

Annexure-I

BIOTECHNOLOGY

TERM OF REFERENCE 1. Defining UG & PG degree for general market needs & for specialized jobs and uniformity in UG & PG nomenclature

1. Degree Nomenclature -

UG Degree: B.Tech. Biotechnology

PG Degrees: M. Tech. and Ph.D

Both UG and PG degree will have four areas of choice for elective *viz.* Plant Biotechnology, Animal Biotechnology, Microbial & Environmental Biotechnology, and Bioinformatics.

1. Plant Biotechnology
2. Animal Biotechnology
3. Microbial and Environmental Biotechnology
4. Bioinformatics

TERM OF REFERENCE 2. Restructuring of UG programmes for increased practical and practice contents

- The curriculum has a **total of 183 credit hours including non-credit hours** for the Biotechnology UG degree programme and various SAUs offering the **degree would have a maximum of only 20 per cent relaxation catering to local needs and based on infrastructural availability.**
- **Four electives, each of 18 credit hours have been finalized for the degree programme and the students will have to opt for one of these electives during their sixth semester of the degree. The electives finalized are as per given:**
 1. Plant Biotechnology
 2. Animal Biotechnology
 3. Microbial and Environmental Biotechnology
 4. Bioinformatics
- The finalized curriculum has more than 68 per cent courses from biotechnology discipline itself.
- There will not be any Rural Agricultural Work Experience Programme (RAWEP) in Biotechnology degree programme. But. It will include a well-structured two-semester '**Student READY Programme**' for a maximum of 40 credit hours divided as follows:
- 24 weeks 'Student Ready In-house Skill Development Modules' of 20 credit hours which includes four modules (only one to be opted):
 - Plant Biotechnology
 - Animal Biotechnology
 - Microbial and Environmental Biotechnology
 - Bioinformatics
- 10 weeks 'Student READY Project Formulation, Execution and Presentation' of 10 credit hours

- 10 weeks On-campus/Off-campus ‘Student READY Entrepreneurial Development in Biotechnology’ of 10 credit hours

Outline of Curriculum

Deficiency/Remedial Courses

Total Credit hours= 6

Course No.	Course Title	Credit hours
Bot. 101	Basic Botany	2+1
Zoo. 101	Basic Zoology	2+1
Math. 101	Basic Mathematics – I	3+0
Math.102	Basic Mathematics - II	3+0

Bot. 101 + Zoo. 101 or Math. 101 + Math. 102

General Courses

Total Credit Hours= 18

Course No.	Course Title	Credit hours
CSPD 101	Communication Skills and Personality Development	1+1
EDBM 201	Entrepreneurship Development and Business Management	1+1
Econ. 201	Economics and Marketing	2+1
Env.101	Environmental Studies and Disaster Management	2+1
FT 101	Food Science and Processing	1+1
HD 101	Human Ethics	1+0
ICT 201	Information and Communication Technology	1+1
ICT 301	Agricultural Informatics	2+1

Biotechnology Core Courses (23)

Total Credit Hours=64

Course No.	Course Title	Credit hours
Biotech. 101	Cell Biology	2+0
Biotech. 102	Basic Genetics	2+1
Biotech. 103	Introduction to Biotechnology	2+1
Biotech. 104	Plant Tissue Culture	2+1
Biotech. 105	Molecular Biology	2+1
Biotech. 201	Recombinant DNA Technology	2+1
Biotech. 202	Introductory Bioinformatics	2+1
Biotech. 203	Plant Genetic Transformation	2+1
Biotech./ECE 204	Fundamentals of Electronics and Instrumentation in	1+1

	Biotechnology	
Biotech. 205	Classical and Molecular Cytogenetics	2+1
Biotech. 301	Immunology	2+1
Biotech. 302	Molecular Genetics	2+0
Biotech. 303	Nanobiotechnology	2+0
Biotech. 304	Animal Biotechnology	3+1
Biotech. 305	Molecular Marker Technology	2+0
Biotech. 306	Genomics and Proteomics	3+0
Biotech. 307	IPR, Biosafety and Bioethics	2+0
Biotech. 308	Computational Biology	2+1
Biochem. 201	General Biochemistry	3+1
Biochem. 301	Enzymology and Enzyme Technologies	2+1
Bot./Zoo. 102	Biodiversity and its Conservation	2+0
Micro. 101	Microbiology	2+1
Micro. 201	Microbial Genetics	2+1

