tissue Culture	2 (0+2)	I
MBB 103 (SEC II)	Laboratory Management and Instrumentation	2 (0+2)	I
MBB 102 (SEC III)	Basic Techniques of Molecular Biology and Biotechnology	2 (0+2)	II
BI 102 (SEC IV)	Bioinformatics and Bio-Computation	2 (0+2)	II
MBB 203 (SEC V)	Methods in Recombinant DNA Technology	2 (0+2)	III
ABT 204 (SEC VI)	Practices in Molecular Marker Technology	2 (0+2)	IV
	Total Credits	**12(0+12)**	

ELECTIVE COURSES: DEPARTMENT-WISE

Course No.	Course Title	Credits	Semester
Agricultural Biotechnology (Elective I: Plant Biotechnology)			
ABT 401	Applications of Genomics and Proteomics	4 (3+1)	VII
ABT 402	Principles of Molecular Breeding	4 (3+1)	VII
ABT 403	Principles and Procedures of Plant Tissue Culture	3 (2+1)	VII
ABT 404	Molecular Breeding in Field and Horticultural Crops	3 (2+1)	VII
ABT 405	Seed Biology, Biotechnology, Production and Management	3 (2+1)	VII
ABT 406	Plant Genetic Transformation	3 (2+1)	VII
	Total Credits	**20(14+6)**	
Bioinformatics and Computational Biology (Elective II: Bioinformatics)			
BI 401	Programming in Bioinformatics	4 (2+2)	VII
BI 402	Bioinformatics Tools and Biological Databases	3 (2+1)	VII
BI 403	Structural Bioinformatics	3 (2+1)	VII
BI 404	Pharmacogenomics	3 (2+1)	VII
BI 405	Metabolomics and Systems Biology	4 (3+1)	VII
BI 406	Computational Methods for Data Analysis	3 (2+1)	VII
	Total Credits	**20(13+7)**	
Industrial Biotechnology (Elective III: Microbial and Environmental Biotechnology)			
IBT 401	Fundamentals of Molecular Pharming and Biopharmaceuticals	4 (3+1)	VII
IBT 402	Microbial Biotechnology	4 (3+1)	VII
IBT 403	Bioprospecting of Genes and Molecules	3 (3+0)	VII
IBT 404	Molecular Ecology and Evolution	3 (3+0)	VII
IBT 405	Food Biotechnology	3 (2+1)	VII
IBT 406	Green Biotechnology	3 (2+1)	VII
	Total Credits	**20(16+4)**	
Molecular Biology and Biotechnology (Elective IV: Animal Biotechnology)			
MBB 401	Principles and Procedures of Animal Cell Culture	4 (3+1)	VII
MBB 402	Animal Genomics	4 (3+1)	VII
MBB 403	Transgenic Animal Production	3 (3+0)	VII
MBB 404	Molecular Virology and Vaccine Production	3 (2+1)	VII

MBB 405	Embryo Transfer Technologies	3 (2+1)	VII
MBB 406	Animal Reproductive Biotechnology	3 (2+1)	VII
	Total Credits	**20(15+5)**	
Elective V: Fisheries Science (To be taught and offered by College of Fisheries Science)			

STUDENTS READY PROGRAMME FOR UG CERTIFICATE AFTER 1ST YEAR AND UG DIPLOMA AFTER 2ND YEAR

Sr. No.	Activities	No. of weeks	Credits
1	General orientation and on campus training by different faculties	1	5
2	Industrial Attachment/ Project Work in Biotechnology (Plant Biotechnology, Animal Biotechnology, Microbial and Environmental Biotechnology and Bioinformatics)	8	4
3	Project Report Preparation, Presentation and Evaluation	1	1
	Total	**10**	**10**

STUDENTS READY PROGRAMME FOR B. TECH. BIOTECHNOLOGY, 4-YEAR PROGRAMME

Sr.No.	Activities	No. of weeks	Credits
1	General orientation and on campus training by different faculties	2	10
2	Industrial Attachment/ Project Work in Biotechnology (Plant Biotechnology, Animal Biotechnology, Microbial and Environmental Biotechnology and Bioinformatics)	16	8
3	Project Report Preparation, Presentation and Evaluation	2	2
	Total	**20**	**20**

NON-GRADIAL COURSES

Course No.	Course Title	Credits	Semester
BIOTECH 100	*Deeksharambh* (Induction cum Foundation Course of 2 Weeks)	2 (0+2)	I
BIOTECH 351	Educational Tour	2 (0+2)	V
TUT	Tutorial	1 (1+0)	I to VI
	Total Credits	**10 (6+4)**	

SUPPORTING COURSES: DEPARTMENT-WISE

COLLEGE OF AGRICULTURE

Course No.	Course Title	Credits	Semester
Agricultural Economics			
AG ECON 301 (MDC)	Agricultural Marketing and Trade	3 (2+1)	IV
	Total Credits	**3 (2+1)**	
Agricultural Extension Education			
EXT 102 (AEC)	Personality Development	2 (1+1)	II
	Total Credits	**2 (1+1)**	
Agronomy			
AGRON 101 (MDC)	Farming Based Livelihood Systems	3 (2+1)	I
	Total Credits	**3 (2+1)**	
Business Management			
ABM 208 (MDC)	Entrepreneurship Development & Business Management	3 (2+1)	II
	Total Credits	**3 (2+1)**	
Entomology			
ENTO 201	Fundamentals of Crop Protection (To be taught jointly by Deptt. of Entomology, Plant Pathology and Nematology)	3 (2+1)	III
	Total Credits	**3 (2+1)**	
Genetics and Plant Breeding			
GPB 202	Basics of Plant Breeding	3 (2+1)	II
	Total Credits	**3 (2+1)**	
Soil Science			
SOILS 102 (VAC)	Environmental Studies and Disaster Management	3 (2+1)	II
	Total Credits	**3 (2+1)**	

COLLEGE OF BASIC SCIENCES AND HUMANITIES

Course No.	Course Title	Credits	Semester
Biochemistry			
BIOCHEM 202	Basic Biochemistry	4 (3+1)	IV
	Total Credits	**4 (3+1)**	
Botany and Plant Physiology			
BIO 103	Basic Biology (To be taught jointly by Deptt. of Botany and Zoology)	2 (2+0)	I
PL PHY 201	Fundamentals of Crop Physiology	3 (2+1)	III
	Total Credits	**5 (4+1)**	

Computer Section			
COMP 202 (VAC)	Agriculture Informatics and Artificial Intelligence	3 (2+1)	IV
	Total Credits	**3 (2+1)**	
Languages and Haryanvi Culture			
ENG 101 (AEC)	Communication Skills	2 (1+1)	I
	Total Credits	**2 (1+1)**	
Mathematics and Statistics			
MATH 103	Basic Mathematics	2 (2+0)	I
MATH 203	Biomathematics	2 (2+0)	III
STAT 301	Biostatistics	2 (1+1)	VI
	Total Credits	**6 (5+1)**	
Microbiology			
MICRO 102	Elementary Microbiology	2 (1+1)	II
	Total Credits	**2 (1+1)**	
Sociology			
SOC 202	Human Ethics	1 (1+0)	IV
	Total Credits	**1 (1+0)**	
Centre of Food Science and Technology			
FST 301	Food Science and Processing	3 (2+1)	VI
	Total Credits	**3 (2+1)**	

OTHER SUPPORTING COURSE

Animal Science			
LPM 201	Livestock Production and Management	3 (2+1)	III
	Total Credits	**3 (2+1)**	

DIRECTORATE OF STUDENTS' WELFARE

Course No.	Course Title	Credits	Semester
NCC I/ NSS I (AEC)	National Cadet Corps I/ National Service Scheme I	2 (0+2)	I
NCC II/ NSS II (AEC)	National Cadet Corps II/ National Service Scheme II	2 (0+2)	II
CCA 102 (AEC)	Co-curricular Activity	1 (0+1) NG	II
CCA 201 (AEC)	Physical Education, First Aid, Yoga Practices and Cultural activities	2 (0+2)	III
NCC III/ NSS III	National Cadet Corps III/ National Service Scheme III	2 (0+2) NG	III
CCA 202	Co-curricular Activity	1 (0+1) NG	IV
NCC IV/ NSS IV	National Cadet Corps IV/ National Service Scheme IV	2 (0+2) NG	V
	Total Credits	**6 (0+6)**	

COURSE CONTENTS: DEPARTMENT-WISE

FOUNDATION COURSES

Course No.	Course Title	Credits	Semester
BIOTECH 100	*Deeksharambh* (Induction cum Foundation course of 2 weeks)	2 (0+2) NG	I
BIOTECH 351	Educational Tour	2 (0+2) NG	V
	Total Credits	**4 (0+4)**	

BIOTECH 100	***DEEKSHARAMBH* (INDUCTION CUM FOUNDATION COURSE OF 2 WEEKS)**	**2 (0+2) NG**	**SEM I**

Objectives

Aims at creating a platform for students to help for cultural Integration of students from different backgrounds, know about the operational framework of academic process in university, instill life and social skills, social awareness, ethics and values, teamwork, leadership, creativity, etc. and identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

The details of activities will be decided by the parent universities. The structure shall include, but not be restricted to:

i. Discussions on the operational framework of the academic process in university, as well as interactions with academic and research managers of the University.
ii. Interaction with alumni, business leaders, prospective employers, outstanding achievers in related fields, and people with inspiring life experiences.
iii. Group activities to identify the strengths and weaknesses of students (with expert advice for their improvement) and to create a platform for students to learn from each other's life experiences.
iv. Activities to enhance the cultural Integration of students from different backgrounds.
v. Field visits to related fields/ establishments.
vi. Sessions on personality development (instilling life and social skills, social awareness, ethics and values, teamwork, leadership, etc.) and communication skills.

BIOTECH 351	**EDUCATIONAL TOUR**	**2 (0+2) NG**	**SEM V**

To be conducted for 10-12 days after 5th Semester.

The students will visit industries/ institutions, preferably outside the state, so that, in addition to visiting the organizations/ industries (related to the profession), they will also be exposed to the geographical variability of different places/ states and the social and cultural differences existing in the country.

After the visit, the students will submit a report/ make a presentation.

AGRICULTURAL BIOTECHNOLOGY

Course No.	Course Title	Credits	Semester
Core Courses			
ABT 101	Introductory Cell Biology	3 (3+0)	I
ABT 103	Fundamentals of Genetics	3 (3+0)	I
ABT 105 (SEC I)	Practices in Plant Tissue Culture	2 (0+2)	I
ABT 102	Introduction to Biotechnology	3 (3+0)	II
ABT 201	Classical and Molecular Cytogenetics	3 (2+1)	III
ABT 202	Molecular Marker Technology	2 (2+0)	IV
ABT 204 (SEC VI)	Practices in Molecular Marker Technology	2 (0+2)	IV
ABT 206	Biodiversity and its Conservation	2 (2+0)	IV
ABT 301	Genomics and Proteomics	3 (3+0)	V
ABT 302	Molecular Diagnostics	3 (2+1)	VI
ABT 304	Fundamentals of Agricultural Biotechnology (For B.Sc. (Hons.) Agriculture and B.Sc. (Hons.) Agribusiness Management)	3(2+1)	VI
	Total Credits	**29 (22+7)**	
Elective Courses			
ABT 401	Applications of Genomics and Proteomics	4 (3+1)	VII
ABT 402	Principles of Molecular Breeding	4 (3+1)	VII
ABT 403	Principles and Procedures of Plant Tissue Culture	3 (2+1)	VII
ABT 404	Molecular Breeding in Field and Horticultural Crops	3 (2+1)	VII
ABT 405	Seed Biology, Biotechnology, Production and Management	3 (2+1)	VII
ABT 406	Plant Genetic Transformation	3 (2+1)	VII
	Total Credits	**20 (14+6)**	
	Grand Total	**49 (36+13)**	

ABT 101	INTRODUCTORY CELL BIOLOGY	3 (3+0)	SEM I

Objectives

1. Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles
2. How are these cellular components used to generate and utilise energy in cells
3. The cellular components underlying mitotic cell division
4. Apply their knowledge of cell biology to selected examples of changes or losses in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

Theory

Origin and evolution of cells. Introduction to microscopy. Sub-cellular structure of prokaryotic and eukaryotic cells. Membrane structure and function: plasma membrane, cell wall and extracellular matrix. Structural organisation and function of intracellular organelles and organelle biogenesis. Nucleus, mitochondria, endoplasmic reticulum, Golgi apparatus, lysosomes, peroxisomes, plastids and vacuoles.The structure and function of the 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.

Suggested Readings

1. Verma PS and Agarwal VK, 2016, Cell Biology, Genetics, Molecular Biology, Evolutionand Ecology. S Chand and Sons.
2. Cooper GM and Hausman RE, 2018, The Cell: A Molecular Approach. Sinauer Associates Inc.

ABT 103	FUNDAMENTALS OF GENETICS	3 (3+0)	SEM I

Objectives

1. To study the history of genetics
2. To study inheritance and variation
3. To study chromosomes and cell division
4. To study the genetic basis of traits

Theory

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

Multiple allelism, linkage and crossing-over, gene-gene interaction, genetic analysis in prokaryotes and eukaryotes, extrachromosomal inheritance, mutations, the Hardy-Weinberg law, quantitative inheritance, an introduction to human genetics, and the genetic basis of evolution are discussed.

Suggested Readings

1. Brah GS, 2014, Animal Genetics: Concepts and Implications, 2nd edn, Kalyani Publishers.
2. Gardener EJ, Simmons MJ and Snustad DP, 1991, Principles of Genetics. John Wiley and Sons, Inc., New York, USA.

ABT 105 (SEC II)	PRACTICES IN PLANT TISSUE CULTURE	2 (0+2)	SEM I

Objectives

This course aims at

1. Imparting hands-on training on the calculation of per cent solutions, molarity, molality, normality, and preparation of buffers.

2. Studying basic equipment used in plant molecular biology and cell culture laboratories, washing, packing and sterilisation of glass and plastic wares for cell culture
3. Studying the preparation of media and reagents for cell culture, primary culture technique, culture and sub-culturing of continuous cell lines, viability assay by trypan blue dye exclusion method, micropropagation, haploid production, embryo rescue, cryopreservation of primary cultures and cell lines
4. Studying the preparation of phytohormones and sterilisation
5. Studying tissue culture laboratory management

Practical

Laboratory safety and aseptic techniques, sterilisation methods for equipment and media, media preparation, preparation of solid and liquid media, ph adjustment and sterilisation of media. Culture initiation and explant selection. Selection of explants: meristem, node, leaf, embryo, etc. Surface sterilisation of plant material. Techniques for explant preparation and inoculation onto culture media. Callus induction and subculture. Subculture techniques: transfer of cultures to fresh media, monitoring and maintenance of cultures, organogenesis and embryogenesis. Micropropagation. Genetic transformation. Cryopreservation and conservation. Project Work: students design and conduct a small-scale tissue culture project. They will choose a plant species, select appropriate explants, culture them in vitro, and document the progress and results.

Suggested Readings

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

ABT 102	INTRODUCTION TO BIOTECHNOLOGY	3 (3+0)	SEM II

Objectives

1. To understand the basic concepts of molecular biology and the methods used in the manipulation of nucleic acids to isolate and characterise genes
2. To understand how molecular tools are used to modify an organism. To study the history, concepts and scope of biotechnology
3. To study the applications of biotechnology

Theory

Introduction to genetic material, history of genetic material, physical and chemical basis of genetic material, structure of DNA and RNA, scope and importance of Biotechnology, plant, microbial, animal, medical, environmental, industrial, marine, agricultural, and food biotechnology, and nanobiotechnology.

Introduction to recombinant DNA technology, vectors, DNA manipulating and modifying enzymes, and gene cloning. Introduction to genomics and proteomics, Molecular markers, DNA sequencing, Genetic transformation and transgenic organisms, Bioinformatics, and Biosafety guidelines.

Suggested Readings

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

ABT 201	CLASSICAL AND MOLECULAR CYTOGENETICS	3 (2+1)	SEM III

Objectives

This course aims to study the

1. Basics of chromatin
2. Chromosome, banding and chromosome variations
3. Genome analysis through chromosome variations

Theory

Introduction and history. Structure of chromatin. Chromosome structure and chromosome landmarks. Specialised chromosomes. Differential staining of the chromosomes - Q-banding, G banding, C banding, R banding. In situ hybridisation-FISH, GISH.

Changes in chromosome number: aneuploidy - monosomy, trisomy and tetrasomy, haploidy and polyploidy - autopolyploidy and allopolyploidy. Methods of doubled haploid production. Structural aberrations of chromosomes: deletions, duplications, inversions and translocations. Locating genes on chromosomes. Genome analysis.

Practical

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

Suggested Readings

1. Becker, K., and Hardin, 2004, The World of Cell. 5th edn, Pearson Edu.
2. Carroll M, 1989, Organelles, The Guilford Press.
3. Charles B, 1993, Discussions in Cytogenetics, Prentice Hall.
4. Fan YS, 2002, Molecular Cytogenetics: Protocols and Applications. Humana Press.
5. Gupta PK, 2007, Cytogenetics, Rastogi publications.
6. Mahabal R, 2010, Fundamentals of Cytogenetics and Genetics, PHI Learning Pvt. Ltd.
7. Popescu P, Hayes H and Dutrillaux B, 2000, Techniques in Animal Cytogenetics, Springer Science and Business Media.

ABT 202	MOLECULAR MARKER TECHNOLOGY	2 (2+0)	SEM IV

Objectives

1. To study the importance and types of molecular markers
2. To study the mapping populations, development, and analysis
3. To study the applications of molecular markers in mapping and breeding

Theory

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, and physical maps.

Application of molecular markers. Assessing genetic diversity and variety protection. Introduction to genomic selection and marker-assisted breeding for accelerated introgression of trait/transgene and quantitative traits. Human and animal health. Association with genetically based diseases. Paternity determinations. Parentage using SNP data. Forensic studies. DNA Fingerprinting.

Suggested Readings

1. Gupta PK, 2015, Molecular Biology and Genetic Engineering, Rastogi Publication.
2. Manikanda Boopathi N, 2013, Genetic mapping and marker-assisted selection, Springer.
3. Manikanda Boopathi N, 2020, Genetic Mapping and Marker Assisted Selection: Basics, Practice and Benefits, Springer.
4. Schook LB (ed), 2020, Gene-mapping techniques and applications, CRC Press.
5. Verma PS, 2018, Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Chaukhamba Auriyantaliya Publishers.
6. Watson JD, Levine M, Baker TA, Gann A, Bell SP and Losick, R., 2014, Molecular Biology of the Gene, Pearson.

ABT 204 (SEC VI)	PRACTICES IN MOLECULAR MARKER TECHNOLOGY	2 (0+2)	SEM IV

Objectives

1. This course aims at imparting skills through hands-on training in the area of molecular markers and their applications
2. To study the development of markers and marker systems, genotyping with various types of markers, mapping, diversity analysis, marker-assisted selection, DNA fingerprinting, diversity and cluster analysis, phylogenetic analysis

Practical

Overview of molecular markers: types, applications, significance. Principles of genetic variation and inheritance, DNA Extraction and quantification, PCR-Based molecular markers, RFLP (Restriction Fragment Length Polymorphism) analysis, AFLP (Amplified Fragment Length Polymorphism) analysis, SSR (Simple Sequence Repeat) analysis, SNP (Single Nucleotide Polymorphism) analysis. Principles of SNP

detection, PCR-based SNP genotyping assays, SNP array and sequencing-based approaches. DNA sequencing and sequence analysis, interpretation of sequencing data and sequence alignment, Marker-Assisted Selection (MAS), genomic selection and marker discovery. Practical Project: students design and conduct a small-scale molecular marker project. They will choose a specific technique or experiment, perform the necessary procedures, analyse data, and present their findings.

Suggested Readings

1. Gupta PK, 2015, Molecular Biology and Genetic Engineering, Rastogi Publication.
2. Manikanda Boopathi N, 2013, Genetic mapping and marker-assisted selection, Springer.
3. Manikanda Boopathi N, 2020, Genetic Mapping and Marker Assisted Selection: Basics, Practice and Benefits, Springer.
4. Schook LB (ed), 2020, Gene-mapping techniques and applications, CRC Press.
5. Verma PS, 2018, Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Chaukhamba Auriyantaliya Publishers.
6. Watson JD, Levine M, Baker TA, Gann A, Bell SP and Losick, R., 2014, Molecular Biology of the Gene, Pearson.

ABT 206	BIODIVERSITY AND ITS CONSERVATION	2 (2+0)	SEM IV

Objectives

1. To study the concepts of biodiversity
2. To study the methods of protecting biodiversity
3. To study regulations on biodiversity conservation

Theory

Concepts of biodiversity, bioresource and wildlife management, conservation strategies: in situ and ex-situ conservation. Wildlife conservation projects in India. Protection of biodiversity for its suitable utilisation. Threats to biodiversity. WCU Red data book; Biodiversity hotspots in India. National bureaus of genetic resources. Biodiversity Mapping. Biogeographical regions.

Sustainable development, diversification of cropping systems, diversity of indigenous livestock, threats to biodiversity, WCU Red data book, vulnerability and extinction of flora and fauna, endangered species in various ecosystems, germplasm banks, environmental impact assessment, bioremediation and biosafety, and introduction to regulatory agencies and legislation.

Suggested Readings

1. Das, M.K., Choudhury, B.P., 2008, A Textbook on Plant Nomenclature and Biodiversity Conservation, Kalyani Publishers.
2. Gaston KJ and Spicer JI, 2004, Biodiversity: An Introduction, Blackwell Publishers.
3. Hopsetti, B.B., Venketashwarlaru, M, 2001, Trends in Wildlife Conservation and Management, Vol. 2, Daya Publishing House.
4. Singh MP and Singh BS, 2002, Plant Biodiversity and Taxonomy, Daya Publishing House.

ABT 301	GENOMICS AND PROTEOMICS	3 (3+0)	SEM V

Objectives

1. To provide an understanding of genomics, structural and functional
2. To study comparative genomics and its applications
3. To study proteomics and related tools

Theory

Introduction to genomics, functional genomics, and proteomics. Structural genomics: classical ways of genome analysis. BAC and YAC libraries. Next-generation sequencing. Genome analysis and gene annotation. Genome projects: E. coli, Arabidopsis, Bovine, and Human. Comparative Genomics: orthologous and paralogous sequences. Synteny, gene order, and phylogenetic footprinting.

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

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

Suggested Readings

1. Andreas H and Samuel C, 2018, Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press.
2. Saraswathy N, Ramalingam P, 2011, Concepts and Techniques in Genomics and Proteomics, Elsevier Science.

ABT 302	MOLECULAR DIAGNOSTICS	3 (2+1)	SEM VI

Objectives

1. To understand the importance of molecular diagnostics
2. To acquaint with various methods of diagnostic methods
3. To compare the advantages of molecular diagnostic methods with those of conventional methods

Theory

Principles and applications of molecular diagnostic tests. Nucleic acid-based diagnostics for the 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.

Advantages of molecular diagnostics over conventional diagnostics, serodiagnostic, DNA array technology, Protein array, tissue array, biosensors and nanotechnology, and development and validation of diagnostic tests.

Practical

Preparations of buffers and reagents. Collection of clinical and environmental

samples for molecular detection of pathogens (bacteria/viruses). Extraction of nucleic acids (DNA and 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.

Suggested Readings

1. Lela B, 2019, Molecular Diagnostics: Fundamentals, Methods and Clinical Applications, FA Davis Company.
2. Singh BD, 2021, Biotechnology Expanding Horizons, Kalyani Publishers.

ABT 304	**FUNDAMENTALS OF AGRICULTURAL BIOTECHNOLOGY (For B.Sc. (Hons.) Agriculture and B.Sc. (Hons.) Agribusiness Management)**	**3 (2+1)**	**SEM VI**

Objectives

To familiarize the students with the fundamental principles of biotechnology, various developments in biotechnology and its potential applications

Theory

Introduction to Plant Tissue Culture and Genetic Engineering: History; Cellular totipotency and cytodifferentiation; Callus culture, Single-cell/suspension culture and their applications; Organogenesis and somatic embryogenesis; Somaclonal variation and its use in crop improvement; Embryo rescue technique and its significance in hybrid development; *In vitro* fertilization, ovule culture and its significance in hybrid development; Protoplast isolation, culture and regeneration; Somatic hybridization (somatic hybrids and cybrids) and its application in crop improvement; Anther and pollen culture for haploid production; Development of disease-free (virus free) plants through apical meristem culture; Micropropagation technique for the generation of quality planting material; Synthetic seeds and its applications; National certification and Quality management of TC plants-secondary metabolite production- *in vitro* germplasm conservation.

Introduction to Molecular Biology: DNA structure, structure and function; DNA replication, transcription and translation, RNA, types and function; Structure of prokaryotic and eukaryotic gene; Central dogma of life - DNA replication, transcription, genetic codes, translation and protein synthesis; Lac Operon concept - Nucleic acid hybridization; Polymerase chain reaction- DNA sequencing – Sanger method; PCR and its applications.

Introduction to recombinant DNA technology: DNA modifying enzymes and vectors; plant genetic transformation – physical (Gene gun method), chemical (PEG mediated) and Agrobacterium-mediated gene transfer methods; Transgenic and its importance in

crop improvement with successful stories; biosafety. Introduction to various molecular markers: RFLP, RAPD, SSR, SNP etc.; Marker-assisted breeding in crop improvement.

Practical

Introduction to Plant Tissue Culture Laboratory; Good Laboratory Practices; Media Preparation and sterilization; Glassware sterilization; Micropropagation; Callus induction and culture; Anther culture; Apical meristem culture; Preparation of synthetic seeds; Isolation of plasmid DNA; Quantification of DNA; Agarose Gel Electrophoresis and visualization of plasmid DNA; Restriction digestion of plasmid DNA and agarose gel electrophoresis; Isolation of Plant genomic DNA; PCR amplification of DNA; Gel electrophoresis of amplified DNA; Visit to tissue culture units /biotech labs.

Suggested Readings

1. Bhojwani SS. 1983. Plant Tissue Culture: Theory and Practice. Elsevier.
2. Singh BD. 2007. Biotechnology: Expanding Horiozon. Kalyani
3. Christou P and Klee H. 2004. Handbook of Plant Biotechnology. John Wiley & Sons.
4. Lewin B. 2008. Gene IX. Peterson Publications/ Panima. W.H. Freeman & Co.
5. Primrose SB. 2001. Molecular Biotechnology. Panima.

ABT 401	APPLICATIONS OF GENOMICS AND PROTEOMICS	4 (3+1)	SEM VII

Objectives

1. To introduce the concepts of omics: genomics, transcriptomics and proteomics
2. To study the methods in genomics and their applications
3. To study the techniques in proteomics

Theory

Genomes of Arabidopsis, rice, tomato, pigeon pea, and wheat. Mutants and RNAi in functional genomics. Site-directed mutagenesis. Transposon tagging. Transient gene expression: VIGS and FACS-based, targeted genome editing technologies, introductory genome editing principles and concepts.

Protein 3D structure modelling (homology modelling and crystallography). Proteome analysis. Protein-protein interaction. FRET, yeast two-hybrid and co-immunoprecipitation, Bimolecular Fluorescence Complementation (BiFC). Applications of genomics and proteomics in agriculture, human health and industry. Metabolomics and Ionomics for elucidating metabolic pathways.

Practical

SDS-PAGE; 2D Electrophoresis. Protein characterisation through HPLC. Specialised crop-based genomic resources: TAIR, Gramene, Graingenes, Maizedb, Phytozome, Cerealdb, Citrusdb and miRbase.

Suggested Readings

1. Connor DO and Hames BD, 2007, Proteomics: Methods Express, Royal College of General Practitioners.
2. Pennington SR, Dunn MJ, 2001, Proteomics from protein sequence to function, BIOS Scientific Publishers Ltd.
3. Sangeetha J and Thangadurai D, 2015, Genomics and Proteomics: Principles, Technologies and Applications, Taylor and Francis
4. Tropp BE, 2012, Molecular Biology: Genes to Proteins, 4th edn, Jones and Bartlett Learning.
5. Verma PS and Agarwal VK, 2014, Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand and Company Pvt. Ltd

ABT 402	PRINCIPLES OF MOLECULAR BREEDING	4 (3+1)	SEM VII

Objectives

1. To introduce the concept of molecular breeding with reference to conventional breeding
2. To study the mapping populations, genotyping, phenotyping and mapping
3. To study the validation of genomic resources and their employment in breeding

Theory

Introduction to molecular breeding, advantages, requirements and methodologies. Limitations of conventional breeding. Development of specific mapping populations, association panels, MAGIC and NAM populations.

Phenotyping and genotyping of the populations, construction of the linkage maps, and linkage-disequilibrium maps. Analysing marker-trait associations, validation of QTL and markers, fine-mapping, and candidate gene discovery.

Marker-assisted selection (MAS) and marker-assisted backcross breeding. Foreground selection, background selection and recombination selection. MAS for major and minor genes, marker-assisted pyramiding, and marker-assisted recurrent selection.

Practical

Methodologies in phenotyping, genotyping, handling marker data, linkage analysis, candidate gene discovery, and fine-mapping. Software for linkage mapping and association mapping. Working on some genotyping and phenotyping datasets for linkage mapping using software such as Mapmaker, MapDisto and QTL mapping software such as WinQTL Cartographer.

Suggested Readings

1. Bharadwaj DN, 2019, Molecular Plant Breeding: Meeting the Challenge of Food Security, Apple Academic Press.
2. Xu Y, 2010, Molecular Plant Breeding, CABI, Science.
3. Singh BD and Shekhawat NS, 2017, Molecular Plant Breeding, Scientific Publishers.

ABT 403	PRINCIPLES AND PROCEDURES OF PLANT TISSUE CULTURE	3 (2+1)	SEM VII

Objectives

1. To understand the concept of totipotency and its applications in plant tissue culture
2. To study the composition of plant tissue culture media and the role of different components
3. To study the principles, procedures and uses of various types of cultures

Theory

History of plant tissue culture. Concept of totipotency. Concept of aseptic culture practices and sterilisation techniques. Components of in vitro culture media and role of different macro and micronutrients, vitamins, plant growth regulators and growth supplements. 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 and ovary culture. Protoplast culture and somatic hybridisation. Soma clonal variation.

Practical

Good laboratory practices include media preparation and sterilisation, surface sterilisation of explants, establishment of callus/cell suspension cultures, micropropagation, embryo culture, anther culture, induction of plant regeneration, hardening, and transfer to soil.

Suggested Readings

1. Bhojwani SS and Razdan MK, 1996, Plant Tissue Culture: Theory and Practice, Elsevier.
2. Chawla HS, 2009, Introduction to Plant Biotechnology: Oxford & IBH Publishing Co Pvt. Ltd.
3. Dixon RA and Gonzales RA, 2003, Plant Cell Culture: A Practical Approach, Oxford University Press.
4. Razdan MK, 2008, Introduction to Plant Tissue Culture: Oxford & IBH Publishing Co Pvt. Ltd.

ABT 404	MOLECULAR BREEDING IN FIELD AND HORTICULTURAL CROPS	3 (2+1)	SEM VII

Objectives

1. To study the principles and applications of molecular breeding in field and horticultural crops
2. To understand breeding objectives in field and horticultural crops
3. To study the success stories of molecular breeding in field and horticultural crops

Theory

MAS for specific traits with examples from field crops with success stories. Development, testing and release of improved genotypes developed using MAS.

Specific case studies. Reproductive biology of major field and horticultural crops. Target traits in major fields and horticultural crops. Breeding methods of self- and cross-pollinated field and horticultural crops. Pseudo-test cross-mapping strategy in fruit crops. Molecular mapping in vegetable crops. Marker-assisted breeding in the field and horticulture. Mutation breeding and characterisation of mutants.

Practical

Use of gene-based and closely linked markers for foreground selection for target traits in target field crops. Hands-on training on MAS with a specific crop. Modifications in DNA extraction methods for field and horticultural. Agarose gel electrophoresis and DNA quantification. Mapmaker: Diversity analysis using UPGMA. Identifying repeat sequences using MISA. Standard gene cloning and expression methods.

Suggested Readings

1. Bal JS, 2013, Fruit Growing, Kalyani Publishers.
2. Bharadwaj DN, 2019, Molecular Plant Breeding: Meeting the Challenge of Food Security, Apple Academic Press
3. Chada KL, 2012, Handbook of Horticulture, ICAR.
4. Kumar N, 2006, Breeding of Horticultural Crops: Principles and Practices, New India Publishing Agency.
5. Kumar N, 2018, Breeding of Horticultural Crops: Principles and Practices: 3rd edn, NIPA.
6. Nagat T, Lorz H and Widholm JM, 2008, Biotechnology in Agriculture and Forestry, Springer.
7. Schnell, R.J., and Priyadarshan, PM, 2012, Genomics of Tree Crops, Springer.
8. Singh BD and Shekhawat NS, 2017, Molecular Plant Breeding, Scientific Publishers.
9. Singh J, 2014, Basic Horticulture, Kalyani Publishers.
10. Singh R, 2012, Fruits. National Book Trust.
11. Spangenberg G, 2001, Molecular Breeding of Forage Crops, Kluwer Academic Publishers.
12. Trivedi PC, 2000, Plant Biotechnology: Recent Advances, Panima Publishers.
13. Xu Y, 2010, Molecular Plant Breeding, CABI, Science.

ABT 405	SEED BIOLOGY, BIOTECHNOLOGY, PRODUCTION AND MANAGEMENT	3 (2+1)	SEM VII

Objectives

1. To provide an overview of the aspects of seed biology
2. To study the principles and methods of quality seed production
3. To study the techniques and management for seed processing

Theory

Seed structure, seed development and maturation. Seed germination. Seed senescence- causes, quality characters.

Molecular seed biology: gene expression during seed development, molecular

markers and seed quality, omics technologies in seed research and male sterility systems. Biofortification and seed enhancement, seed coatings and treatments, biopesticides and biofertilisers. Advances in seed biotechnology, sustainable seed production practices and future challenges and opportunities in seed science.

Principles of quality seed production. Factors affecting quality seed production. Causes of varietal deterioration and maintenance of genetic purity during seed production.

Post-harvest handling of seeds - threshing methods - drying methods - advantages and disadvantages. Seed processing principles and sequencing. Seed enhancement technologies (coating, priming, pelleting and hardening)

Practical

Seed production in rice varieties and hybrids. Seed production in sorghum varieties and hybrids. Seed production in pearl millet varieties and hybrids. Seed production in maize. Hybrid seed production in maize. Seed production in pulses (black, green, and red gram). Seed production in groundnut and gingelly. Seed production in sunflower varieties and hybrids. Seed production in cotton. Seed production in solanaceous vegetables. seed production techniques of bhendi and onion. Seed production in cucurbits (snake gourd, bitter gourd, ash gourd, ridge gourd and pumpkin).

Suggested Readings

1. Basra A, 2006, Handbook of Seed Science and Technology (Seed Biology, Production, and Technology), CRC Press.
2. Khedar OP, Singh RV, Sinsinwar YK and Ved Prakash V, 2013, Seed Production Technology in Field Crops, Pointer, ISBN 10: 817132746x, ISBN 13: 9788171327461

ABT 406	PLANT GENETIC TRANSFORMATION	3 (2+1)	SEM VII

Objectives

1. To study the historical developments of plant transformation
2. To study the methods of plant transformation
3. To get acquainted with the methods used for analysing the transgenics

Theory

History of plant genetic transformation. Development of gene constructs. Methods of genetic transformation: Agrobacterium-mediated, biolistic, electroporation, liposome, polyethene glycol, and in planta methods.

Selection and characterisation of transgenic plants using selectable and reportable markers. PCR; qRT-PCR; Southern and Northern hybridisation, ELISA and Western blotting. Application of genetic transformation for the improvement of important traits. Biosafety aspects of transgenic plants and regulatory framework.

Practical

Preparation of stock solutions. Construction of a binary vector. Preparation of competent cells of Agrobacterium tumefaciens and transformation. Restriction analysis of plasmids, confirmation of transformed bacterial colonies. Agrobacterium tumefaciens-mediated and biolistic plant transformation.

Suggested Readings

1. Gardener EJ, Simmons MJ and Snustad DP, 1991, Principles of Genetics. John Wiley and Sons, Inc., New York, USA.
2. Grierson D, 2012, Plant Genetic Engineering, Springer Netherlands.
3. Primose SB and Twyman RM, 2006, Principles of Gene Manipulation and Genomics, 7th edn, Blackwell Publishing.
4. Sambrook JF and Russell DW (Eds), 2001, Molecular Cloning: A Laboratory Manual, 3rd edn, Vols 1, 2 and 3, Cold Spring Harbor Laboratory Press.

BIOINFORMATICS AND COMPUTATIONAL BIOLOGY

Course No.	Course Title	Credits	Semester
Core Courses			
BI 102 (SEC IV)	Bioinformatics and Bio-computation	2 (0+2)	II
BI 202	Introductory Bioinformatics	4 (3+1)	IV
BI 302	Computational Biology	3 (2+1)	VI
	Total Credits	**9 (5+4)**	
Elective Courses			
BI 401	Programming in Bioinformatics	4 (2+2)	VII
BI 402	Bioinformatics Tools and Biological Databases	3 (2+1)	VII
BI 403	Structural Bioinformatics	3 (2+1)	VII
BI 404	Pharmacogenomics	3 (2+1)	VII
BI 405	Metabolomics and Systems Biology	4 (3+1)	VII
BI 406	Computational Methods for Data Analysis	3 (2+1)	VII
	Total Credits	**20 (13+7)**	
	Grand Total	**29 (18+11)**	

BI 102 (SEC IV)	BIOINFORMATICS AND BIO-COMPUTATION	2 (0+2)	SEM II

Objectives

1. To expose the students to the construction and use of computers, special algorithms, new complexity theories, computer science and related mathematics
2. To understand the scientific and economic impact of bioinformatics
3. To have a better understanding of organisms, their metabolism and their evolution
4. To study their applications in health care and drug design, new (bio) materials and their engineering, food engineering, and food production

Practical

Information search and data retrieval, genome analysis and gene mapping, alignment of pairs of sequences, alignment of multiple sequences and phylogenetic analysis, tools for similarity search and sequence alignment, profiles and hidden Markov models, gene identification and prediction, gene expression analyses, protein classification and structure analysis and visualisation, protein structure prediction, computational methods for pathway and systems biology, technologies and strategies for drug discovery, biomarkers in drug development, computer-aided drug design.

Suggested Readings

1. Altman RB, Dunker AK, Hunter L, Ritchie MD, Murray TA and Klein TE, 2017, Biocomputing, https://doi.org/10.1142/10388.
2. Laplante PA (Ed), 2004, Biocomputing, Ova Biomedical.