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

Elective I. Plant Biotechnology		
Course No.	Course Title	Credit hours
Biotech. 411	Plant Tissue Culture and its Applications	2+1
Biotech. 412	Principles and Applications of Plant Genetic Transformation	2+1
Biotech. 413	Applications of Genomics and Proteomics	2+1
Biotech. 414	Molecular Breeding in Field Crops	2+1
Biotech. 415	Molecular Breeding of Horticultural Crops and Forest Trees	2+1
Biotech. 416	Epigenetics and Gene Regulation	2+1
Elective II. Animal Biotechnology		
Biotech. 421	Principles and Procedures of Animal Cell Culture	2+1
Biotech. 422	Animal Genomics	2+1
Biotech. 423	Embryo Transfer Technologies	2+1
Biotech. 424	Transgenic Animal Production	3+0
Biotech. 425	Molecular Diagnostics	2+1

Biotech. 426	Molecular Virology and Vaccine Production	2+1
Elective III. Microbial and Environmental Biotechnology		
Biotech. 431	Microbial Biotechnology	2+1
Biotech. 432	Bio-prospecting of Molecules and Genes	3+0
Biotech. 433	Molecular Ecology and Evolution	3+0
Biotech. 434	Fundamentals of Molecular Pharming and Biopharmaceuticals	2+1
Biotech. 435	Food Biotechnology	2+1
Biotech. 436	Green Biotechnology	2+1
Elective IV. Bioinformatics		
Biotech. 441	Programming for Bioinformatics	2+2
Biotech. 442	Bioinformatics Tools and Biological Databases	2+1
Biotech. 443	Structural Bioinformatics	2+1
Biotech. 444	Pharmacogenomics	2+1
Biotech. 445	Metabolomics and System Biology	2+1
Biotech. 446	Computational Methods for Data Analysis	1+1

Basic Science Courses (5)

Total Credit Hours=14

Course No.	Course Title	Credit hours
Bot. 201	Plant Physiology	2+1
Math. 201	Biomathematics	2+1
Phy. 201	Biophysics	2+1
Stat. 101	Basic Statistics	1+1
Stat. 301	Biostatistics	2+1

Agriculture Courses (5)

Total Credit Hours= 15

Course No.	Course Title	Credit hours
Agron. 101	Crop Production Technology	2+1
*Hort. 101	Production Technologies for Horticultural Crops	2+1
*PB 101	Basics of Plant Breeding	2+1
*PB 201	Breeding of Field Crops	2+1
*Ent-Pl.Path. 201	Fundamentals of Crop Protection	2+1

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

Animal Science Courses (5)

Total Credit Hours= 15

Course No.	Course Title	Credit hours
**AS 101	Anatomy and Physiology of Livestock	3+0
**AS 102	Introduction to Animal Breeding	2+1
AS 201	Livestock Production and Management	2+1
**AS 202	Livestock Product Technology	2+1
**AS203	Animal Health Care	2+1

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

Student READY Programme (2 Semesters)

Total Credit Hours=40

Course No.	Course Title	Credit hours
Biotech. 491	In-house Skill Development Modules	20
Biotech. 492	Project Formulation, Execution and Presentation	10
Biotech. 493	Entrepreneurial Development in Biotechnology (on campus /off campus)	10

Non Credit Courses (2)

Total Credit Hours=6

Course Title	Non Credit hours
Educational Tour	2
NCC/NSO/NSS	4

COURSES SCHEDULE FOR B.TECH. BIOTECHNOLOGY IN SAUs					
Semester-wise Distribution of Courses Finalized for B.Tech. (Biotechnology) Curriculum					
Semester I			Semester II		
Course No.	Course Title	Cr hrs	Course No.	Course Title	Cr hrs
Bot. 101/ Math. 101	Basic Botany/ Basic Mathematics - I	2+1/ 3+0	Zoo. 101/ Math. 102	Basic Zoology/ Basic Mathematics - II	2+1/3+0
Agron. 101	Crop Production Technology	2+1	Biotech. 104	Plant Tissue Culture	2+1
Biotech.101	Cell Biology	2+0	Biotech. 105	Molecular Biology	2+1
Biotech. 102	Basic Genetics	2+1	Bot. / Zoo. 102	Biodiversity and its Conservation	2+0
Biotech. 103	Introduction to	2+1	*Hort. 101/	Production technologies for	2+1/3+0