BI 202	INTRODUCTORY BIOINFORMATICS	4 (3+1)	SEM IV

Objectives

1. To train the students on applications of computers in analysing the biomolecules (DNA, RNA and protein)
2. To study various types of databases
3. To study various operations and algorithms in bioinformatics

Theory

Introduction to bioinformatics. Development and scope of bioinformatics. Applications of computers in bioinformatics. Operating systems, hardware, software, internet, WWW resources, FTP, and the application of bioinformatics in agriculture.

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

Introduction to sequence alignment and its applications. Pairwise and multiple sequence alignment, the concept of local and global alignment; Algorithms. Dot Matrix method, dynamic programming methods (Needleman–Wunsch and Smith–Waterman). Tools of MSA: ClustalW, TCoffee. Phylogeny. Introduction to BLAST and FASTA; MSA and phylogeny. Assembly and annotation.

Practical

Hands-on training on databases, database construction and management, algorithms and analysis of DNA, RNA and proteins.

Suggested Readings

1. Baxevanis AD, Ouellette BFF, 2011, Bioinformatics: A practical guide to the analysis of genes and proteins, John Wiley and Sons.
2. Mount DW, 2001, Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor.
3. Xiong J, 2012, Essential Bioinformatics, Cambridge University Press.

BI 302	COMPUTATIONAL BIOLOGY	3 (2+1)	SEM VI

Objectives

1. To study the basics of web-based servers and software in genome analysis.
2. To study the procedure and steps in DNA/RNA/protein sequence submission
3. To study the methods of analysing the sequences for similarity and phylogenetics

Theory

Introduction to computational biology. Web-based servers and software for genome analysis. Ensembl, UCSC genome browser, MUMMER, BLASTZ. Sequence submission: sequence submission, whole genome sequence submission; NGS: basics and types. Introduction to bio programming; Perl, Python and R development of web server; basic concepts.

Protein interaction databases: BIND, DIP, GRID, STRING, PRIDE. Principles of

Protein structure prediction. Fold Recognition (threading). Homology modelling. SCOP, CATH, PDB, PROSITE, PFAM. Methods for comparison of 3D structures of proteins. 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.

Suggested Readings

1. Creighton TE, 1993, Proteins: Structures and Molecular Properties, 2nd edn, W. H. Freeman.
2. Dov S, 2003, Microarray Bioinformatics, 1st edn, Cambridge University Press.
3. Malcolm Campbell A and Laurie JH, 2007, Discovering Genomics, Proteomics and Bioinformatics. 2nd edn, Benjamin Cummings.
4. Mount D, 2001, Bioinformatics: Sequence and Genome Analysis, 2nd edn, Cold Spring Harbor Laboratory Press.
5. Setubal J and Meidanis J, 2004, Introduction to Computational Molecular Biology, PWS Publishing Company.

BI 401	PROGRAMMING IN BIOINFORMATICS	4 (2+2)	SEM VII

Objectives

1. To study the importance and essentials of programming in bioinformatics
2. To study the operating system, algorithms, languages and functions for bioinformatics with hands-on practical
3. To study programming language

Theory

Introduction: operating systems, programming concepts, algorithms, flow chart, programming languages, compiler and interpreter. Computer number format: decimal, binary, octal and hexadecimal.

C-Language: history, constants, 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. Program related to arithmetic operations, arrays and file handling in C.

Practical

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. 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.

Suggested Readings

1. Balagurusamy E, 2008, Programming in ANSI C, Tata McGraw-Hill Education.
2. Christiansen T, Foy BD, Wall L and Orwant J, 2012, Programming Perl, 4th edn, O'Reilly Media.
3. Kanetkar Y, 2013, Let Us C, BPB Publications.
4. Tisdall J, 2003, Mastering Perl for Bioinformatics, O'Reilly Media.

BI 402	BIOINFORMATICS TOOLS AND BIOLOGICAL DATABASES	3 (2+1)	SEM VII

Objectives

1. To study various tools of bioinformatics for sequence analysis
2. To study biological data, databases and their applications
3. To study algorithms and methods for bioinformatic analysis and visualisation of results

Theory

Introduction: biological data types, collection, and classification schema of biological databases.

Biological databases retrieval systems. Sequence and molecular file formats.

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

Bioinformatics tools: concept of alignment, scoring matrices, alignment algorithms, heuristic methods, multiple sequence alignment, phylogenetic analysis, molecular visualisation tools.

Practical

NCBI; ExPASY: Swiss Prot; EBI; Search engines: ENTREZ and SRS; Perform local alignment using all BLAST variants. Multiple sequence alignment using Clustal W. T Coffee. Phylogenetic analysis by PHYLIP. MEGA.

Suggested Readings

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

BI 403	STRUCTURAL BIOINFORMATICS	3 (2+1)	SEM VII

Objectives

1. To acquaint the students with the creation of new methods of analysing and manipulating biological macromolecular data in order to solve problems in biology and generate new knowledge
2. To study the analysis and prediction of the three-dimensional structure of biological macromolecules such as proteins, RNA, and DNA

Theory

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, domains, profiles, fingerprints and protein family databases.

Structural features of RNA, RNA secondary structure predictions. RNA folding. Small RNA prediction.

Structure prediction: basics of protein folding, protein folding problem, molecular chaperones. Secondary structure prediction methods and algorithms: homology, ab initio and folding-based tertiary structure prediction. Structure validation tools and energy minimisation techniques. Introduction to molecular dynamics and simulation, Monte-Carlo methods, Markov chain and HMM. Structure visualisation and comparison methods.

Practical

Protein structural classification databases, 3D-Structural databases searching and retrieval, Ramachandran Plot, structural visualisation tools, tools for protein secondary and tertiary structure prediction; RASMOL, Cn3D, CHIMERA, SWISS-PDB viewer, CPH, MODELLER, SWISS Model, Easy Modeller, Procheck. GROMAC. SANJIVNI. BHAGIRATH.

Suggested Readings

1. Allan H, 2008, Modeling for Beginners, Wiley.
2. Creighton TE, 1993, Proteins: Structures and Molecular Properties, W. H. Freeman.
3. Malcolm CA, and Laurie JH, 2007, Discovering Genomics, Proteomics and Bioinformatics, Benjamin Cummings.
4. Mount DW, 2001, Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor.
5. Setubal J, and Meidanis J, 1997, Introduction to Computational Molecular Biology, PWS Publishing Company.

BI 404	PHARMACOGENOMICS	3 (2+1)	SEM VII

Objectives

The students are exposed

1. To develop strategies for individualising therapy for patients, to optimise outcomes through knowledge of human genome variability and its influence on drug response.
2. To study the research on genes and medications which has advanced the understanding of the genetic basis of individual drug responses

Theory

Basic concepts of pharmacogenomics, clinical application and challenges in pharmacogenomics. Human Genome Project, genetic diseases, personalised 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.

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 the active site of proteins using various software, bioavailability using Mol inspiration, docking using HEX and AUTODOCK.

Suggested Readings

1. Allan H, 2008, Modeling for Beginners, Wiley- Blackwell Publishing.
2. Gupta SP, 1996, Quantum Biology, New Age International Pvt. Ltd.
3. Holtje HD, Wolfgang S, Didier R, and Hans D, 2003, Molecular Modeling: Basic Principles and applications, Wiley-VCH.
4. Lisa B, 2014, Combinatorial Library Methods and Protocols, Humana Press.

BI 405	METABOLOMICS AND SYSTEMS BIOLOGY	4 (3+1)	SEM VII

Objectives

1. To comprehensively identify and quantify all endogenous and exogenous small-molecule metabolites in a biological system in a high-throughput manner.
2. To study the model and discover emergent properties of cells, tissues, and organisms functioning as a system.

Theory

Introduction to metabolomics, metabolomic databases, metabolite architecture, metabolic footprinting, enzyme discovery, E. coli metabolomics, fungal exo-metabolome, and diagnostic biomarkers in metabolomics.

Introduction to systems biology, transcriptome analysis, simple synthetic networks, noise in gene expression, structure of biological networks, pathway architecture, applications of systems biology in the discovery of disease signatures, drug targeting and design, and metabolomics in systems biology.

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.

Suggested Readings

1. Berg JM, Tymoczko JL and Stryer L, 2002, Biochemistry, 5th edn, W. H. Freeman and Company.

2. Fersht A, 1999, Structure and mechanism of protein science, W. H. Freeman and Company.
3. Klipp E, Herwig R, Kowald A, Wierling C and Lehrach H, 2006, Systems biology in practice, concepts, implementation and application, Wiley VCH.
4. Nielsen J, and Jewett MC, 2007, Metabolomics, A Powerful Tool in Systems Biology, Springer-Verlag Berlin Heidelberg, ISBN 978-3-540-74718-5.
5. Tomita M, and Nishioka T, 2005, Metabolomics, The Frontier of Systems Biology, Springer-Verlag, ISBN 4-431-25121-9.
6. Vaidyanathan S, Harrigan GG and Royston G, 2005, Metabolome analysis: Strategies for system biology, Springer
7. VD and Voet J, (Ed) Biochemistry, 3rd edn, John Wiley and Sons.

BI 406	COMPUTATIONAL METHODS FOR DATA ANALYSIS	3 (2+1)	SEM VII

Objectives

1. To apply statistical analysis and technologies to data to find trends and solve problems
2. To introduce students to some of the key computational techniques used in modelling and simulation of real-world phenomena
3. To study the applications of computational methods in biology using sequence data

Theory

Introduction to UNIX/LINUX operating system. Knowledge discovery and data mining techniques. Machine learning and pattern recognition, hidden Markov models. Artificial neural networks, support vector machines.

Principal component analysis, ANOVA. AMOVA and different clustering methods. Gene prediction algorithms and phylogeny algorithms. Basics of the 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.

Suggested Readings

1. Gareth J, Daniela W, Trevor H, and Robert T, 2013, An Introduction to Statistical Learning: with Applications in R, Springer.
2. Mathur KS, 2010, Statistical Bioinformatics with R, Elsevier.

BIO-NANOTECHNOLOGY

Course No.	Course Title	Credits	Semester
Core Course			
BNT 301	Nano-biotechnology	4 (3+1)	V
	Total Credits	**4 (3+1)**	

BNT 301	NANO-BIOTECHNOLOGY	4 (3+1)	SEM V

Objectives

1. To provide an understanding of the concepts and terminologies related to nanobiotechnology
2. To study nanosystems, their synthesis and application

Theory

Introduction to nanotechnology. Concepts and Terminology. Nano-Bio Interface. Biologically based nanosystems, molecular motors, biosensors and other devices.

Self-assembly of molecules for nanotechnology applications; biomimetics, bio templating, and de novo-designed nanostructures and materials; DNA nanotechnology; nanomanipulations, material design, synthesis, and their applications.

Practical

Introduction to nanomaterials and their properties. Nanoscale characterisation techniques. Scanning electron microscopy (SEM) and transmission electron microscopy (TEM). Atomic force microscopy (AFM) for nanoscale imaging and manipulation. Spectroscopic techniques (UV-Vis, fluorescence, Raman) for nanoparticle analysis. Nanoparticle synthesis and functionalisation, chemical synthesis methods for nanoparticles (top-down and bottom-up approaches), and surface functionalisation techniques for controlling nanoparticle properties. Biomolecular interactions at the nanoscale, nanotoxicology, and safety assessment. Projects and presentations.

Suggested Readings

1. Gabor L, Hornyak J, Moore J, Tibbals, HF and Joydeep D, 2009, Fundamentals of Nanotechnology, CRC Press.
2. Kumar U, 2008, Nanotechnology: A Fundamental Approach, Agrobios

INDUSTRIAL BIOTECHNOLOGY

Course No.	Course Title	Credits	Semester
	Core Courses		
IBT 301	Microbial Genetics	4 (3+1)	V
IBT 303	Enzymology and Enzyme Technologies	3 (2+1)	V
IBT 302	Industrial Biotechnology	3 (3+0)	VI
IBT 304	IPR, Biosafety and Bioethics	2 (2+0)	VI
	Total Credits	**12 (10+2)**	
	Elective Courses		
IBT 401	Fundamentals of Molecular Pharming and Biopharmaceuticals	4 (3+1)	VII
IBT 402	Microbial Biotechnology	4 (3+1)	VII
IBT 403	Bioprospecting of Genes and Molecules	3 (3+0)	VII
IBT 404	Molecular Ecology and Evolution	3 (3+0)	VII
IBT 405	Food Biotechnology	3 (2+1)	VII
IBT 406	Green Biotechnology	3 (2+1)	VII
	Total Credits	**20 (16+4)**	
	Grand Total	**32 (26+6)**	

IBT 301	MICROBIAL GENETICS	4 (3+1)	SEM V

Objectives

1. To provide an understanding of using microorganisms for genetic analyses
2. To study genetic variability and recombination among microbes
3. To study plasmids, their types and use in recombinant DNA technology

Theory

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.

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, life cycle, mode of infection. Mutation: types, mutagens, DNA damage and repair. Transposable elements: Lac operon, yeast genetics.

Concept and application of recombinant DNA technology. Use of genetic tools to improve the microbial strains for 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 the replica plating technique. Isolation of genomic DNA from E. coli. Isolation and curing of plasmid. Identification of plasmid by electrophoresis/antibiotic plates.

Suggested Readings

1. Michael RG and Joseph S, 2012, Molecular Cloning: A Laboratory Manual, Cold Spring Harbor Laboratory Press.
2. Reece, RJ, 2013, Analysis of Genes and Genomes, Wiley.

IBT 303	ENZYMOLOGY AND ENZYME TECHNOLOGIES	3 (2+1)	SEM V

Objectives

1. To study the basic structure, function and types of enzymes.
2. To study enzyme kinetics, regulation of enzyme activity and applications of enzymes.

Theory

Classification and nomenclature of enzymes. General characteristics of enzymes, active sites, cofactors, and prosthetic groups. Metalloenzymes: Isolation, purification, characterisation and assays of enzyme and international units. Criteria for purity.

Enzyme kinetics, the effect of pH and temperature, and the 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 the optimum pH and temperature of enzymes. Thermostability of enzymes. Activators and inhibitors of enzyme catalysis. Immobilization of enzymes. Isoenzyme analysis.

Suggested Readings

1. Nelson DL and Cox MM, 2017, Lehninger principles of biochemistry, 7th edn, W. H. Freeman.
2. Satyanarayana U and Chakrapani U, 2021, Essentials of Biochemistry, Elsevier.

IBT 302	INDUSTRIAL BIOTECHNOLOGY	3 (3+0)	SEM VI

Objectives

1. To understand various industrial bioprocesses
2. To acquaint with the production of primary metabolites and secondary metabolites
3. To study the industrial production of bioproducts

Theory

Introduction to industrial bioprocess. Fermentation- bacterial, fungal and yeast. Traditional and Modern Biotechnology: A Brief Survey of Organisms, Processes, and Products. Basic concepts of upstream and downstream processing in bioprocess.

Production of primary metabolites. Primary metabolites- production of commercially

important primary metabolites like organic acids and alcohols.

Production of secondary metabolites. Secondary metabolites- production processes for various classes of secondary metabolites: antibiotics, vitamins and steroids.

Production of bioproducts. Production of biopesticides, biofertilizers, bio-preservatives, biopolymers, biodiesel, cheese, beer, and mushroom culture, as well as bioremediation.

Suggested Readings

1. Balasubramanian D, Bryce CFA, Dharmalingam K, Green J and Kunthala J, 2004, Concepts in Biotechnology, Universities Press Pvt.Ltd.
2. Dubey RC, 2006, A Textbook of Biotechnology, S. Chand and Sons.
3. Kumar HD, 1998, A Textbook on Biotechnology, 2nd edn, Affiliated East West Press Pvt.
4. Ratledge C, and Bjorn K, 2001, Basic Biotechnology, 2nd edn, Cambridge University Press.

IBT 304	IPR, BIOSAFETY AND BIOETHICS	2 (2+0)	SEM VI

Objectives

1. To study the importance and forms of IPR.
2. To study the role of IPR in connection with biodiversity and research outcomes.
3. To study the biosafety guidelines for handling the GMOs.

Theory

Introduction to Intellectual Property, concepts and types. International treaties for the protection of the Ips. Indian Legislation for the protection of various types of intellectual property. Patent search, filing process. Material transfer agreements.

Biodiversity definition, importance, and geographical causes of diversity. Species and population biodiversity, and the maintenance of ecological biodiversity hotspots in India. Convention on Biological Diversity. Cartagena Protocol of Biosafety and Risk Management for GMOs. Biosafety guidelines, rules, regulations, and regulatory framework for GMOs in India.

Suggested Readings

1. Deepa G and Shomini P, 2013. IPR, Biosafety and Bioethics, Pearson Education.
2. Singh BD, 2021, Biotechnology Expanding Horizons, Kalyani Publishers.

IBT 401	FUNDAMENTALS OF MOLECULAR PHARMING AND BIOPHARMACEUTICALS	4 (3+1)	SEM VII

Objectives

1. To provide a basic understanding of the principles of molecular pharming
2. To study various hosts and techniques for molecular pharming
3. To study the biopharmaceuticals that are successfully pharmed

Theory

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, immobilisation techniques.

Biopharmaceutical analytical techniques, biopharma drug discovery and development, production of specific vaccines and therapeutic proteins, click chemistry/ biorthogonal chemistry for application in plant science.

Practical

Isolation and 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 immobilisation techniques. Visit to the biopharmaceutical industry.

Suggested Readings

1. Brown TA, 2010, Gene Cloning and DNA Analysis: An Introduction, 6th edn, Wiley-Blackwell Publishing.
2. Kirkosyan A and Kaufman PB, 2009, Recent Advances in Plant Biotechnology, Springer.
3. Primrose SB and Twyman RM, 2013, Principles of Gene Manipulation and Genomics, John Wiley and Sons.

IBT 402	MICROBIAL BIOTECHNOLOGY	4 (3+1)	SEM VII

Objectives

1. To study the scope and methods of using industrially useful microorganisms
2. To study the applications of microbes in industry and agriculture
3. To study the methods used for improving microorganisms

Theory

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.

Biotransformation and biodegradation of pollutants, biodegradation of lignocelluloses and agricultural residues. Biotechnological treatment of wastewater, sewage and sludge. Industrial production of alcohols, ethanol, acids (citric acid, acetic acid), solvents (glycerols, acetone, butanol), antibiotics (penicillin, streptomycin, tetracycline), amino acids (lysine, glutamic acid), and 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, utilisation of plant biomass by recombinant microorganisms. Production of secondary metabolites from microbes.

Suggested Readings

1. Glaze AN and Nikaido H, 2007, Microbial Biotechnology: Fundamentals of Applied Microbiology. 2nd edn, Cambridge University Press.
2. Mohapatra PK, 2006, Textbook of Environmental Biotechnology, International Publishing House Pvt. Ltd.

IBT 403	BIOPROSPECTING OF GENES AND MOLECULES	3 (3+0)	SEM VII

Objectives

1. To study the concepts of bioprospecting
2. To study the methods and techniques used for producing bioactive molecules
3. To study the IPR in relation to novel genes and molecules

Theory

Concepts and practices of bioprospecting. Traditional and modern bioprospecting. Gene prospecting. Isolation, synthesis and purification of new bioactive molecules; clinical and field trials; intellectual property rights and the legal framework. Patenting of new genes and/or novel biomolecules and their applications.

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.

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 bioactivities. Elucidation of novel molecular form and process technology. Development of techniques for large-scale industrial production of the bioactive product and developing market linkage.

Suggested Readings

1. Mohapatra PK, 2006. Textbook of Environmental Biotechnology, International Publishing House Pvt. Ltd.
2. Sharma PD, 2012, Ecology and Environment, 11th edn, Rastogi Publications.
3. Upadhyay SK and Singh SP, 2021, Bioprospecting of Plant Biodiversity for Industrial Molecules, ISBN: 978-1-119-71721-8.
4. Upadhyay SK and Singh SP, 2021, Bioprospecting of Microorganism-Based Industrial Molecules, John Wiley and Sons.

IBT 404	MOLECULAR ECOLOGY AND EVOLUTION	3 (3+0)	SEM VII

Objectives

1. To study the meaning and concepts of molecular evolution
2. To study the concepts of speciation and domestication in conjunction with evolution
3. To study the application of molecular tools for understanding molecular evolution

Theory

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 ribotyping. Ribosomal RNA sequencing. Molecular tools in phylogeny, classification, and identification.

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.

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

Suggested Readings

1. Beebee T. and Rowe G., 2008, An Introduction to Molecular Ecology, 2nd ed., Oxford University Press.
2. Brown TA, 2007, Genome 3, Garland Science Publishing.
3. Carvalho GR, 2002, Advances in Molecular Ecology, IOS Press, Netherlands.

IBT 405	FOOD BIOTECHNOLOGY	3 (2+1)	SEM VII

Objectives

1. To study the meaning and concepts of food biotechnology
2. To study the techniques in food processing and preservation
3. To study the application of microorganisms and genetic engineering in food biotechnology

Theory

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.

Industrial use of microorganisms. Commercially exploited microbes: Saccharomyces, Lactobacillus, Penicillium, Acetobacter, 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 microorganisms. Use of laboratories and industrial-scale shakers. Batch and continuous cultures. Use of fermenters. Detection of pathogens in food and feed. Detection of GM food. Visit to the food processing industry.

Suggested Readings

1. Hui YH and Khachatourians GG, 1995. Food Biotechnology: Microorganisms, Wiley-VCH

2. Shetty K, Paliyath G, Pometto A and Levin RE, 2006, Food Biotechnology, 2nd edn, CRC Press.

IBT 406	GREEN BIOTECHNOLOGY	3 (2+1)	SEM VII

Objectives

1. To study the meaning and concepts of green biotechnology
2. To study the methods and products for better plant growth
3. To study carbon sequestration and other biosafety approaches for a better environment

Theory

Green biotechnology: definition, concept and implication. Bio-fertilisers 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 the biodegradation of plastics and polymers. GMOs for Bioremediation and Phytoremediation: their roles. Strategies for the detection and control of soil, air, and water pollutants, as well as circular economy-based resource utilisation for biofuel generation.

Carbon sequestration; methanogenic microbes for methane reduction. Microbes for phytic acid degradation. 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. Biotechnology and Sustainable Development: Sustainable Agriculture Practices and Biotechnology, Biotechnological Solutions for Food Security, Biotechnology in the Context of Climate Change Mitigation, and Policy and Regulatory Aspects of Green Biotechnology.

Practical

Identification and efficiency assays of microorganisms for biodegradation and bioremediation. Isolation of Bacillus thuringiensis and plant-growth-promoting rhizobacteria. Production of biofertilisers, biopesticides, and biofuels. Assays for the removal of oil spillage.

Suggested Readings

1. Kirkosyan A and Kaufman PB, 2009, Recent Advances in Plant Biotechnology, Springer.
2. Kumar A, 2004, Environmental Biotechnology, Daya Publishing House.
3. Murray DC, 2011, Green Biotechnology, Dominant Publishers and Distributors.

MOLECULAR BIOLOGY AND BIOTECHNOLOGY

Course No.	Course Title	Credits	Semester
Core Courses			
MBB 101	Molecular Biology	3 (3+0)	I
MBB 103 (SEC I)	Laboratory Management and Instrumentation	2 (0+2)	I
MBB 102 (SEC III)	Basic Techniques of Molecular Biology and Biotechnology	2 (0+2)	II
MBB 201	Recombinant DNA Technology	2 (2+0)	III
MBB 203 (SEC V)	Methods in Recombinant DNA Technology	2 (0+2)	III
MBB 301	Molecular Genetics	3 (3+0)	V
MBB 303	Animal Biotechnology	3 (2+1)	V
MBB 305	Immunology	3 (2+1)	V
MBB 304	Epigenetics and Gene Regulation	2 (2+0)	VI
MBB 306	Introduction to Animal Breeding	3 (2+1)	VI
	Total Credits	**25 (16+9)**	
Elective Courses			
MBB 401	Principles and Procedures of Animal Cell Culture	4 (3+1)	VII
MBB 402	Animal Genomics	4 (3+1)	VII
MBB 403	Transgenic Animal Production	3 (3+0)	VII
MBB 404	Molecular Virology and Vaccine Production	3 (2+1)	VII
MBB 405	Embryo Transfer Technologies	3 (2+1)	VII
MBB 406	Animal Reproductive Biotechnology	3 (2+1)	VII
	Total Credits	**20 (15+5)**	
	Grand Total	**45 (31+14)**	

MBB 101	MOLECULAR BIOLOGY	3 (3+0)	SEM I

Objectives

1. To study the principles and techniques of molecular biology
2. To study the central dogma of life
3. To study the tools in molecular biology

Theory

History of molecular biology. Central dogma of life. Structure of DNA and RNA. Gene structure and function. DNA replication and transcription. Genetic code and translation. Structure of prokaryotic and eukaryotic nuclear and organelle genomes. Gene regulation in prokaryotes. The lac operon concept and the tryptophan operon concept. Introduction to microbial genetics: conjugation, transformation and transduction. Tools in molecular biology. Role of enzymes in molecular biology. Principles of Polymerase Chain Reaction and Electrophoresis.

Suggested Readings

1. Cooper GM and Hausman RE, 2018, The Cell: A Molecular Approach. Sinauer

Associates Inc., 8th edn.
2. Lewin B, 2017, Gene XII, Oxford University Press.
3. Nelson DL and Cox MM, 2017, Lehninger Principles of Biochemistry. 7th edn. W. H. Freeman.
4. Satyanarayana U and Chakrapani U, 2021, Essentials of Biochemistry, Elsevier.

MBB 103 (SEC I)	LABORATORY MANAGEMENT AND INSTRUMENTATION	2 (0+2)	SEM I

Objectives

1. To study the establishment and management of different molecular biology laboratories
2. To impart hands-on training on good laboratory practices, calculation of per cent solutions, molarity, molality, normality, and preparation of buffers
3. To study basic equipment used in animal molecular biology and cell culture laboratories, record keeping, teamwork, and SOP of different instruments of the labs
4. Safe disposal of laboratory chemicals and reagents as per the biosafety guidelines.

Practical

Importance of laboratory safety and regulatory compliance. Quality management systems: ISO 9001, GLP, GMP, laboratory safety and regulatory compliance. Risk assessment and hazard identification. Inventory management and equipment maintenance. Principles of laboratory inventory management. Equipment calibration and preventive maintenance. Documentation and record-keeping for regulatory compliance. Quality assurance and control. Introduction to quality assurance (QA) and quality control (QC). Quality control checks for laboratory reagents and instruments, Troubleshooting common laboratory errors and deviations. Spectroscopy and spectrophotometry, applications in quantitative analysis and molecular biology. Chromatography techniques, microscopy and imaging. Molecular biology techniques. Instrumentation project: students design and conduct a small-scale project using one of the laboratory instruments covered in the course. They will collect data, analyse results, and present their findings.

Suggested Readings

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

MBB 102 (SEC III)	BASIC TECHNIQUES OF MOLECULAR BIOLOGY AND BIOTECHNOLOGY	2 (0+2)	SEM II

Objectives

1. To provide hands-on training on the isolation and purification of DNA. Measurement of nucleic acid concentration using spectrophotometer and gel electrophoresis. Designing of PCR primers, DNA amplification using PCR, elution of PCR products, SDS-PAGE, staining and destaining of proteins, Western blot.
2. To study bacteriological media, preparation of media for bacterial culture, preparation of competent cells and transformation, isolation of plasmids from bacteria, and preservation of bacterial clones.
3. To study basic computing. Introduction to UNIX, LINUX. Nucleotide information resource: EMBL, GenBank, DDBJ, unigene, protein information resources: SwissProt, TrEMBL, UniProt; structure databases: PDB, MMDB. Search engines: Entrez, ARSA, SRS. Similarity searching: BLAST and interpreting results. Multiple sequence alignment: ClustalW; structure visualisation of DNA and proteins using Rasmol.

Practical

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

Suggested Readings

1. Green MR and Sambrook J, 2012, Molecular cloning: A Laboratory Manual, 4th edn, Cold Spring Harbor.
2. Kreuzer H and Massey A, 2008, Molecular biology and biotechnology: a guide for students, 3rd edn, ASM Press.
3. Rapley R and Whitehouse D, (Eds), 2015, Molecular biology and biotechnology, Royal Society of Chemistry.

MBB 201	RECOMBINANT DNA TECHNOLOGY	2 (2+0)	SEM III

Objectives

1. The students will be trained on the principles of genetic engineering
2. To study the components like vectors, enzymes, and host cells
3. To study methods used for confirming cloning and expression

Theory

Recombinant DNA technology. Restriction endonucleases: types and uses. DNA manipulating enzymes, DNA ligases. Vectors: properties of an ideal vector, structure of vector, cloning vectors and expression vectors; plasmids, cosmids, phagemids, BACs, PACs, YACs, transposon vectors, shuttle vectors, co-integrating vectors. Competent cells. Gene isolation and cloning; Genetic transformation of E. coli, gel electrophoresis, preparation of probes, Southern blotting, Northern blotting, Western blotting, PCR and PCR-based methods in recombinant DNA technology.

Suggested Readings

1. Singh BD, 2021, Biotechnology Expanding Horizons, Kalyani Publishers.

MBB 203 (SEC V)	METHODS IN RECOMBINANT DNA TECHNOLOGY	2 (0+2)	SEM III

Objectives

1. Hands-on training in good laboratory practices, media and stock preparation
2. To enable skill development by providing hands-on training on methods in recombinant DNA technology

Practical

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

Suggested Readings

1. Carson S and Robertson D, 2005, Manipulation and Expression of Recombinant DNA, Elsevier.
2. Glick BR and Patten CL, 2022, Molecular biotechnology: principles and applications of recombinant DNA, John Wiley and Sons.
3. Green MR and Sambrook J, 2012, Molecular cloning: A Laboratory Manual, 4th edn, Cold Spring Harbor.

MBB 301	MOLECULAR GENETICS	3 (3+0)	SEM V

Objectives

1. This course introduces DNA structure and function
2. To study DNA functions like replication and gene expression
3. To provide an understanding of gene regulation in prokaryotes and eukaryotes

Theory

Structures, properties and modification of DNA. Molecular mechanisms of DNA replication and repair. Types of mutation. Linkage and recombination. Molecular mechanisms of crossing over. Centromere and telomere sequences, and DNA

packaging. Repetitive DNA sequences and transposable elements. Markers and QTLSynthesis and processing of RNA and proteins. Regulation of gene expression.

Genetic code, properties of genetic code, structure of a gene, promoters and their isolation.

Synthesis and processing of RNA.

Regulation of gene expression. Transcription factors – their classification and role in gene expression. Epigenetic control of gene expression. Analysis of gene expression. Small RNAs, RNA interference and its applications.

Suggested Readings

1. Allison LA, 2011, Fundamental Molecular Biology, Wiley Global Education.
2. Brown TA, 1998, Genetics: A Molecular Approach, 3rd edn, Stanley Thornes.
3. Gardener EJ, Simmons MJ and Snustad DP, 1991, Principles of Genetics, John Wiley and Sons, Inc, New York, USA.
4. Hartl DL, 2021, Essential genetics and genomics, 7th edn, Jones and Bartlett Learning.
5. Lewin B, 2009, Genes, Jones and Bartlett Learning.
6. Lewin B, 2017, Gene XII, Oxford University Press.
7. Tropp BE, 2014, Principles of Molecular Biology, Jones and Bartlett Learning.
8. Tropp BE. 2012. Molecular Biology: Genes to Proteins, 4th edn, Jones and Bartlett Learning.

MBB 303	ANIMAL BIOTECHNOLOGY	3 (2+1)	SEM V

Objectives

1. To study historical developments in animal biotechnology
2. To study the biotechnological tools for improving animal health and products
3. To study the use of molecular markers for animal genome analysis

Theory

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

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 utilisation of feed. Introduction to nutrigenomics. Milk biome. Manipulation of lactation by biotechnological tools. Application of biotechnology in meat and meat products.

Genome and protein-based diagnostics of important animal diseases: FMD, brucellosis, PPR, mastitis, bluetongue, 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, and in vitro fertilisation. PCR-based detection of animal pathogens. PCR-RFLP. Immunohistochemical localisation of protein markers in tissues/cells—meat species identification by PCR.

Suggested Readings

1. Singh B, Gautam SK, Chauhan MS and Singla SK, 2015, Textbook of Animal Biotechnology, The Energy and Resources Institute, TERI.
2. Srivastava AK and Singh RK, 2018, Animal Biotechnology, CBS Publishers and Distributors, ISBN 9788120416482, 8120416481.

MBB 305	IMMUNOLOGY	3 (2+1)	SEM V

Objectives

1. To study the meaning and importance of immunology
2. To study the classes of antigens and antibodies
3. To study the immunological techniques and DNA vaccines

Theory

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

Allergies and hypersensitive response. Immunodeficiency. Concept of Vaccines and Vaccinology. Conventional Vaccines. Recombinant subunit vaccines. DNA vaccines and vectored vaccines. Immunological techniques. Immunological application in animal science, monoclonal antibodies and their uses.

Practical

Preparation of buffers and reagents. Precipitation and agglutination tests; HA and HI tests; immunoblotting, immune electrophoresis, and fluorescent antibody tests; enzyme immunoassays, including ELISA variants and Western blotting. Raising of antisera in laboratory animals. Collection and preservation of antisera – separation, filtration and aliquoting.

Suggested Readings

1. Judy O, Jenni P, Sharon S and Patricia J, 2018, Kuby Immunology.

MBB 304	EPIGENETICS AND GENE REGULATION	2 (2+0)	SEM VI

Objectives

1. To have an understanding the epigenetics, its manifestation, and consequences
2. To study the forms of DNA and histone modifications and their role in gene regulation
3. To study the influence of epigenetics on the small RNAs

Theory

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.

Introduction to small RNAs: history and biogenesis. In silico predictions, target gene identification, and methylation of heterochromatin by het-associated siRNAs. Gene regulation by small RNA and other classes of siRNAs. Role in epigenetics. Jacob-Monod model, RNA editing, and genome imprinting.

Suggested Readings

1. Sambrook JF and Russell DW (Eds), 2001, Molecular Cloning: A Laboratory Manual, 3rd edn, Vols 1, 2 and 3, Cold Spring Harbor Laboratory Press.
2. Mohanpuria P, Kumar V, Mahajan M, Mohammad H and Yadav SK, 2010, Gene Silencing: Theory, Techniques and Applications: Genetics-Research and Issues, Nova Science Publishers.

MBB 306	INTRODUCTION TO ANIMAL BREEDING	3 (2+1)	SEM VI

Objectives

a) To study the developments and goals of animal breeding
b) To study population genetics
c) To study the methods of animal breeding

Theory

Population and population genetics; Hardy-Weinberg law; Hardy-Weinberg equilibrium. Approaching equilibrium for sex-linked trait; linkage equilibrium. Effect of linkage on HW equilibrium. Stochastic and deterministic forces acting on population, mutation, migration, and selection.

Dissection of phenotype into its components. Transmitting ability, the substitution effect of the allele. Breeding value. Definition, concept. Heritability: definition, concept, estimation of heritability from regression of offspring to parents. Resemblance among relatives. Repeatability. Definition, concept and estimation. Correlated traits. Phenotypic and genetic correlations, environmental correlations, and selection index. Basic concept and types. Basis of selection. Selection differential and genetic gain.

Breeding strategies in large ruminants (cattle, buffalo), small ruminants (sheep, goat) and swine. Poultry breeding. Lab animal breeding. Breed improvement program 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 the effect of allelic substitution. Estimation of heritability, regression of offspring on parents. Estimation of repeatability. Phenotypic correlation, genetic correlation, and environmental correlation. Chi-squared test for determining goodness of fit for HW-equilibrium. Linkage analysis from pedigree data. Selection index.

Suggested Readings

1. Brah GS, 2014, Animal Genetics: Concepts and Implications, 2nd edn, Kalyani Publishers.
2. Mackay TFC and Falconer DS, 2009, Introduction to quantitative genetics, 4th edn, Pearson.

MBB 401	PRINCIPLES AND PROCEDURES OF ANIMAL CELL CULTURE	4 (3+1)	SEM VII

Objectives

1. To study the principles and importance of animal cell culture
2. To study the basic requirements for animal cell culture
3. To study the techniques in cryopreservation and applications of animal cell culture

Theory

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

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

Cryopreservation and revival of cells. Hybridoma technology. Scaling up methods, bioreactors. Overview of insect cell culture. Stem cell culture and its application, an overview of induced pluripotent stem cells (iPSCs). Common cell culture contaminants and their management.

Practical

Basic equipment used in animal cell culture laboratories. Washing, packing and sterilisation of glass and plastic wares for cell culture. Preparation of media and reagents for cell culture. The primary culture technique of chicken embryo fibroblast/any other animal tissue. Culture and sub-culturing of continuous cell lines. Viability assay by the 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.

Suggested Readings

1. Freshney I, 2016, Culture of Animal Cells: A Manual of Basic Technique and Specialised Applications.

MBB 402	ANIMAL GENOMICS	4 (3+1)	SEM VII

Objectives

1. To study the genome sequencing and organisation of the animal genome and chromosomal aberrations
2. To study the application of genomics in the development of molecular markers

3. To study the application of genomics and molecular markers in animals

Theory

Genome organisation in eukaryotes. Satellite DNA: VNTRs and families, LINE and SINE. Sex determination: chromosomal basis of sex determination, molecular markers for sex determination, environmental sex determination. Chromosomal aberrations: euploidy, chromosomal non-disjunction and aneuploidy, polyploidy, induced polyploidy, syndromes, structural aberrations. Robertsonian translocations, position effect, chromosomal mosaics, Philadelphia chromosome, chromosomal aberrations and evolution.

Molecular markers: markers, genetic markers: RAPD, STR, DNA fingerprinting, SSCP, RFLP, SNP, EST; SNP Analysis. Karyotyping. Somatic cell hybridization, SNP-array. Radiation hybrid maps. FISH technique. Major histocompatibility complex. Concept and its relevance in disease resistance and immune response. Quantitative trait Loci. Marker Assisted Selection: concept, linkage equilibrium, application in animal sciences. Genomic selection: concept, linkage disequilibrium. Methodologies of genomic selection. Mitochondrial DNA analysis and its application in livestock: applying DNA markers for breed characterisation, molecular signatures.

Practical

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

Suggested Readings

1. Brown TA, 2006, Genomes. 5th edn, Wiley-Blackwell.
2. Dale JW, Schantz MV and Plant N, 2012, From Genes to Genomes: Concepts and Applications of DNA Technology, John Wiley and Sons.
3. Green and Sambrook JF and Russel DW, 2014, Molecular Cloning: A Laboratory Manual, 4th Ed, Vol I, II and III, Cold Spring Harbor Laboratory Press.
4. Reece, RJ, 2004, Analysis of Genes and Genomes, Wiley.
5. Sue C, Heather BM, Scott DW and Melissa CS, 2019, Molecular Biology Techniques: A Classroom Laboratory Manual, Academic Press.