	Biotechnology		**AS 101	Horticultural Crops/ Anatomy and Physiology of Livestock	
CSPD 101	Communication Skills and Personality Development	1+1	Micro. 101	Microbiology	2+1
Env. 101	Environmental Studies and Disaster Management	2+1	*PB 101/ **AS 102	Basics of Plant Breeding/ Introduction to Animal Breeding	2+1
FT 101	Food Science and Processing	1+1	Stat. 101	Basic Statistics	1+1
HD 101	Human Ethics	1+0			
	NCC/NSO/NSS	0+1 NC		NCC/NSO/NSS	0+1 NC
Total		15+7 (22) +1 NC=23	Total		15+7(22)+ 1 NC=23
Semester III			Semester IV		
Course No.	Course Title	Cr hrs	Course No.	Course Title	Cr hrs
AS 201	Livestock Production and Management	2+1	EDBM 201	Entrepreneurship Development and Business Management	1+1
Biotech. 201	Recombinant DNA Technology	2+1	Biochem. 201	General Biochemistry	3+1
Bot. 201	Plant Physiology	2+1	Biotech. 202	Introductory Bioinformatics	2+1
ICT 201	Information and Communication Technology	1+1	Biotech. 203	Plant Genetic Transformation	2+1
Econ. 201	Economics and Marketing	2+1	Biotech./ECE 204	Electronics and Instrumentation in Biotechnology	1+1
*Ent.- Pl.Path. 201/ **AS 202	Fundamentals of Crop Protection/ Livestock Product Technology	2+1	Biotech. 205	Classical and Molecular Cytogenetics	2+1
Math. 201	Biomathematics	2+1	Micro. 201	Microbial Genetics	2+1
*PB 201/ **AS 203	Breeding of Field Crops/ Animal Health Care	2+1	Phy. 201	Biophysics	2+1
	NCC/NSO/NSS	0+1 NC		NCC/NSO/NSS	0+1 NC
Total		15+8(23)+ 1 NC=24	Total		15+8 (23) +1 NC=24

Semester V			Semester VI		
Course No.	Course Title	Cr hrs	Course No.	Course Title	Cr hrs
Biochem. 301	Enzymology and Enzyme Technologies	2+1	Biotech. 308	Computational Biology	2+1
Biotech. 301	Immunology	2+1	Stat. 301	Biostatistics	2+1
Biotech. 302	Molecular Genetics	2+0	Optional/ Elective Courses (6)	Electives (4): Only one to be chosen (each with six courses)	18
Biotech. 303	Nanobiotechnology	2+0			
Biotech. 304	Animal Biotechnology	3+1		1. Plant Biotechnology	12+6
Biotech. 305	Molecular Marker Technology	2+0		2. Animal Biotechnology	13+5
Biotech. 306	Genomics and Proteomics	3+0		3. Microbial and Environmental Biotechnology	14+4
Biotech. 307	IPR, Biosafety and Bioethics	2+0		4. Bioinformatics	11+7
ICT 301	Agricultural Informatics	2+1			
Total		20+4=24	Total		22+2=24
Semester VII			Semester VIII		
Course No.	Module*	Cr hrs	Course No.	Course Title	Cr hrs
Biotech. 491 Student READY - In-house Skill Development Modules	1. Plant Biotechnology 2. Animal Biotechnology 3. Microbial and Environmental Biotechnology 4. Bioinformatics *To opt only one module as per the chosen elective	0+20	Biotech. 492	Student READY - Project Formulation, Execution and Presentation	0+10
Edu. Tour 490	Educational Tour	2 NC	Biotech. 493	Student READY - Entrepreneurial Development in Biotechnology (- On-campus/Off Campus)	0+10
Total		20+2NC =22	Total		0+20 =20

Curriculum Summary

Remedial Courses Credit hours: 6

General Course Credit hours: 18

Biotechnology Courses Credit hours: 122

Basic Science Course Credit hours: 14

Agriculture Course Credit hours: 15*

Animal Sciences Courses Credit hours: 15**

Compulsory Credit Hours of Credit Courses: 178

Edu. Tour Educational Tour: 0+2 NC

NCC/NSO/NSS: 4 NC

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

Contents of the Courses

Deficiency/ Remedial Courses

Students joining degree programme with +2 in medical stream will take Math. 101 and Math. 102 as remedial courses, while the students joining B.Tech. Biotechnology with +2 in Non-Medical stream will take Bot. 101 and Zoo. 101 as remedial courses. These courses will cover syllabus for +1 & +2 classes. There will be a total of six credit hours in each of the deficiency/remedial courses package.

1. Basic Botany 2+1

Theory

UNIT I

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

UNIT II

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

UNIT III

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

Practical

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

Suggested Readings

- Bendre A & Kumar A. 1999. *Textbook of Practical Botany*. Vol. 2, 7th Ed., Rastogi Publications.
- Bendre AM & Pande PC. 2009. *Introduction to Botany*. Rastogi publications.
- Dutta AC. 1995. *A Class Book of Botany*, 16th Edition. Oxford University Press.

2. Basic Zoology 2+1

Theory

UNIT I

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

UNIT II

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

Practical

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

Suggested Readings

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

3. Basic Mathematics-I 3+0

Theory

UNIT I

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

UNIT II

Geometric series: nth term of G.P. series, sum of G.P. series, geometric mean; Harmonic series, harmonic mean; Arithmetico geometric series and special series $\sum n$,

$\sum n^2$, $\sum n^3$. Partial fractions; Logarithms; Binomial theorem for any index: Expansion, middle term, general term, terms independent of x.

Unit III

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

Suggested Readings

NCERT 2012. *Mathematics of Class XI*. NCERT India.

Sharma RD. 2014. *Mathematics of Class XI*. Dhanpat Rai Publisher.

Basic Mathematics-II 3+0

Theory

UNIT I

Functions; Limit: Introduction, left handed and right handed limits, general rules for calculation of limits Standard limits $\lim_{x \rightarrow a} \frac{x^n - a^n}{x - a}$,

$\lim_{x \rightarrow 0} \frac{\sin x}{x}$, $\lim_{x \rightarrow 0} (1 + x)^{\frac{1}{x}}$, $\lim_{x \rightarrow 0} \frac{a^x - 1}{x}$, $\lim_{x \rightarrow 0} \frac{\log(1+x)}{x}$. Continuity: Definition of continuity, continuity of algebraic functions, Continuity of trigonometric and exponential functions.

UNIT II

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

UNIT III

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

UNIT IV

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

Suggested Readings

NCERT 2012. *Mathematics of Class XII*. NCERT India.

Sharma RD. 2014. *Mathematics of Class XII*. Dhanpat Rai Publisher.

General / Common Courses

1. Communication Skills and Personality Development 1+1

Theory

UNIT I

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

UNIT II

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

Practical

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

Suggested Readings

Carnegie, Dale. 2012. *How to Win Friends and Influence People in the Digital Age*. Simon & Schuster.

Covey Stephen R. 1989. *The Seven Habits of Highly Successful People*. Free Press.

Spitzberg B, Barge K & Morreale, Sherwyn P. 2006. *Human Communication: Motivation, Knowledge & Skills*. Wadsworth.

Verma, KC. 2013. *The Art of Communication*. Kalpaz.

2. Entrepreneurship Development and Business Management 1+1

Theory

UNIT I

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

UNIT II

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

UNIT III

Management: Definition, importance and functions; Levels of management; Planning: Definition, steps in planning, types of plan; Organizing: Meaning of organizing and organization; Developing leadership skills; Encoding and decoding communication skills; Developing organizational and managerial skill; Problem solving skill; Supply chain management and total quality management; Project planning, formulation and report preparation.

Practical

Preparation of project report for starting a new venture; Case studies of successful entrepreneurs, analysis and discussion; Preparation of complete marketing plan of selected product/service; Case studies related to project management; Visits to industrial and agri-business houses; Numerical problems; Preparation of project report for various business ventures.