MBB 403	TRANSGENIC ANIMAL PRODUCTION	3 (3+0)	SEM VII

Objectives

1. To study the historical developments of developing transgenic animals
2. To study the methods of animal transformation
3. To get acquainted with the methods used for analysing the transgenics
4. To study the applications of transgenic animals

Theory

History of transgenesis: Isolation of genes, preparation of gene construct. Methods of transgenic animal production: Calcium chloride-mediated transfection, lipofection,

electroporation, microinjection, and nano delivery.

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

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

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

Suggested Readings

1. Pinkert CA, 2014, Transgenic Animal Technology.

MBB 404	MOLECULAR VIROLOGY AND VACCINE PRODUCTION	3 (2+1)	SEM VII

Objectives

1. To study the viruses to develop vaccines
2. To study the antigens and methods of producing the vaccines
3. To study the properties of ideal vaccines

Theory

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, and biosafety and biosecurity principles.

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. Stabilisers, preservatives and vehicles. Quality control and testing of vaccines. Sero-surveillance and sero-monitoring.

Practical

Outline of a virology lab and guidelines for working in a virology lab. Processing of clinical specimens for isolation of viruses. Cultivation of viruses in cell cultures and embryonated eggs. Harvesting of the virus. Study of cytopathic effects. Titration of virus and estimation of TCID50. Hemagglutination and hemagglutination inhibition test. Detection of virus by SNT, AGID and ELISA.

Suggested Readings

1. Maclachlan NJ and Dubovi EJ, 2016, Fenner's Veterinary Virology, 5th edn, Elsevier.

MBB 405	EMBRYO TRANSFER TECHNOLOGIES	3 (2+1)	SEM VII

Objectives

1. To study the veterinary reproductive technologies used to obtain offspring from animals as an alternative to natural mating
2. To study the techniques in embryo transfer
3. To study gene transfer and biopharming in conjunction with embryo transfer

Theory

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

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; Animal Biopharming, animal gene bank; regulatory issues (social, ethical, religious, and environmental); cloning of domestic animals; conservation of endangered species; and characterisation of embryonic stem cells and their applications.

Practical

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

Suggested Readings

1. Gordon I, 2004, Reproductive Technologies in Farm Animals, CABI.
2. Hafez ESE, 2000, Reproduction in Farm Animals, Lippincott, Williams and Wilkins.

MBB 406	ANIMAL REPRODUCTIVE BIOTECHNOLOGY	3 (2+1)	SEM VII

Objectives

This course aims

1. To study the basics of animal reproductive technologies used to analyse, understand and enhance the fertility of animals.
2. To study male and female reproduction and methods of checking the quality of gametes
3. To study the direct and indirect methods of checking pregnancy

Theory

Follicle development, oogenesis, endocrinology of female reproduction, spermatogenesis, endocrinology of male reproduction, structure of spermatozoa and oocyte, semen: composition and contribution to semen by different accessory glands, capacitation of spermatozoa, acrosome reaction, estrus cycle, estrus detection.

Oocyte maturation analysis, methods of semen collection, semen analysis

(morphological, microscopic, biochemical or molecular, computer-assisted sperm analysis), semen extenders, cryopreservation of semen, oocytes and embryos (history and methods: slow, rapid/ vitrification), polyspermy. fertilization, embryo development, gastrulation, pregnancy diagnosis: different methods (direct and indirect).

Basic terms related to infertility, morphological abnormality in semen, male infertility: terms and causes (genetic and infectious), female infertility: terms and causes (genetic and infectious), artificial gametes, sex sorting of semen.

Practical

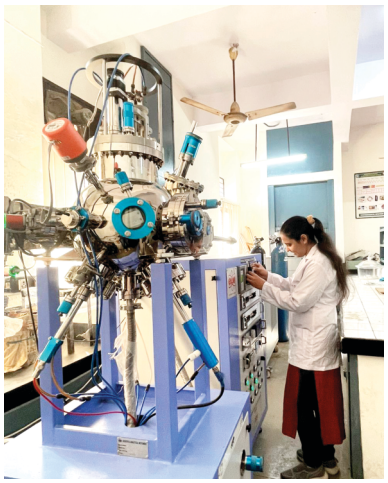
Semen collection by artificial vagina, semen analysis (color, volume etc., live dead staining, mass motility, progressive motility, concentration of semen, HOST, abnormality in semen, TUNEL assay, Free Radical Assay). Preparation of semen extender, calculation for semen dose preparation, semen dose preparation, oocyte Maturation assessment.

Suggested Readings

1. Dugwekar YG, 2006, Reproductive Biotechnology of Farm Animals, Agrotech Publishing Academy.
2. Hafez ESE and Hafez B, 2000, Reproduction in Farm Animals, 7th edn, Blackwell Publishing.
3. Yadav PS, Singh B, Singh I and Sethi RK, 2010, Reproductive Biotechnology in Buffalo, SSPH, ISBN: 8189304801.

COLLEGE OF BASIC SCIENCES & HUMANITIES


National Science Day-2025
Harnessing Science for a Self-Reliant and Sustainable Viksit Bharat-2047
Keynote Speaker
Dr. Devinder Kumar
Chief Guest
Prof. B. R. Kamboj
Vice-Chancellor




WESTERN SYDNEY
UNIVERSITY

COLLEGE OF BASIC SCIENCES & HUMANITIES

SUPPORTING COURSES FOR B.SC. (HONS.) AGRICULTURE, B.SC. (HONS.) AGRIBUSINESS MANAGEMENT, B.SC. (HONS.) COMMUNITY SCIENCE, B.F.Sc., B.TECH (AGRICULTURAL ENGINEERING) AND B.TECH. BIOTECHNOLOGY

Course No.	Course Title	Credits	Semester
	Biochemistry		
BIOCHEM 202	Basic Biochemistry (For B.Tech. Biotechnology)	4 (3+1)	IV
BIOCHEM 302	Essentials of Plant Biochemistry (For B.Sc. (Hons.) Agriculture)	3 (2+1)	VI
	Total Credits	**7 (5+2)**	
	Botany and Plant Physiology		
BIO 101	Introductory Biology (Need based) (For B.Sc. (Hons.) Agriculture and B.Sc. (Hons.) Agribusiness Management)	1 (1+0) NG	I
BIO 103	Basic Biology (For B.Tech. Biotechnology)	2 (2+0)	I
PL PHY 201	Fundamentals of Crop Physiology (For B.Sc. (Hons.) Agriculture and B.Tech. Biotechnology)	3 (2+1)	Agri.: V Biotech: III
	Total Credits	**5 (4+1)**	
	Chemistry		
CHEM 201	Engineering Chemistry (For B. Tech. (Agricultural Engineering)	3 (2+1)	III
	Total Credits	**3 (2+1)**	
	Computer Section		
COMP 101 (SEC I)	Computer Applications in Agriculture (For B.Sc. (Hons.) Agribusiness Management)	2 (0+2)	I
COMP 202 (VAC)	Agricultural Informatics and Artificial Intelligence (For B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness Management, B.Sc. (Hons.) Community Science, B.F.Sc. and B.Tech. Biotechnology)	3 (2+1)	Agri: III AM: III CS: IV FS: IV Biotech: IV
	Total Credits	**5 (2+3)**	
	Languages and Haryanavi Culture		
ENG 101 (AEC)	Communication Skills (For B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness Management, B.Sc. (Hons.) Community Science, B.F.Sc., B.Tech. (Agricultural Engineering) and B.Tech. Biotechnology)	2 (1+1)	Agri: I AM: I FS: I Biotech: I CS: II AE: II

ENG 301 (AEC)	Human Values and Personality Development (For B. Tech. Agricultural Engineering)	2 (1+1)	V
	Total Credits	**4 (2+2)**	
Mathematics and Statistics			
MATH 101	Introductory Mathematics (Need based) (For B.Sc. (Hons.) Agriculture & B.Sc. (Hons.) Agribusiness Management)	1 (1+0) NG	I
MATH 103	Basic Mathematics (For B.Tech. Biotechnology)	2 (2+0)	I
MATH 201	Engineering Mathematics I (For B. Tech. Agricultural Engineering)	3 (3+0)	III
MATH 203	Biomathematics (For B.Tech. Biotechnology)	2 (2+0)	III
MATH 202	Engineering Mathematics II (For B. Tech. Agricultural Engineering)	3 (3+0)	IV
STAT 301	Biostatistics (For B.Tech. Biotechnology)	2 (1+1)	VI
STAT 302	Basic and Applied Agril Statistics (For B.Sc. (Hons.) Agriculture)	3 (2+1)	VI
STAT 401	Agricultural Statistics and Data Analysis (for B. Tech. Agricultural Engineering)	2 (1+1)	VII
STAT 402	Statistical Methods (For B.Sc. (Hons.) Community Science)	2 (1+1)	VII
	Total Credits	**19 (15+4)**	
Microbiology			
MICRO 101 (SEC II)	Production Technology for Bio-agents and Bio-fertilizers (For B.Sc. (Hons.) Agribusiness Management)	2 (0+2)	I
MICRO 102	Elementary Microbiology (For B.Tech. Biotechnology)	2 (1+1)	II
MICRO 302	Agricultural Microbiology and Phyto-remediation (For B.Sc. (Hons.) Agriculture)	2 (1+1)	VI
	Total Credits	**6 (2+4)**	
Physics			
PHY 203	Engineering Physics (For B. Tech. Agricultural Engineering)	3 (2+1)	III
	Total Credits	**3 (2+1)**	
Sociology			
SOC 101	Rural Sociology and Educational Psychology (For B.Sc. (H) Agriculture)	2 (2+0)	I
SOC 201	Rural Sociology (For B.Sc. (Hons.) Community Science)	2 (2+0)	III
SOC 202	Human Ethics (For B.Tech. Biotechnology)	1 (1+0)	IV
	Total Credits	**5 (5+0)**	

COURSE CONTENTS: DEAPRTMENT-WISE
BIOCHEMISTRY

Course No.	Course Title	Credits	Semester
BIOCHEM 202	Basic Biochemistry (For B.Tech. Biotechnology)	4 (3+1)	IV
BIOCHEM 302	Essentials of Plant Biochemistry (For B.Sc. (Hons.) Agriculture)	3 (2+1)	VI
	Total Credits	**7 (5+2)**	

BIOCHEM 202	BASIC BIOCHEMISTRY (For B.Tech. Biotechnology)	4 (3+1)	SEM IV

Objectives

1. To study the structure and functions of biomolecules of living organisms
2. To study metabolism and bioenergetics
3. To study secondary metabolites and their applications

Theory

Introduction and importance. Acids, bases and buffers of living systems. Biomolecules: carbohydrates, lipids, proteins and nucleic acids – structure, functions and properties, Vitamins and animal hormones.

Bioenergetics. Metabolism – basic concept: glycolysis, citric acid cycle, gluconeogenesis, HMP pathway, oxidative phosphorylation, fatty acid oxidation; ketone bodies.

Overview & significance of secondary metabolites: alkaloids, phenolics and their applications in food and pharmaceutical industries. Role of phytohormones: Auxin, Gibberellins, Cytokinin, Ethylene and Abscisic acid.

Practical

Qualitative tests for carbohydrates, amino acids, proteins and lipids. Extraction and characterization of lipids by TLC. Determination of acid, iodine and saponification values of oil. Extraction, quantitative estimation and separation of sugars by paper chromatography.

Suggested Readings

1. Nelson DL and Cox MM, 2017, Lehninger principles of biochemistry, 7th edn, W. H. Freeman.
2. Satyanarayana U and Chakrapani U, 2021, Essentials of Biochemistry, Elsevier.

BIOCHEM 302	ESSENTIALS OF PLANT BIOCHEMISTRY (For B.Sc. (Hons.) Agriculture)	3 (2+1)	SEM VI

Objectives

To impart the fundamental knowledge on structure and function of cellular components, biomolecules and the biological processes in plants

Theory

Biochemistry − Introduction and importance, Properties of water, pH and buffer, plant cell and its components. Bio-molecules − Structure, classification, properties and function of carbohydrates, amino acids, proteins, lipids and nucleic acids. Vitamins − physiological and metabolic role. Enzymes: General properties; Classification; Mechanism of action; Michaelis and Menten and Line Weaver Burk equation and plots; Introduction to allosteric enzymes, use of enzymes. Metabolic energy and its generation − Metabolism − Basic concepts, Glycolysis, Citric acid Cycle, Pentose phosphate pathway, oxidative phosphorylation, Fatty acid oxidation. Biosynthetic Pathways −Photosynthesis, Gluconeogenesis, nitrogen fixation, fatty acid and starch formation. Regulation of metabolic pathways. Secondary metabolites, Terpenoids, Alkaloids, Phenolic and their applications in food and pharmaceutical industries.

Practical

Preparation of standard solutions and reagents, Determination of pH, Qualitative tests of carbohydrates and amino acids, Quantitative estimation of soluble sugars and starch, Estimation of protein by Kjeldhal method and Lowry’ s method, Preparation of mineral solution from ash, Estimation of fat by Soxhlet method, Determination of acid value, saponification value and iodine number, Estimation of ascorbic acid, Qualitative/quantitative tests of secondary metabolites.

Suggested Readings

1. Nelson and Cox. 2008. Lehninger Principles of Biochemistry. Fourth/Fifth edition. Freeman (Can be downloaded)
2. Conn, Stumpf, Bruening and Doi. 2006. Outlines of Biochemistry. Fifth Edition. Wiley
3. Horton, Moran, Rawn, Scrimgeour, Perry. 2011. Principles of Biochemistry. Fifth Edition. Pearson/Prentice Hall (Can be downloaded)
4. Heldt. 2005. Plant Biochemistry. Elsevier (Can be downloaded)
5. Goodwin and Mercer. 2005. Introduction to Plant Biochemistry. 2nd edition. CBS.

BOTANY AND PLANT PHYSIOLOGY

Course No.	Course Title	Credits	Semester
BIO 101	Introductory Biology (need based) (For B.Sc. (Hons.) Agriculture and B.Sc. (Hons.) Agribusiness Management)	1 (1+0) NG	I
BIO 103	Basic Biology (For B.Tech. Biotechnology)	2 (2+0)	I
PL PHY 201	Fundamentals of Crop Physiology (For B.Sc. (Hons.) Agriculture and B.Tech. Biotechnology)	3 (2+1)	Agri.: V Biotech: III
	Total Credits	**5 (4+1)**	

BIO 101	INTRODUCTORY BIOLOGY (NEED BASED) NON-GRADIAL (For B.Sc. (Hons.) Agriculture & B.Sc. (Hons.) Agribusiness)	1 (1+0) NG	SEM I

Objectives

To impart the basics of plant cell and structure of flowers to non-biology background students.

Theory

Introduction to the living world, diversity and characteristics of life, origin of life, Evolution and Eugenics. Binomial nomenclature and classification Cell and cell division. Morphology and anatomy of flowering plants. Seed and seed germination. Plant systematics viz; Brassicaceae, Fabaceae and Poaceae. Role of animals in agriculture.

Suggested Readings

1. Biology- Text Book of class XI, NCERT, New Delhi
2. Biology- Text Book of class XII, NCERT, New Delhi

BIO 103	BASIC BIOLOGY (For B.Tech. Biotechnology)	2 (2+0)	SEM I

Objectives

1. To study the basic taxonomy and classification of plants
2. To study the features of the plant kingdom and morphology
3. To study the internal structure of plants
4. To study cells and biomolecules
5. To study the animal kingdom and nomenclature
6. To study the organisation of mammalian systems

Theory

The plant kingdom and features of each group. Morphology, modifications and functions of root, stem, leaf, flower and inflorescence. Pollination and fertilisation. Fruit types. Structure of dicot and monocot seeds, and seed germination.

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

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

Introduction to Zoology. Structure and functions of the cell and cell organelles. The difference between prokaryotic and eukaryotic cells. Structure and function of biomolecules. Types of simple and compound tissues.

Binomial nomenclature. Classification and general survey of the animal kingdom. Functional organisation 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.

Suggested Readings

1. Bendre AM and Kumar A, 1999, Textbook of Practical Botany. Vol. 2, 7th edn, Rastogi Publications.
2. Bendre AM and Pande PC, 2009, Introduction to Botany, Rastogi publications.
3. Bhatia K.N. and Tyagi M.P. 2020 Elementary Biology. A Truemen publication
4. David M Hillis; H Craig Heller; Sally D Hacker; David W Hall; David E Sadava. 2020. Life: the science of biology, 12th edn, Sunderland publication. eBook
5. Dutta AC, 1995, A Class Book of Botany, 16th edn, Oxford University Press.
6. NCERT 2021. Biology of Class XI. NCERT, India.
7. Pande PC and Jain DK, 2022, A textbook of Botany, Angiosperm. S. Chand publications.
8. Bhatia KN and Tyagi MP, 2020, Elementary Biology, A Truemen Publication.
9. Chopra G and Dhami PS, 2021, A Textbook of Biology, Pradeep Publications.
10. David MH, Craig HH, Sally DH, David WH and David ES, 2020, Life: the science of biology, 12th Ed, Sunderland Publication.
11. NCERT, 2022, Biology of Class XI, 2022-23. NCERT, India.

PL PHY 201	**FUNDAMENTALS OF CROP PHYSIOLOGY (For B.Sc. (Hons.) Agriculture and B.Tech. Biotechnology)**	**3 (2+1)**	**SEM Agri.: V Biotech: III**

Objectives

To explain about the basic physiological process of plant viz. plant cell and water relations, mineral nutrition, carbon metabolism, reproductive physiology and plant growth and development

Theory

Definitions of plant physiology and crop physiology; Importance of crop physiology; Relationship of crop physiology with other branches of crop science; Diffusion and osmosis; Physiological roles of water to crop plants; Definition of water potential and components of water potential; Water absorption by plants: Concept of active and passive absorption; Water loss by plants: Types of water loss: transpiration, stomatal physiology and guttation; Water use efficiency; Essential and beneficial elements; Passive and active transport of mineral element; Functions of essential elements; Criteria of essentiality of nutrients; Correction measures for nutrient deficiency symptoms; Foliar nutrition and root feeding − significance; Aeroponics Imbibition; Field capacity, permanent wilting point and available soil moisture; Apoplast, symplast and transmembrane, Ascent of sap − theories and mechanism; Soil-plant-atmospheric continuum. Significance of transpiration. Stomatal opening and closing mechanisms. Definition of Cavitation and embolism. Antitranspirants - types and examples. Hydroponics and sand culture. Overview of plant cell - organelle and their functions. Brief outline of: Photosynthetic apparatus, pigment system, quantum requirement and quantum yield; Structure of chloroplast, Examples of different photosynthetic pigments (chlorophyll, carotenoids, phycobilins etc.), Difference between chlorophyll a and chlorophyll b, Structure of chlorophyll a and chlorophyll b, Short discussion on quantum requirement and quantum yield, Red drop and Emerson enhancement effect, Pigment system I and II.

Introduction to light reaction of photosynthesis, Light absorption by photosynthetic pigments and transfer of energy. Source of O2 during photosynthesis: Hill reaction; Brief introduction to cyclic and non-cyclic photo-phosphorylation: production of assimilatory powers; Introduction to C3, C4 and CAM pathways: Calvin Cycle, Hatch and Slack Cycle, CAM Cycle; Significance of these pathways (concept of photorespiration, absence of photorespiration in C4 plant: Productivity of C4 plant, CAM: an adaptive mechanism); Factors affecting photosynthesis (light, temperature, CO2, O2 etc.). Outline of the process of respiration: Definition and importance, Glycolysis, Kreb Cycle and ETC, Factors affecting respiration (O2, temperature, CO2 etc.). Terminologies / Definitions: Growth, Development and Differentiation. Measurement of plant growth (fresh weight, dry weight, linear dimension, area etc.). Introduction to CGR, RGR, NAR etc. Photoperiodism: Photoperiodic Classification of plants: Short Day Plant, Long Day Plant, Day Neutral plant etc. Introduction to Photoperiodic induction site of photo-inductive perception, Role of Phytochrome Introduction to Vernalization (What is vernalization, devernalization etc.), Meaning, classification (seasonal, sequential etc), relation with abscission. Physiological and biochemical changes during senescence, Abscission and its significance, Concept of stay green, Hormonal regulation of senescence. Terminologies / Definitions: Plant hormone, Plant growth regulators (PGR), Plant growth inhibitor. Recognized classes of PGR (Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic acid) and their major physiological roles, Agricultural uses of PGRs (IBA, NAA, 2, 4 −D, GAs, Kinetin etc).