Suggested Readings

- Harold Koontz & Heinz Weihrich. 2004. *Essentials of Management: An International Perspective*, 2nd Ed. Tata Mc-Graw Hill Publishing Pvt Ltd.
- Mukesh Pandey & Deepali Tewari. 2010. *The Agribusiness Book*. IBDC Publishers.
- Nandan H. 2011. *Fundamentals of Entrepreneurship*. PHI Learning Pvt Ltd India.
- Philip Kotler, Kavin Lane Keller, Abraham Koshy & Mithileshwar Jha. 2012. *Marketing Management: A South Asian Perspective*. Pearson Education.
- Poornima Charantimath. 2006. *Entrepreneurship Development: Small Business Enterprise*. Pearson Education.
- Stephans P Robbins & Mary Coulter. 2003. *Management*. Pearson Education.

3. Economics and Marketing 2+1

Theory

UNIT I

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

UNIT II

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

UNIT III

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

Practical

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

Suggested Readings

Acharya SS & Aggarwal NL. 2011. *Agricultural Marketing in India*. Fifth Edition. Oxford and IBH Publishing Company Pvt. Ltd.

Ahuja HL. 2007. *Advanced Economic Theory*. S Chand and Company.

Chandra P. 1984. *Projects: Preparation, Appraisal & Implementation*. McGraw Hill Inc.

Dewett KK. 2005. *Modern Economic Theory*. S Chand and Company.

Gupta RD & Lekhi RK. 1982. *Elementary Economic Theory*. Kalyani Publishers.

Sampat Mukherjee. 2002. *Modern Economic Theory*. New Age International.

4. Environmental Studies and Disaster Management 2+1

Theory

ENVIRONMENTAL STUDIES

UNIT I

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

UNIT II

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

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

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

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

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

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

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

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

UNIT III

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

UNIT IV

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

UNIT V

Environmental Pollution: definition, cause, effects and control measures air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear hazards; Solid waste management: causes, effects and control measures of urban and industrial wastes; Role of an individual in prevention of pollution; Pollution case studies.

UNIT VI

Social issues and the environment; From unsustainable to sustainable development; Urban problems related to energy; Water conservation, rain water harvesting, watershed management; Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust; Wasteland reclamation; Consumerism and waste products; Environment Protection Act; Air (Prevention and Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; Issues involved in enforcement of environmental legislation; Public awareness.

UNIT VII

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

DISASTER MANAGEMENT

UNIT I

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

UNIT II

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

UNIT III

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

Practical

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

Suggested Readings

Ahluwalia VK & Malhotra S. 2006. *Environmental Science*. Ane Books India.

Anjaneyulu Y. 2004. *Introduction to Environmental Science*. BS Publications.

Chauhan AS. 2009. *Environmental Studies*. 3rd Edition. Jain Brothers.

Das RC & Behera DK. 2008. *Environmental Science - Principles and Practice*. Prentice –Hall of India Pvt Ltd.

Dhaliwal GS & Kukal SS. 2005. *Essentials of Environment Science*. Kalyani Publishers. Santra

5. Food Science and Processing 1+1

Theory

UNIT I

Definition: Food and nutrition; Food production and consumption trends in India; Major

deficiencies of calories, proteins, vitamins and micronutrients; Food groups and concept of balanced diet; RDA.

UNIT II

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

UNIT III

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

Practical

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

Suggested Readings

- Potter NN & Hotchkiss JH. 1995. *Food Science*. Chapman and Hall Publishers.
- Swaminathan M. 2005. *Handbook of Foods and Nutrition*. Ganesh and Co. Pvt. Ltd.
- Swaminathan M. 1990. *Food Science, Chemistry and Experimental Foods*. BAPPCO.
- Vickie A., Vaclavik & Elizabeth W. Christian. 2003. *Essentials of Food Science*, 2nd Ed. Kluwer Academic/ Plenum Publishers, New York.

6. Human Ethics 1+0

Theory

UNIT I

Universal human aspirations: Happiness and prosperity; Human values and ethics: Concept, definition, significance and sources; Fundamental values: Right conduct, peace, truth, love and non-violence; Ethics: professional, environmental, ICT; Sensitization towards others particularly senior citizens, developmentally challenged and gender.

UNIT II

Spirituality, positive attitude and scientific temper; Team work and 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

- Gaur RR, Sangal R & Bagaria GP. 2011. *A Foundation Course in Human Values and Professional Ethics*. Excel Books.
- Mathur SS. 2010. *Education for Values, Environment and Human Rights*. RSA International.

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

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

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

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

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

7. Information and Communication Technology 1+1

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

Practical

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

Suggested Readings

Gurvinder Singh, Rachhpal Singh & Saluja KK. 2003. *Fundamentals of Computer Programming and Information Technology*. Kalyani Publishers.

Harshawardhan P. Bal. 2003. *Perl Programming for Bioinformatics*. Tata McGraw-Hill Education.

Kumar A 2015. *Computer Basics with Office Automation*. IK International Publishing House Pvt Ltd.

Rajaraman V & Adabala N. 2015. *Fundamentals of Computers*. PHI
Recommended Latest Online Tutorials (over Internet).

8. Agricultural Informatics

2+1

Theory

UNIT I

Introduction to computers; Anatomy of computers; Memory concepts, units of memory; Operating system, definition and types; Applications of MS-Office for creating, editing and formatting a document; Data presentation, tabulation and graph creation; Statistical analysis, mathematical expressions; Database, concepts and types, creating database; Uses of DBMS in Agriculture; Internet and World Wide Web (WWW), concepts, components and creation of web; HTML & XML coding.

UNIT II

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

UNIT III

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

Practical

Study of computer components, accessories; Practice of important DOS commands; Introduction of different operating systems such as windows, Unix, Linux; Creating files and folders; File management; Use of MS-WORD and MS Power point for creating, editing and presenting a scientific document; Handling of tabular data; Animation, video tools, art tool, graphics, template and designs; MS-EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data,

Bhatia KN & Prashar AN. 1990. *Plant Physiology*. Trueman Book Company.

Salisbury FB. & Ross CW. 1992. *Plant Physiology*. Wordsworth Publishing Company.

Srivastava HN. 2000. *Plant Physiology*. Pradeep Publications.

2. Biomathematics

2+1

Theory

UNIT-I

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

UNIT-II

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

Practical

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

Suggested Readings

Grewal BS. 2013. *Higher Engineering Mathematics*. Khanna Publishers, India.

Rastogi SK. 2008. *Biomathematics*. Krishna Prakashan Media Pvt. Ltd.

Srivastava AC & Srivastava PK. 2011. *Engineering Mathematics*. Vol.I . PHI Learning Pvt. Ltd.

Srivastava AC & Srivastava PK. 2011. *Engineering Mathematics*. Vol.III . PHI Learning Pvt. Ltd.

3. Biophysics

2+1

Theory

UNIT I

Quantum mechanics; Electronic structure of atoms; The wave particle duality, wave length of de-Broglie waves; Phase and group velocity; Some basic concepts of quantum

mechanics; Schrodinger's wave equations; Particle in a box; Quantum mechanical tunneling; Ist and IInd law of thermodynamics; Enthalpy; Entropy; Statistical and thermodynamic definition of entropy; Helmholtz free energy, Equilibrium thermodynamic; Near-equilibrium thermodynamic; Gibbs free energy; Chemical potential; Thermodynamic analysis of membrane transport.

UNIT II

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

UNIT III

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

Practical

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

Suggested Readings

Chang R. 2005. *Physical Chemistry for the Biosciences*. University Science Books.

Glaser. 2012. *Biophysics*. Springer.

Pattabhi V & Gautam N. 2002. *Biophysics*. Narosa Publishing House.

Rodney Cotterill. 2002. *Biophysics: An Introduction*. John Wiley & Sons.

Srivastava PK. 2006. *Elementary Biophysics: An Introduction*. Narosa Publishing House.

4. Basic Statistics 1+1

Theory

UNIT I

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

UNIT II

Tests of significance: Null hypothesis, alternate hypothesis, Type I & II Error, one and two tail tests, level of significance and confidence interval; SND test for means: Single

sample and two samples Z-test; Student's t-test for means, single sample, two samples and paired t-test; F-test;

UNIT III

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

Practical

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

Suggested Readings

Freud JE & Perles BM. 2006. *Modern Elementary Statistics*. 12th Ed. Pearson India.

Kapoor VK. 2003. *Problems and Solutions in Statistics*. 7th Edition. Sultan Chand and Sons.