Practical

Study on structure and distribution of stomata; Demonstration of imbibition, osmosis, plasmolysis, estimation of water potential, relative water content; Tissue test for mineral nutrients, identification of nutrient deficiency and toxicity symptoms in plant; Identification of nutrients by hydroponics; Estimation of photosynthetic pigments, rate of photosynthesis, respiration and transpiration; Plant growth analysis; Study on senescence and abscission, hormonal regulation of senescence; Demonstration of the effects of different PGRs on plants, Leaf anatomy of C3 and C4 plants.

Suggested Readings

1. Devlin's Exercises in Plant Physiology by Robert Devlin, Francis H. Witham and David F. Blaydes
2. Fundamentals of Plant Physiology by Lincoln Taiz, Eduardo Zeiger, Ian Max Molle and Angus Murphy
3. Plant Physiology by Robert M. Devlin and Francis H. Witham
4. Plant Physiology by Lincoln Taiz and Eduardo Zeiger
5. Plant Physiology by Frank B. Salisbury and Cleon W. Ross

CHEMISTRY

Course No.	Course Title	Credits	Semester
CHEM 201	Engineering Chemistry (For B. Tech. Agricultural Engineering)	3 (2+1)	III
	Total Credits	**3 (2+1)**	

CHEM 201	ENGINEERING CHEMISTRY (For B. Tech. Agricultural Engineering)	3 (2+1)	SEM III

Objectives

To make the students acquainted with applications of chemistry in engineering and different chemical processes in agricultural and food engineering

Theory

Phase rule**:** Phase, component, degree of freedom, application to one component system, viz. water system, sulphur system, two component system, viz. pb-Ag system, desilverisation of Pb.

Colloids**:** Classification, properties like optical activity-Tyndall effect, Brownian movement, electrical properties –electrophoresis.

Corrosion**:** causes, types and methods of prevention- proper designing. Cathodic protection using pure metal and metal alloys, use of inhibitors.

Water**:** Temporary and permanent hardness, disadvantages of hard water, scale and sludge formation of boilers, boiler corrosion.

Basic idea on thermo-gravimetric analysis, polarographic analysis, nuclear radiation, detectors and analytical applications of radio-active materials, discovery of isotopes and new elements, release of atomic energy, radio-active tracer and carbon dating.

Fuels**:** Classifications, calorific value and its determination by bomb calorimeter.

Principles of food chemistry**:** Lipids, proteins, carbohydrates and their classifications, vitamins and their importance.

Enzymes and co-enzymes important in food processing and storage, their use in manufacturing of ethanol and acetic acid by fermentation method.

Introduction to food preservatives, definition, types natural and artificial preservative and its use, colouring and flavouring reagents of foods.

Lubricants**:** Classifications, properties-viscosity, flash point and fire point mechanism, thick film, thin film and extreme pressure, neutralization point, saponification number and mechanical stability.

Polymers**:** Type of polymerization with examples (addition, free radical); Different properties of polymers chemical resistance, crystallinity. Effect of heat on polymers, general use, molecular weight determination.

Introduction to IR spectroscopy**:** Basic principles of spectroscopy, Beer-Lambarts law, types of vibration, symmetric, asymmetric vibration and it type, absorbances of different functional group in IR.

Practical

To separate colored components by using Paper Chromatography.To determine of temporary and permanent hardness of water by EDTA method; To study the different types of fuels and compare their characteristics; To study different types of foods and their ingredients; Determination of alkalinity in the given water sample; Determination of available chlorine in bleaching powder; To estimate chloride in water sample; To estimate dissolved oxygen in water sample; Determination of viscosity of lubricant by REDWOOD Viscometer; To determine flash and fire point of an oil by PENSKY MARTEN's flash point apparatus; To determine λ max and verification of Beer-Lambert law.

Suggested Readings

1. Bahl, B. S., Bahl, A. and Tuli, B. D. 2007. *Essentials of Physical Chemistry*. S. Chand and Co. Ltd, Delhi.
2. Finar, I. L. 2002. *Organic Chemistry*. Vol I and II. Pearson.
3. Glasstone, S. *Elements of Physical Chemistry*. The Macmillan Company of India Limited.
4. Jain and Jain. 2016. *Engineering Chemistry*. Dhanpat Rai Publication.
5. Jain, P. L. and Jain, M. 1994. *Engineering Chemistry*. Dhanpat Rai publishing company Pvt. Ltd, Delhi.
6. Morrison, R. T., Boyd, R. N. and Bhattacharjee, S. K. 2010. *Organic Chemistry*. Pearson.
7. Sharam, Y. R. 2013. *Elementary Organic Spectroscopy*. S Chand.

COMPUTER SECTION

Course No.	Course Title	Credits	Semester
COMP 101 (SEC I)	Computer Applications in Agriculture (For B.Sc. (Hons.) Agribusiness Management)	2 (0+2)	I
COMP 202 (VAC)	Agricultural Informatics and Artificial Intelligence (For B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness Management, B.Sc. (Hons.) Community Science, B.F.Sc. and B.Tech. Biotechnology)	3 (2+1)	Agri: III AM: III CS: IV FS :IV Biotech: IV
	Total Credits	**5 (2+3)**	

COMP 101 (SEC I)	**COMPUTER APPLICATIONS IN AGRICULTURE (For B.Sc. (Hons.) Agribusiness Management)**	**2 (0+2)**	**SEM I**

Objectives

1. To understand the role of computer applications in modern agricultural practices.
2. To learn to use agricultural software and tools for data analysis, modeling, and decision- making.
3. To explore the application of Geographic Information Systems (GIS) and remote sensing in precision agriculture.
4. To develop skills in utilizing technology to optimize farm management, improve productivity, and reduce environmental impact.

Practical

Working with MS-DOS/Windows. Database concept and type. Database design. Data entry operation. Word processing: MS Office. Database management program. Use of electronic spreadsheet and graphics. Statistical and mathematical functions. Advanced statistical analysis Toolpak in MS Excel. Use of SPSS/SAS statistical packages. Basics of computer networking – LAN, SAN, Network topologies, Internet and Intranet – Basics of Email – Exposure to web browsing (structure of URL), Types of websites – Internet service provider – using internet news. Application of Geographic Information System (GIS) and remote sensing in agriculture

Suggested Readings

1. Computers in Agriculture: Fundamentals and Applications (Hardcover – 20 October 2016) by Sharma Manish, Anil Bhatt
2. Computer Applications in Agriculture By William Otto Rasmussen.
3. Computer Applications in Agriculture and Agribusiness (Paperback – Import, 1 June 1994) by Michael E. Newman (Author).

COMP 202 (VAC)	**AGRICULTURAL INFORMATICS AND ARTIFICIAL INTELLIGENCE (For B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness Management, B.Sc. (Hons.) Community Science, B.F.Sc. and B.Tech. Biotechnology)**	**3 (2+1)**	**SEM Agri: III AM: III CS: IV FS: IV Biotech: IV**

Objectives

1. To acquaint student with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision-making processes, etc.
2. To provide basic knowledge of computer with applications in Agriculture
3. To make students familiar with Agricultural-Informatics, its components and applications in agriculture

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating data base, Uses of DBMS in Agriculture. Internet and World Wide Web (WWW): Concepts and components.

Computer programming: General concepts, Introduction general programming concepts. Concepts and standard input/output operations. e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture. Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management. Smartphone mobile apps in agriculture for farm advice: Market price, post-harvest management etc. Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information. Decision support systems: Concepts, components and applications in Agriculture. Agriculture Expert System, Soil Information Systems etc., for supporting farm decisions. Preparation of contingent crop planning and crop calendars using IT tools. Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

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

Suggested Readings

1. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India.
2. Fundamentals of Computer by V. Rajaroman.
3. Introduction to Information Technology by Pearson.
4. Introduction to Database Management System by C. J. Date.
5. Introductory Agri-Informatics by Mahapatra, Subrat K et al, Jain Brothers Publication.

LANGUAGES AND HARYANAVI CULTURE

Course No.	Course Title	Credits	Semester
ENG 101 (AEC)	Communication Skills (For B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness, B.Sc. (Hons.) Community Science, B.F.Sc., B.Tech. (Agricultural Engineering) and B.Tech. Biotechnology)	2 (1+1)	Agri: I AM: I FS: I Biotech: I CS: II AE: II
ENG 301	Human Values and Personality Development (for B. Tech. Agriculture Engineering)	2 (1+1)	V
	Total Credits	**4 (2+2)**	

ENG 101 (AEC)	**COMMUNICATION SKILLS (For B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness Mangement, B.Sc. (Hons.) Community Science, B.F.Sc., B.Tech. Agricultural Engineering and B.Tech. Biotechnology)**	**2 (1+1)**	**SEM Agri: I AM: I FS: I Biotech: I CS: II AE: II**

Objectives

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication.

Theory

Communication Process**:** The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar**:** Sentence structure, modifiers, connecting words and verbal; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults;

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed;

Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested Readings

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

ENG 301	**HUMAN VALUES AND PERSONALITY DEVELOPMENT (For B. Tech. Agricultural Engineering)**	**2 (1+1)**	**SEM V**

Objectives

1. To make students realize their potential strengths, cultivate their inter-personal skills and improve employability
2. Development of a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
3. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
4. Strengthening of self-reflection.
5. Development of commitment and courage to act.

Theory

Personality definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Type A and Type B Behaviours, personality and Organizational Behaviour. Technical Writing: Reports & its types, Letters & its types. Foundations of individual behaviour and factors influencing individual behaviour, Models of individual behaviour, Perception and attributes and factors affecting perception. Learning: Meaning and definition, theories and principles of learning,

Learning and organizational behaviour, Learning and training, learning feedback. Speaking on given topics.

Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behaviour, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics. Comprehension Passages (General & Technical articles).

Practical

Learning Styles and Strategies, Motivational needs, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behaviour. Introduction to Phonetics and spoken English, Phonemic symbols, Syllable, Word Accent.

Suggested Readings

1. Andrews, Sudhir. 1988. How to Succeed at Interviews. Tata McGraw-Hill.
2. Heller, Robert. 2002. Effective Leadership. Essential Manager series. Dk Publishing.
3. Hindle, Tim. 2003. Reducing Stress. Essential Manager series. Dk Publishing.
4. Lucas, Stephen. 2001. Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
5. Mile, D.J. 2004. Power of Positive Thinking. Delhi. Rohan Book Company.
6. Kumar, Pravesh. 2005. All about Self- Motivation. New Delhi. Goodwill Publishing House.
7. Smith, B. 2004. Body Language. Delhi: Rohan Book Company.
8. Shaffer, D. R. 2009. Social and Personality Development (6th Edition). Belmont, CA: Wadswor.
9. Human Values and Professional Ethics by R R Gaur, R Sangal, G P
10. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
11. The Story of Stuff (Book).
12. Rediscovering India - by Dharampal
13. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
14. India Wins Freedom - Maulana Abdul Kalam Azad
15. Vivekananda - Romain Rolland (English)

MATHEMATICS AND STATISTICS

Course No.	Course Title	Credits	Semester
MATH 101	Introductory Mathematics (Need based) (For B.Sc. (Hons.) Agriculture and B.Sc. (Hons.) Agribusiness Management)	1 (1+0) NG	I
MATH 103	Basic Mathematics (For B.Tech. Biotechnology)	2 (2+0)	I
MATH 201	Engineering Mathematics I (For B. Tech. Agricultural Engineering)	3 (3+0)	III
MATH 203	Biomathematics (For B.Tech. Biotechnology)	2 (2+0)	III
MATH 202	Engineering Mathematics II (For B. Tech. Agricultural Engineering)	3 (3+0)	IV
STAT 301	Biostatistics (For B.Tech. Biotechnology)	2 (1+1)	VI
STAT 302	Basic and Applied Agril Statistics (For B.Sc. (Hons.) Agriculture)	3 (2+1)	VI
STAT 401	Agricultural Statistics and Data Analysis (For B. Tech. Agricultural Engineering)	2 (1+1)	VII
STAT 402	Statistical Methods (For B.Sc. (Hons.) Community Science)	2 (1+1)	VII
	Total Credits	**19 (15+4)**	

MATH 101	INTRODUCTORY MATHEMATICS (Need Based) (For B.Sc. (Hons.) Agriculture and B.Sc. (Hons.) Agribusiness Management)	1 (1+0) NG	SEM I

Objectives

To make the students acquainted with the basic mathematics applied in agriculture and their applications

Theory

Algebra: Progressions- Arithmetic, Geometric and Harmonic Progressions. Matrices: Definition of Matrices, Addition, Subtraction, Multiplication, Transpose and Inverse up to 3rd order by adjoint method, Properties of determinants up to 3rd order and their evaluation.

Differential Calculus: Definition - Differentiation of function using first principle, Derivatives of sum, difference, product and quotient of two functions, Methods, Increasing and Decreasing Functions. Application of Differentiation- Growth rate, Average Cost, and Marginal cost, Marginal Cost, Marginal Revenue. Partial

differentiation: Homogeneous function, Euler's theorem, Maxima and Minima of the functions of the form y = f (x) and y = f (x1, x2).

Integral Calculus: Integration -Definite and Indefinite Integrals-Methods- Integration by substitution, Integration by parts. Area under simple well-known curves.

Mathematical Models: Agricultural systems - Mathematical models - classification of mathematical models- Fitting of Linear, quadratic and exponential models to experimental data.

Suggested Readings

1. NCERT, 2012, Mathematics of Class XII, NCERT, India.
2. Sharma RD, 2014, Mathematics of Class XII, Dhanpat Rai Publisher.
3. Narayan, S. 2004. *Differential Calculus*. S. Chand and Co. Ltd. New Delhi.
4. Narayan, S. 2004. *Integral Calculus*. S. Chand and Co. Ltd. New Delhi.

MATH 103	**BASIC MATHEMATICS (For B.Tech. Biotechnology)**	**2 (2+0)**	**SEM I**

Objectives

1. To study the basic principles and functions in mathematics, like limits and continuity
2. To study differentiation and integration
3. To study matrices and determinants

Theory

Functions: Defination, types of functions. Limit: Introduction, left-handed and right-handed limits, general rules for calculating limits, Standard limits. Continuity: Definition of continuity, continuity of algebraic functions, continuity of trigonometric and exponential functions. Types of discontinuity

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

Integration: Integration of simple functions, Integration by substitution, integration by partial fractions, integration by parts, integration by trigonometric substitution.

Matrices and Determinants: Definition of matrix, addition, subtraction and multiplication, inverse of matrix. Properties of determinants Solution of linear equations by Cramer's rule and the inverse of a matrix.

Suggested Readings

1. NCERT, 2012, Mathematics of Class XII, NCERT, India.
2. Sharma RD, 2014, Mathematics of Class XII, Dhanpat Rai Publisher.

MATH 201	ENGINEERING MATHEMATICS I (For B. Tech. Agricultural Engineering)	3 (3+0)	SEM III

Objectives

To make the students acquainted with the basic mathematics, including calculus, Matrices and complex analysis applied in engineering and their applications in solving engineering problems

Theory

Differential calculus: Functions of two or more variables, Taylor's and Maclaurin's expansions, Maxima and minima.

Integral calculus: Double integrals, change of order of integration, triple integrals, application of double and triple integrals to find area and volume.

Vector calculus: Scalar and vector point functions, vector differential operator Del, gradient of scalar point function, divergent and curl of vector point function and their physical interpretations, line, surface and volume integrals, Green's, Stock's and Divergence theorem (without proofs).

Fourier series: Periodic functions, Euler's formulae, functions having arbitrary period, even and odd functions, half-range series expansion, series expansion of functions with finite discontinuity.

Complex Analysis: Functions of a complex variable, limit, continuity and analytic function, Cauchy-Reimann equations, harmonic functions.

Matrices: Elementary transformations, Gauss elimination, Gauss-Jordan method to find the inverse of a matrix. rank of a matrix, solution of linear equations, Eigen values and Eigen vectors, Cayley-Hamilton Theorem-its use to find the inverse of a matrix, linear transformation, diagonalization of matrices.

Suggested Readings

1. Grewal, B. S. 2004. Higher Engineering Mathematics. Khanna Publishers Delhi.
2. Narayan, S. 2004. A Text Book of Vector. S. Chand and Co. Ltd. New Delhi.
3. Narayan, S. 2004. Differential Calculus. S. Chand and Co. Ltd. New Delhi.
4. Narayan, S. 2004. Integral Calculus. S. Chand and Co. Ltd. New Delhi.

MATH 203	BIOMATHEMATICS (For B.Tech. Biotechnology)	2 (2+0)	SEM III

Objectives

1. To study the basic theories of mathematics
2. To study factor reduction and eigenvalues
3. To study the applications of biomathematics

Theory

Rolle's theorem, Lagrange's theorem, Taylor's and Maclaurin's series. Partial differentiation, Euler's theorem on homogeneous functions, and change of variable. Jacobian, maxima and minima of two or more than two variables, Elementary transformations, Rank of matrix, Echelon form, Solution of system of linear

equations, eigenvalues and eigenvectors of a matrix. Reduction formulae, definite integrals and their properties, Area under simple, well known curves.

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

Suggested Readings

1. Grewal BS, 2013, Higher Engineering Mathematics, Khanna Publishers.
2. Rastogi SK, 2008, Biomathematics, Krishna Prakashan Media Pvt. Ltd.
3. Srivastava AC and Srivastava PK, 2011, Engineering Mathematics, Vol. I, PHI Learning Pvt. Ltd.
4. Srivastava AC and Srivastava PK, 2011, Engineering Mathematics, Vol.III, PHI Learning Pvt. Ltd.

MATH 202	ENGINEERING MATHEMATICS II (For B. Tech. Agricultural Engineering)	3 (3+0)	SEM IV

Objectives

To make the students acquainted with the application of various advanced mathematics such as differential equations, Laplace transform and applications of numerical methods in engineering.

Theory

Ordinary Differential Equations: First order differential equations, exact and reducible to exact form by integrating factors, linear differential equation and Bernoulli's equation, equations of first order and higher degree, Clairaut's equation. Higher order differential equations: Methods of finding complementary functions and particular integrals, methods of variation of parameters, Cauchy's and Legendre's linear equations, simultaneous linear differential equations with constant coefficients.

Partial Differential Equations: Partial derivative and total derivative, homogeneous functions and Euler's theorem. Formation of PDE, higher order linear PDE with constant coefficients, solution of non-linear PDE, Charpit's method.

Laplace Transform: rules for Laplace transform and inverse Laplace transform, applications to find solutions of ordinary and simultaneous differential equations.

Numerical Methods: Finite difference operators and their relationship, factorial notation. Newton's forward and backward interpolation formula, Newton's divide difference interpolation and Lagrange's interpolation formula, numerical differentiation and integration rule, numerical solutions of ODE by Taylor's series, Euler's and modified Euler's method, Runge-Kutta method of order four.

Suggested Readings

1. Grewal, B S. 2004. Higher Engineering Mathematics. Khanna Publishers Delhi.
2. Narayan, S. 2004. A Text Book of Vector. S. Chand and Co. Ltd., New Delhi.
3. Narayan, S. 2004. Differential Calculus. S. Chand and Co. Ltd., New Delhi.
4. Narayan, S. 2004. Integral Calculus. S. Chand and Co. Ltd. New Delhi.
5. Ramana, B. V. 2008. Engineering Mathematics. Tata McGraw-Hill, New Delhi.

STAT 301	BIOSTATISTICS (For B.Tech. Biotechnology)	2 (1+1)	SEM VI

Objectives

1. To study the variables and descriptive statistics
2. To study various distributions
3. To study experimental data analysis and interpretation

Theory

Random variables: expected value and its variance; probability distribution of random variables; conditional probability; Bayes' theorem and its applications; introduction to uniform, binomial, Poisson, normal, exponential, and gamma probability distributions.

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. Positive and negative predictive values.

Chi-square test: testing heterogeneity, use in the genetic experiment, detection of linkage, linkage ratios and their 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 the transition probability matrix in Markov Chains. Calculation of sensitivity and specificity. Positive and negative predictive values. Detection and linkage using chi-square test; one-way and two-way analysis of variance. Analysis of covariance. Incomplete block designs. Estimation of heritability.

Suggested Readings

1. Gupta SC, Kapoor VK, 2007, Fundamentals of applied statistics, 4th edn, S Chand and Sons.
2. Kaps M and Lamberson WR, 2017, Biostatistics for Animal Science, 3rd edn, CABI.
3. Triola MM, Triola MF and Roy J, 2017, Biostatistics for the Biological and Health Sciences, 2nd edn, Pearson.

STAT 302	BASIC AND APPLIED AGRIL STATISTICS (For B.Sc. (Hons.) Agriculture)	3 (2+1)	SEM VI

Objectives

To provide an idea on statistical concepts of both descriptive and inference Statistics which will be useful to do statistical analysis

Theory

Introduction to Statistics and its Applications in Agriculture: Types of Data. Scales of measurements of Data. Summarization of Data. Classification of Data. Frequency Distribution. Methods of Classification. Definition of Grouped and Ungrouped Data. Definition of Class Interval (formula for determining the no. of class interval), Width of CI, Class Limits (Boundaries), Mid Points. Types of Frequency Distribution. Diagrammatic Presentation of Data. Bar Diagrams −Simple, Multiple, Sub-divided and Percentage Bar Diagrams. Pie-diagram. Graphical Presentation of Data − Histogram, Frequency Polygon and Ogives.

Measures of Central Tendency: Requisites for an Ideal Measure of Central Tendency. Different Types of Measure. Arithmetic Mean− Definition, Properties, Merits, Demerits and Uses. A.M. (examples) for Grouped and Ungrouped Data. Step-deviation Method. Weighted Mean. Definition of Geometric Mean and Harmonic Mean. Relationship between A.M., G.M. and H.M. Median-Definition, Merits, Demerits and Uses. Graphical Location of Median. Mode- Definition, Merits, Demerits and Uses. Graphical Location of Mode. Relationship between Mean, Median and Mode.

Measures of Dispersion: Characteristics for an Ideal Measure of Dispersion. Different Types of Measures of Dispersions. Definition of Range, Interquartile Range, Quartile Deviation and Mean Deviation. Standard Deviation- Definition, Properties. S.D. and Variance for Grouped and Ungrouped Data. Variance of Combined Series. Co-efficient of Dispersions. Co-efficient of Variation.

Measures of Skewness and Kurtosis: Definition of Symmetrical Distribution. Definition of Skewness, Measures of Skewness. Definition of Kurtosis. Measure of Kurtosis. Relationship between Mean, Median and Mode for Symmetrical and Skewed Distribution.

Probability Theory and Normal Distribution: Introduction to Probability. Basic Terminologies. Classical Probability-Definition and Limitations. Empirical Probability- Definition and Limitations. Axiomatic Probability.

Addition and Multiplication Theorem (without proof): Conditional Probability. Independent Events. Simple Problems based on Probability. Definition of Random Variable. Discrete and Continuous Random Variable. Normal Distribution-Definition, Prob. Distribution, Mean and Variance. Assumptions of Normal Distribution. Normal Probability Curve. Correlation and Regression. Definition of Correlation. Scatter Diagram. Karl Pearson's Coefficient of Correlation. Types of Correlation Coefficient. Properties of Correlation Coefficient. Definition of Linear Regression. Regression Equations. Regression Coefficients. Properties of Regression Coefficients. Tests of Significance. Definition. Null and Alternative Hypothesis. Type

I and Type II Error. Critical Region and Level of Significance. One Tailed and Two Tailed Tests. Test Statistic. One Sample, Two Sample and Paired t-test with Examples: F-test for Variance. ANOVA and Experimental Designs. Definition of ANOVA. Assignable and Non assignable Factors. Analysis of One-way Classified Data. Basic Examples of Experimental Designs. Terminologies. Completely Randomized Design (CRD). Sampling Theory. Introduction. Definition of Population, Sample, Parameter and Statistic. Sampling Vs Complete Enumeration. Sampling Methods. Simple Random Sampling with Replacement and without Replacement. Use of Random Number Table.

Practical

Diagrammatic and Graphical representation of data. Calculation of A.M., Median and Mode (Ungrouped and Grouped data). Calculation of S.D. and C.V. (Ungrouped and Grouped data). Correlation and Regression analysis. Application of t-test (one sample, two sample independent and dependent). Analysis of variance one-way classification. CRD. Selection of random sample using simple random sampling.

Suggested Readings

1. Fundamentals of Statistics by D. N. Elhance, Kitab Mahal Publishers.
2. Fundamentals of Applied Statistics by S.C. Gupta and V. K. Kapoor, Sultan Chand and Sons.
3. Basic Statistics by B. L. Agarwal, New Age International Publishers.
4. Agricultural Statistics by S.P. Singh and R.P.S. Verma, Rama Publishing House.
5. Agriculture and Applied Statistics-I by P.K. Sahu, Kalyani Publishers.
6. Agriculture and Applied Statistics-II by P. K. Sahu and A. K. Das, Kalyani Publishers.

STAT 401	**AGRICULTURAL STATISTICS AND DATA ANALYSIS (For B. Tech. Agricultural Engineering)**	**2 (1+1)**	**SEM VII**

Objectives

To make the students acquainted with important statistical data analysis tools and application of these for research in agricultural engineering

Theory

Introduction to statistics: Definition, advantages and limitations; Data- types of data, quantitative and qualitative; variable - discrete and continuous; Frequency distribution table: construction of frequency distribution table (inclusive and exclusive)- number of classes, length of class, tally marks, frequency, class midpoint, cumulative frequencies, frequency curves, graphs and charts. Measures of central tendency: Definition, characteristics of ideal average, different measures; arithmetic mean, median, mode, geometric mean and harmonic mean for grouped and ungrouped data, merits and demerits; Measures of dispersion: definition, different measures (absolute and relative); range, quartile deviation, mean deviation, standard deviation (SD), variance and coefficient of variation. Probability: Definition and

concept of probability; Random variable: concept of random variable and expectation; Simple linear correlation: concept, definition, types and its properties; Simple linear regression: concept, definition and its properties; Normal distribution: definition, density function, curve, properties, standard normal distribution (SND), properties including area under the curve (without proof); Binomial distribution: definition, density function and properties; Poisson distribution: definition, density function and properties; Introduction to sampling: definition of statistical population, sample, random sampling, parameter, statistic, sampling distribution, concept of standard error of mean. Testing of hypothesis – hypothesis, null hypothesis, types of hypotheses, level of significance, degrees of freedom – statistical errors; Large Sample test (Z-test), small sample t-test (one tailed, two tailed and paired tests); Testing of significance through variance (F-test), Chi-square test: goodness of fit and testing of independence of attributes (2 × 2 contingency table)

Practical

Construction of frequency distribution tables and frequency curves; Computation of arithmetic mean, median and mode for un-grouped and grouped data; Computation of harmonic and geometric mean; Computation of standard deviation (SD); Variance and coefficient of variation for un-grouped and grouped data; Computation of skewness, kurtosis; Standard normal distribution test for single sample mean (population SD known and unknown); SND test for two samples means (population SD known and unknown); Computation of binomial distribution; Computation of Poisson distribution; Calculation of correlation coefficient and its testing; Calculation of regression coefficient, regression line; Student's t-test for single sample mean; t-test for two samples means; Paired t test; F– test for equality for two sample variance test; Computation of Chi-square test: goodness of fit and testing of independence of attributes (2 × 2 contingency table) and m × n.

Suggested Readings

1. Agrawal, B. L. 1991. Basic Statistics. Wiley Eastern Ltd. New Age International Ltd.
2. Chandel, S. R. S. 1999. A Handbook of Agricultural Statistics. Achal Prakasan Mandir, Kanpur
3. Gupta, S. C. and Kapoor, V. K. 1970. Fundamentals of Mathematical Statistics. Sultan Chand & Sons. Gupta, S. C. and Kapoor, V. K. 2019. Fundamental Applied Statistics. Sultan Chand & Sons.
4. Nageswara Rao, G. 2007. Statistics for Agricultural Sciences. BS Publications.
5. Rangaswamy, R. 2018. A Text Book of Agricultural Statistics. New Age Int. Publications Ltd.

STAT 402	**STATISTICAL METHODS (For B.Sc. (Hons.) Community Science)**	**2 (1+1)**	**SEM VII**

Objectives

To develop understanding among students about sampling and data analysis techniques, methods of data analysis using various statistics.

Theory

Introduction to statistics and its applications in agriculture, graphical representation of data, measures of central tendency. Dispersion and their merits and demerits. Probability and distribution: definition of probability, addition and multiplication theorem (without proof). Simple problems based on probability. Binomial and Poisson Distributions. Correlation and regression: definition of correlation, Scatter Diagram. Karl Pearson's Coefficient of Correlation, Spearman correlation coefficient and their properties. Linear Regression Equations. Introduction to Test of Significance, One sample; two sample test t for Means, Chi-Square Test of Independence of Attributes in 2 ×2 Contingency Table. Introduction to Sampling Methods, Sampling versus Complete Enumeration, Simple Random Sampling with and without replacement, Use of Random Number Tables for selection of Simple Random Sample. Introduction to various statistical packages.

Practical

Graphical Representation of Data. Measures of Central Tendency (Ungrouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Central Tendency (Grouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Dispersion (Ungrouped Data). Measures of Dispersion (Grouped Data). Moments, Measures of Skewness & Kurtosis (Ungrouped Data). Moments, Measures of Skewness & Kurtosis (Grouped Data). Correlation & Regression Analysis. Application of One Sample t-test. Application of Two Sample Fisher's test. Chi-Square test of Goodness of Fit. Chi-Square test of Independence of Attributes for 2 ×2 contingency table. Selection of random sample using Simple Random Sampling. Use of software packages.

Suggested Readings

1. Agarwal, B. L. 2006. Basic Statistics. New Age International Publisher.
2. Gupta SC. 2006. *Fundamentals of Statistics.* Himalaya Publ. House.
3. Panse VG & Sukhatme PV. 1985. *Statistical Methods for Agricultural Workers.* ICAR. Rao GN. 2007. *Statistics for Agricultural Science.* Oxford & IBH.
4. Snedecor GW & Cochran WG. 1968. *Statistical Methods.* Oxford & IBH.
5. Sprent P. 1993. Applied Non-parametric Statistical Methods. 2nd Ed. Chapman & Hall.
6. Sukthame & Ashok C. 1984. *Sampling Theories and Surveys with Application.* 3rd Ed. ICAR.
7. Wetherill GB. 1982. Elementary Statistical Methods. Chapman & Hall.
8. William S. Cleveland (1994) The Elements of Graphing Data, 2ndEd., Chapman & Hall

MICROBIOLOGY

Course No.	Course Title	Credits	Semester
MICRO 101 (SEC II)	Production Technology for Bio-agents and Bio-fertilizers (For B.Sc. (Hons.) Agribusiness Management)	2 (0+2)	I
MICRO 102	Elementary Microbiology (For B.Tech. Biotechnology)	2 (1+1)	II
MICRO 302	Agricultural Microbiology and Phyto-remediation (For B.Sc. (Hons.) Agriculture)	2 (1+1)	VI
	Total Credits	**6 (2+4)**	

MICRO 101 (SEC II)	**PRODUCTION TECHNOLOGY FOR BIO-AGENTS & BIO-FERTILIZERS (For B.Sc. (Hons.) Agribusiness Management)**	**2 (0+2)**	**SEM I**

Objectives

1. To understand the principles and methods of producing bio-agents and bio-fertilizers.
2. To learn techniques for mass production and formulation of beneficial microorganisms.
3. To explore the role of bio-agents and bio-fertilizers in sustainable agriculture and soil health management.
4. To develop skills to integrate bio-agents and bio-fertilizers into crop production systems for enhanced yield and reduced environmental impact.

Practical

Agricultural Microbiology: Relevance of Biofertilizer in Agriculture. Types of Biofertilizers [(a) Nitrogen fixers: Rhizobium, Azotobacter, Azospirillum, Glucano acetobacter, Cyanobacteria and Azolla; (b) P-solubilizers: PSB, PSF; (c) K-solubilizers; (d) Zn-solubilizers; (e) P-mobilizers: AM fungi; (f) Development of consortia]. Mass Production Techniques [(a) Carrier based; (b) Liquid Biofertilizers]. Methods of application. Quality Control (Standards as per FCO (1985) amended in 2009).

Suggested Readings

1. Atlas Bartha. Microbial Ecology - Fundamentals and Application. Pearson (Fourth edn).
2. Bhoopander Giri, Ram Prasad et al. Biofertilizers for Sustainable Agriculture and Environment (Soil Biology Book 55).
3. Bikas R. Pati and Santi M. Mandal. Recent Trends in Biofertilizers.
4. Eiri Board. Handbook of Biofertilizers and Vermiculture. 1 January 2009.

5. Himadri Panda. Complete Technology Book on Biofertilizer and Organic Farming.
6. J. Nicklin, K. Graeme-Cook, T. Paget and R. Killington. Instant Notes in Microbiology. Viva.
7. M K Rai. Handbook of Microbial Biofertilizers.
8. Mark S. Coyne. Soil Microbiology - An Exploratory Approach. Delmar Publishers-2004
9. Michael Madigan, John Martinko, David Stahl and David Clark. Brock-Biology of Microorganisms. Pearson (Thirteen Edition).

MICRO 102	ELEMENTARY MICROBIOLOGY (For B.Tech. Biotechnology)	2 (1+1)	SEM II

Objectives

To study the-

1. History of microbiology and major groups of eukaryotes and prokaryotes
2. Preservation methods and repositories
3. Bacterial growth and metabolism
4. Applications of microbes

Theory

History of microbiology and its applied areas. Microorganisms and their role in health and the environment. Control and prevention measures against microorganisms/ diseases. Introduction to eukaryotic and prokaryotic cells. Major groups of eukaryotes: fungi, algae and protozoa. Major groups of prokaryotes: bacteria, archaea, rickettsia and chlamydia. Preservation of microorganisms and microbial repositories at the national and international levels.

Bacterial growth. Metabolism in bacteria, ATP generation, chemoautotrophy, photoautotrophy, respiration, and fermentation. Viruses, Bacteriophages, structure and properties, lytic and lysogenic cycles, viroids, and prions. Role of microorganisms in nutrient recycling (Biogeochemical cycles)

Beneficial microorganisms in agriculture, biofertilisers, and microbial pesticides. Microbes in composting and biodegradation. Microbiology of water and food.

Practical

Microscope and other instruments in a microbiological laboratory. Media preparation, sterilisation and aseptic methods for isolation, identification, preservation and storage. Identification of bacteria by staining methods. Purification of microorganisms by streak plate method. Enumeration of bacteria by pour plate and spread plate methods. Micrometry.

Suggested Readings

1. Woolverton CJ, Sherwood LM, and Willey JM, 2016, Prescott's Microbiology, McGraw-Hill Education.

MICRO 302	AGRICULTURAL MICROBIOLOGY AND PHYTO-REMEDIATION (For B.Sc. (Hons.) Agriculture)	2 (1+1)	SEM VI

Objectives

1. To get an introduction to microbiology with specific focus on its significance in agriculture science
2. To get acquainted with the bacterial structure and the function of the different bacterial components
3. To get highlights on different fields of microbiology
4. To get highlights on the bioremediation of polluted soils using microbial mediators and phytoremediation
5. To get a concept of biological control and the role of biopesticides in plant disease management.

Theory

Introduction to Microbiology: Definition, applied areas of Microbiology and Importance of Microbiology. History of Microbiology: Discovery of microscope, spontaneous generation theory, Germ theory of diseases, Immunization, fermentation, and origin of life**.** Bacteria: cell structure, nutritional classification of bacteria, growth. Bacterial genetics: Genetic recombination- transformation, conjugation and transduction, genetic engineering. Soil Microbiology: Nutrient mineralization and transformation**,** Air Microbiology: Phyllosphere microflora, Phylloplane microflora, microflora of floral parts etc. Food Microbiology: Microbial spoilage and principles of food preservations, Food poisoning**.** Water Microbiology: Types of water, water microorganisms, and microbial analysis of water e.g. coliform test, Purification of water. Industrial Microbiology: Microbial products, Biodegradation, Biogas production, Biodegradable plastics etc. Biological control: Microbial biopesticides for plant disease management Concepts of rhizosphere microbiology- Rhizodeposits - biochemical nature, release mechanism in rhizosphere, function, Carbon flow in rhizosphere, Rhizosphere microbiomeresidents and their roles. Potential of plant growth promoting rhizobacteria (PGPR) and endophytes on soil health and sustainability**.** Bioremediation of polluted soils using microbial mediators**.** Phytoremediation of polluted soils**.**

Practical

Study of the microscope; Acquaintance with laboratory material and equipment; Microscopic observation of different groups of microorganisms: moulds & yeasts; Direct staining of bacteria by crystal violet; Negative or indirect staining of bacteria by nigrosin; Gram staining of bacteria; Study of phyllosphere and rhizosphere microflora; Measurement of microbial growth; Preparation of culture media; Isolation and purification of rhizospheric microbes; Isolation and purification of N-fixers; Isolation and purification of Nutrient solubilizers; Isolation and purification of Endophytes.

Suggested Readings

1. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. 2002. Microbiology. 5th Edition, Tata McGraw-Hill, New Delhi.
2. Rangaswami, G. and Bagyaraj, D. J. 2005. Agricultural Microbiology. Prentice-Hall of India Pvt. Ltd., New Delhi.
3. Mukherjee, N. and Ghosh, T. 2004. Agricultural Microbiology. Kalyani Publishers, Calcutta
4. Dubey, H.C. 2007. A Textbook of Fungi, Bacteria and Viruses. Vikas Publishing House Ltd., New Delhi − 10014
5. Salyers, A. A. and Whitt, D. D. 2001. Microbiology: diversity, disease, and the environment. Fitzgerald Science Press, Inc.
6. Prescott, L. M. 2002. Microbiology 5th Edition. McGraw-Hill Inc, US

PHYSICS

Course No.	Course Title	Credits	Semester
PHY 203	Engineering Physics (For B. Tech. Agricultural Engineering)	3 (2+1)	III
	Total Credits	**3 (2+1)**	

PHY 203	ENGINEERING PHYSICS (For B. Tech. Agricultural Engineering)	3 (2+1)	SEM III

Objectives

To make the students acquainted with applications of physics in engineering and different physical processes in agricultural engineering

Theory

Unit-I: Magnetism : Dia, para and ferro-magnetism- classification; Langevin theory of dia, and para magnetism, adiabatic demagnetization, Weiss molecular field theory and ferromagnetism, Curie-Weiss law.

Unit-II: Introduction to quantum mechanics : Wave particles duality, photoelectric effect, de-Broglie concept, uncertainty principle, wave function, time dependent and time independent Schrodinger equation.

Unit-III: Spectroscopy : Qualitative explanation of Zeeman effect, Stark effect and Paschen back effect, Raman spectroscopy.

Unit-IV: Solid state physics : Statement of Bloch function, bands in solids, distinction between metals, insulators and semi-conductors; Semiconductors: intrinsic and extrinsic semi-conductors, donors and acceptor levels, law of mass action, determination of energy gap in semi-conductors, Hall effect; Superconductivity: super conductivity, critical magnetic field, Meissner effect, Type I and II superconductors, isotope effect, London equations, BCS Theory, Josephsons effect, DC and AC squids, introduction to high Tc superconductors.

Unit-V: LASERS and MASERS : Spontaneous and stimulated emission, Einstein A & B coefficients, population inversion, Ruby lasers, He-Ne laser and semiconductor laser; Masers.

Unit-VI: Optical fibre and Illumination : Optical fibre**:** Physical structure, basic theory, type of modes, characteristics of optical fibre and applications.

Illumination**:** Laws of illumination, luminous flux, luminous intensity, candle power and brightness.

Practical

To verify law of transverse vibrations along a string using electrical tuning fork; To study hysteresis loss of magnetic materials; To demonstrate the Meissner effect; To measure the transition temperature of a high; temperature superconductor; Determine dielectric constant of material using De Sautys bridge; Study the variation of magnetic field with distance along the axis of a current carrying circular coil and to determine the radius of the coil; Determine the energy band gap in a semi-conductor

using a p-n junction diode; Determine the low resistance using Carey Foster bridge without calibrating the bridge wire.

Suggested Readings

1. Avadhanulu M N. 2013. An Introduction to Lasers theory and applications. S. Chand Publication
2. Chattopadhyay D and Rakshit P C. 2011. Electricity and Magnetism. S. Chand
3. Ghatak A K and Lokanathan S. 2022. Quantum Mechanics, Theory and Application. Trinity Press.
4. Griffiths D J and Schroeter 2018. Introduction to Quantum Mechanics. Cambridge University Press.
5. Khandelwal D P. 1985. A laboratory Manual of Physics. Vani Publications.
6. Kittel C. 2005. Introduction to Solid State Physics. Wiley Eastern Pvt. Ltd.
7. Mani H S and Mehta G K. 2022. Modern Physics. Affiliated East-West Press.
8. Omar M A. 2002. Elementary Solid State Physics. Pearson.
9. Prakash S. 2011. Optics. Pragati Prakashan, Meerut.
10. Saraf B and Khandelwal D P. 1982. Physics through Experiments, Vol. I & II. Vikas Publication, New Delhi.
11. Subramanyam N, Lal B and Avadhanulu M N. 2012. A Text book of Optics. S. Chand.
12. Taneja, S.P. 2004. Modern Physics for Engineers, R. Chand & CO, New Delhi.

SOCIOLOGY

Course No.	Course Title	Credits	Semester
SOC 101	Rural Sociology and Educational Psychology (For B.Sc. (Hons.) Agriculture)	2(2+0)	I
SOC 201	Rural Sociology (For B.Sc. (Hons.) Community Science)	2 (2+0)	III
SOC 202	Human Ethics (For B.Tech. Biotechnology)	1 (1+0)	IV
	Total Credits	**5 (5+0)**	

SOC 101	RURAL SOCIOLOGY AND EDUCATIONAL PSYCHOLOGY (For B.Sc. (Hons.) Agriculture)	2 (2+0)	SEM I

Objectives

Provide knowledge on concept and importance of sociology and rural sociology as well as the relationship with Extension Education

Theory

Sociology and rural sociology: Meaning, definition, scope, importance of rural sociology in Agricultural Extension, and interrelationship between rural sociology and Agricultural Extension. Extension Education and Agricultural Extension: Meaning, definition, scope, and importance. Indian Rural Society: important characteristics, differences and relationship between rural and urban societies. Social Groups: Meaning, definition, classification, factors considered information and organization of groups, motivation in group formation and role of social groups in Agricultural Extension.

Social Stratification: Meaning, definition, functions, basis for stratification, forms of social stratification- characteristics and- differences between class and caste system. Cultural concepts: culture, customs, folkways, mores, taboos, rituals. Traditions: Meaning, definition and their role in Agricultural Extension. Social Values and Attitudes: Meaning, definition, types and role of social values and attitudes in agricultural Extension. Social Institutions: Meaning, definition, major institutions in rural society, functions, and their role in agricultural Extension. Social Organizations: Meaning, definition, types of organizations and role of social organizations in agricultural Extension. Social Control: Meaning, definition, need of social control and means of social control. Social change: Meaning, definition, nature of social change, dimensions of social change and factors of social change. Leadership: Meaning, definition, classification, roles of leader, different methods of selection of professional and lay leaders. Training of Leaders: Meaning, definition, methods of training, Advantages and limitations in use of local leaders in Agricultural Extension, Psychology and educational psychology: Meaning, definition, scope, and importance of educational psychology in Agricultural Extension. Intelligence: Meaning, definition, types, factors affecting intelligence and importance of intelligence in Agricultural Extension. Personality: Meaning, definition, types, factors influencing

the personality and role of personality in agricultural Extension. Teaching: Learning process: Meaning and definition of teaching, learning, learning experience and learning situation, elements of learning situation and its characteristics. Principles of learning and their implication of teaching.

Suggested Readings

1. A. R. Desai -Rural Sociology in India
2. Dahama O. P. and Bhatnagar, O. P. - Education and Communication for Development
3. J.B. Chitambar -Introductory Rural Sociology
4. M.B. Ghorpade- Essential of psychology
5. C.N. Shankar Rao – Sociology: Principles of Sociology with an Introduction to Sociological Thought. S Chand and Company Ltd. New Delhi.
6. Prepared You Tube videos
7. R Velusamy Textbook on Rural Sociology and Educational Psychology
8. Ray, G. L. -Extension Communication and Management
9. Sandhu A. S. -Textbook on Agricultural Communication
10. Web Materials

SOC 201	**RURAL SOCIOLOGY** **(For B.Sc. (Hons.) Community Science)**	**2 (2+0)**	**SEM III**

Objectives

1. To develop understanding about sociological concepts with special reference to rural community.
2. To understand approaches to rural planning and status of rural women

Theory

Sociology and Rural sociology – Meaning and significance; Difference between rural and urban community; Indian rural social stratification: Caste & Class- Concept, characteristics and difference, Change in social stratification and implementation of constitutional provisions; Indian rural institutions: Social- Family and marriage (Nature, forms and changes), Economic- Jajmani system and division of labour, Political- Panchayati Raj; Religion: Functional significance of beliefs, traditions and customs; Rural poverty: Meaning, types and causes; Rural social change: Concept, process and factors of transformation; Planned social change- Approaches to rural planning, improvement and transformation; Status of women in rural India and their role in rural and agricultural development.

Suggested Readings

1. Chitambar, J.B. (1973). Introductory rural sociology. New York, John Wilex and Sons.
2. Desai, A.R. (1978). Rural sociology in India. Bombay, Popular Prakashan, 5th Rev.ed.
3. Doshi,S.L. (2007). Rural sociology. Delhi Rawat Publishers.
4. Jayapalan, N. (2002). Rural sociology. New Delhi, Altanic Publishers.
5. Sharma, K.L. (1997). Rural society in India. Delhi, Rawat Publishers

SOC 202	HUMAN ETHICS (For B.Tech. Biotechnology)	1 (1+0)	SEM IV

Objectives

1. To study the meaning and concepts of human behaviour
2. To study human ethical values
3. To study spirituality and attitude
4. To study the methods of stress management

Theory

Universal human aspirations, happiness, and prosperity. Human values and ethics: concept, definition, significance, and sources. Fundamental values: right conduct, peace, truth, love, and non-violence. Ethics: professional, environmental, and ICT. Sensitisation towards others, particularly senior citizens, the developmentally challenged, and gender.

Spirituality, positive attitude and scientific temper. Teamwork and volunteering. Rights and responsibilities. Road safety, Human relations, and family harmony. Modern challenges and value conflict. Sensitization against drug abuse and other social evils. Developing personal code of conduct (SWOT Analysis). Management of anger and stress.

Suggested Readings

1. Gaur RR, Sangal R and Bagaria GP, 2011, A Foundation Course in Human Values and Professional Ethics, Excel Books.
2. Mathur SS, 2010, Education for Values, Environment and Human Rights, RSA International.
3. Sharma RA, 2011, Human Values and Education -Axiology, Inculcation and Research, R. Lall Book Depot.
4. Sharma RP and Sharma M, 2011, Value Education and Professional Ethics, Kanishka Publishers.
5. Srivastava S, 2011, Human Values and Professional Ethics, S K Kataria and Sons.
6. Srivastava S, 2011, Environmental Science, S K Kataria and Sons.
7. Tripathi, A. N., 2009, Human Values, New Age International (P) Ltd, Publishers.

CENTRE OF FOOD SCIENCE AND TECHNOLOGY

Course No.	Course Title	Credits	Semester
FST 301	Food Science and Processing (For B.Tech. Biotechnology)	3 (2+1)	VI
FST 401	Food Safety and Standards (For B.Sc. (Hons.) Agriculture)	4 (3+1)	VII
FST 402	Food Science and Nutrition (For B.Sc. (Hons.) Agriculture)	4 (3+1)	VII
	Total Credits	**11 (8+3)**	

FST 301	**FOOD SCIENCE AND PROCESSING (For B.Tech. Biotechnology)**	**3 (2+1)**	**SEM VI**

Objectives

1. To study food and nutrition for good health
2. To study food spoilage, processing and preservation
3. To study the methods of assessing physical and chemical qualities

Theory

Food and nutrition; Food production and consumption trends in India; Food groups and concept of balanced diet, RDA, biotoxins, antinutritional factors and secondary metabolites; Major deficiencies of calories, proteins, vitamins and micronutrients; 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; Postharvest handing and processing technology of fruits, vegetables, cereals, oilseeds, milk, meat and poultry; Food safety, adulteration, HACCP and Indian 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.

Suggested Readings

1. Gopalan, C., Rama Sastri, B.V. and Bala Subramanian, S.C. (2005). *Nutritive Value of Indian Foods*. NIN, ICMR, Hyderabad.
2. ICAR. (2013). *Handbook of Agricultural Engineering*. ICAR Publications, New Delhi
3. Manay, S. & Shadaksharaswamy, M. (2020). *Foods Facts and Principles*. New Age International Publishers.
4. Srivastava, R.P. and Kumar, S. (2019). *Fruit and Vegetable Preservation-Principles and Practices*, CBS Publishers.
5. www.fassi.gov.in

FST 401	FOOD SAFETY AND STANDARDS (For B.Sc. (Hons.) Agriculture)	4 (3+1)	SEM VII

Objectives

1. To know hazards and understand to protect food from contamination
2. To understand the need for food safety systems
3. To use the scientific approach and practices towards safety

Theory

Food safety: definition, importance and factors affecting food safety; recent concerns- new and emerging pathogens, recent outbreaks; hazards- types (physical, chemical, biological), sources of contamination, management of hazards/contaminations- need and control of parameters: temperature, production design, packaging and food storage; hygiene and sanitation- personal hygiene, food establishments and surface sanitation; pest and rodent control; water- hygiene and quality standards; waste disposal; food safety measures: food safety management systems- basic concepts, components, need and newer approaches to food safety; risk analysis; PRPs- GHPs, GMPs, SSOPs, etc.; HACCP and TQM; GFSI; Food laws and standards: Indian food regulatory regime- FSSA; global scenario- CAC, WTO, SPS, TBT, etc.; other laws and standards related to food- ISO series; Indian and International standards for food products; product labelling and nutritional labelling, organic foods.

Practical

Quality attributes of raw and processed foods, water quality analysis; assessment of surface sanitation by swab/rinse method; personal hygiene; process flow for food establishment; GHP and GMP in a food factory; FSMS: hazard identification and risk analysis; OPRPs. development of HACCP plan; understand the ISO 22000; organizational structure of FSSAI and CAC; design a label for food product.

Suggested Readings

1. Deshpande, H.W. & Katke, S.D. 2021. Food Quality, Assurance and Certification.
2. Fernandes, C. *Safe Food Handling: HACCP Booklet for Food Handlers*, Notion Press.
3. Fortin, N.D. 2009. Food Regulation. John Wiley & Sons, New Jersey.
4. Khatekar, D. & Sarkate, N. 2023. *Handbook of Food Safety*, Step Up Academy.
5. Mathur, P. 2018. *Food Safety and Quality Control*, The Orient Blackswan.
6. Sherikar, A.T., Bachhil, V.N. & Thapliyal, D.C. 2013. *Textbook of Elements of Veterinary Public Health*. ICAR.

FST 402	FOOD SCIENCE AND NUTRITION (For B.Sc. (Hons.) Agriculture)	4 (3+1)	SEM VII

Objectives

To impart knowledge on the biochemical aspects of various nutrients and its interactions in food during processing, storage and deterioration

Theory

Introduction on fundamentals of food science and human nutrition; food- sources and its functions; basic food groups; concept of balanced diets; nutritional requirements and recommended daily allowances (RDA); malnutrition- over and under nutrition and nutritional disorders; water in foods, properties and water activity; major food constituents-carbohydrates, proteins, fats- sources, classification, functions, physico-chemical and nutritional characteristics; effect of processing; digestion, absorption, transport and metabolism in human system; vitamins and minerals- classification, dietary sources, functions, deficiency diseases and effect of processing; anti-nutritional factors; postharvest storage and losses during processing; food spoilage; enzymes in food industry; food additives.

Practical

Standard solutions and buffers; TSS; pH; acidity; water activity; proximate analysis of foods; calorific value of foods, estimation of vitamins, phenols, flavonoids, carotenoids, anti-nutrients in food stuff

Suggested Readings

1. De Man, J.M. 1976. *Principles of Food Chemistry*. AVI.
2. Gibney M.J., Lanham-New S.A., Cassidy, A. & Voster, H.H. (ed.) 2009. *Introduction to Human Nutrition*. Wiley-Blackwell
3. Gopalan, C., Rama Sastri, B.V. & Bala Subramanian, S.C. 2021. *Nutritive Value of Indian Foods*, NIN, ICMR, Hyderabad.
4. Kumar, D. 2019. *Food Science and Nutrition*, Random Publications.
5. Manay, N.S. & Shadaksharaswamy, M. 2020. *Foods Facts and Principles*, New Age International Publishers.
6. Mudambi, R.S. & Rao, S. 1985. *Food Science*, Wiley Eastern Ltd.
7. Rekhi, T. and Yadav, H. 2014. *Fundamentals of Food and Nutrition*. Elite Publishing House.
8. Swaminathan, M. 1999. *Essentials of Foods and Nutrition*, Vol. I. The Bangalore Printing and Publishing Co. Ltd., Bangalore.
9. Trueman, P. 2007. *Nutritional Biochemistry*, MJP Publishers

DIRECTORATE OF STUDENTS' WELFARE


Chaudhary Charan Singh Haryana Agricultural University, Hisar
NATIONAL SERVICE SCHEME
NATIONAL INTEGRATION CAMP
October 23-29, 2024
Youth for my Bharat
Dr. M.L. Khichar
Prof. B.R. Kamboj
Sh. Randhir Panihar
M.L.A., NALWA
Dr. Dinesh Kumar
State NSS Officer


Chaudhary Charan Singh Haryana Agricultural University, Hisar
NATIONAL SERVICE SCHEME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DIRECTORATE OF STUDENTS' WELFARE

Course No.	Course Title	Credits	Semester
NCC I/ NSS I (AEC)	National Cadet Corps I/ National Service Scheme I	2 (0+2)	I
NCC II/ NSS II (AEC)	National Cadet Corps II/ National Service Scheme II	2 (0+2)	II
CCA 102	Co-curricular Activity	1 (0+1) NG	II
CCA 201 (AEC)	Physical Education, First Aid, Yoga Practices and Cultural Activities	2 (0+2)	III
NCC III/ NSS III	National Cadet Corps III/ National Service Scheme III	2 (0+2) NG	III
CCA 202	Co-curricular Activity	1 (0+1) NG	IV
NCC IV/ NSS IV	National Cadet Corps IV/ National Service Scheme IV	2 (0+2) NG	V
	Total Credits	**6 (0+6)**	

NCC I/ NSS I (AEC)	NATIONAL CADET CORPS I/ NATIONAL SERVICE SCHEME I	2 (0+2)	SEM I

National Cadet Corps (NCC I)

Objectives

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen.
2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation.

Practical/ Awareness programmes

- Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
- Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
- Sizing, numbering, forming in three ranks, open and close order march, and dressing.
- Saluting at the halt, getting on parade, dismissing, and falling out.
- Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march.
- Marking time, forward march, and halt. Changing step, formation of squad and squad drill.
- Command and control, organization, badges of rank, honors, and awards
- Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/ personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects.

- Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.
- Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

As per government guidelines, for getting B and C certificate in NCC, minimum years of requirement is 2 and 3 years, respectively along with 1-2 annual camps.

National Service Scheme (NSS I)

Objective

1. Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in programme, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness programmes

- Orientation: history, objectives, principles, symbol, badge; regular programs under NSS
- Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.
- NSS program activities: Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.
- Community mobilization: Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration.
- Indian history and culture, role of youth in nation building, conflict resolution and peacebuilding. Volunteerism and shramdaan. Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism.
- Citizenship, constitution, and human rights: Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society.

A student enrolled in NSS course should put in at least 60 hours of social work in different activities in a semester other than five regular one-day camp in a year and one special camp for duration of 7 days at any semester break period in the two years. Different activities will include orientation lectures and practical works. Activities directed by the Central and State Government have to be performed by all the volunteers of NSS as per direction.

NCC II/ NSS II (AEC)	NATIONAL CADET CORPS II/ NATIONAL SERVICE SCHEME II	2 (0+2)	SEM II

National Cadet Corps (NCC II)

Objective

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen.
2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation.

Practical/ Awareness programmes

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

National Service Scheme (NSS II)

Objective

1. To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skillful in executing democratic leadership, developing skill in programme, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness programmes

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

CCA 201 (AEC)	**PHYSICAL EDUCATION, FIRST AID, YOGA PRACTICES AND CULTURAL ACTIVITIES**	**2 (0+2)**	**SEM III**

Objectives

1. To make the students aware about Physical Education, First Aid and Yoga Practices
2. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yog, Types of Yog, Introduction to Yog,

- Asanas (Definition and Importance) Padmasan,san, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh

- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
- Role of yoga in sports
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics Need and requirement of first aid. First Aid equipment and upkeep. First aid Techniques, First aid related with Respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Music- Importance of Music in life, rhythm in music, role of music in personality development, naad, swar, shruti, alankar, gamak, vadi-samvadi, in music. Importance of expression, Dance and Meditation.

Dramatics- History and theory of theatre. Acting, directing, stage design craft of script and dialogue

Haryana Folk Lore and Culture- Society and Folk Lore, Historical context, folk music in different regions, instruments used in Haryana Folk Lore, Singing style of different folk gharanas.

COMMITTEE FOR FINALISATION OF UG COURSE CURRICULUM