Snedecor GW. & Cochran WG. 1989. *Statistical Methods*. Iowa State University Press.

5. Biostatistics 2+1

Theory

Unit I

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

Unit II

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

Unit III

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

Practical

Expected value and variance of discrete and continuous distributions; Uniform, Binomial, Poisson, Normal, Exponential and Gamma Probability distributions; Hardy-Weinberg Law; Construction of transition probability matrix in Markov Chains; Calculation of sensitivity and specificity; Detection and linkage using Chi-square test; One-way and

two-way analysis of variance; Analysis of covariance; Incomplete block designs; Testing of heritability.

Suggested Readings

Biswal PC. 2009. *Probability and Statistics*. PHI Learning Pvt. Ltd.

Kaps M. & Lamberson W. 2007. *Biostatistics for Animal Science*. CABI Publishing.

Narayan P, Bhatia VK & Malhotra PK. 1989. *Handbook of Statistical Genetics*. Indian Agricultural Statistics Research Institute, New Delhi, India.

Pal N. & Sahadeb Sarkar. 2009. *Statistics – Concepts and Applications*. 2nd Ed. PHI Learning Pvt. Ltd.

Core Courses in Biotechnology

1. Cell Biology 2+0

Theory

UNIT I

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

UNIT II

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

Suggested Readings

Alberts B, Johnson A, Lewis J, Raff M, Roberts K & Walter P. 2008. *Molecular Biology of the Cell*. 5th Ed. Garland Science/ Taylor and Francis Group.

Lodish H, Berk A, Kaiser CA, Krieger M, Bretscher A, Ploegh H, Amon A & Scott MP. 2012. *Molecular Cell Biology*. W. H. Freeman.

Sadava DE. 1993. *Cell Biology: Organelle Structure and Function*. Jones and Bartlett Publishers.

2. Basic Genetics 2+1

Theory

UNIT I

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

UNIT II

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

Practical

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

Suggested Readings

Gupta PK. 2014. *Genetics* 4th ed. Rastogi Publications.

Inbasekar P. 2009. *Cell Biology and Genetics*. Panima Publications.

Miglani GS. 2000. *Basic Genetics*. Narosa Publishing house, New Delhi.

Russell PJ. 2013. *iGenetics: Pearson New International Edition: A Molecular Approach*. Pearson.

Watson JD, Bakee TA, Bell SP, Gann A, Levine M & Losick R. 2008. *Molecular Biology of the Gene*. 6th Ed. Pearson Education International.

3. Introduction to Biotechnology 2+1

Theory

UNIT I

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

UNIT II

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

Practical

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

Suggested Readings

Brown T A. 2002. *Genomes 2*. 2nd ed. New york:Wiley-Liss.

Prave P, Faust U, Sittig W & Sukatsch DA. 1987. *Basic Biotechnology: A Student's Guide*. VCH Verlagsgesellschaft.

Prave P, Faust U & Sittig W. 1987. *Fundamentals of Biotechnology*. VCH Verlagsgesellschaft.

Renneberg R. 2008. *Biotechnology for Beginners*. Academic Press Publishers.

4. Plant Tissue Culture 2+1

Theory

UNIT I

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

UNIT II

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

Practical

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

Suggested Readings

Bhojwani SS & Razdan MK. 1996. *Plant Tissue Culture: Theory and Practice*. Elsevier.

Bhojwani SS & Dantu PK. 2013. *Plant Tissue Culture: An Introductory Text*. Springer

Dixon RA & Gonzales RA. 2003. *Plant Cell Culture: A Practical Approach*. Oxford University press.

Helgason CD & Miller CL. 2005. *Basic Cell Culture Protocols*. 3rd Ed. Humana Press.

5. Molecular Biology 2+1

Theory

UNIT I

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

UNIT II

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

Practical

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

Suggested Reading

Allison LA. 2011. *Fundamental Molecular Biology*. Wiley Global Education.

Carson S, Miller HB & Witherow DS. 2012. *Molecular Biology Techniques A Classroom Laboratory manual*. Elsevier.

Kreuzer H & Massey A. 2008. *Molecular Biology and Biotechnology: A Guide for Teachers*. ASM Press.

Lodish H, Berk A, Kaiser CA, Krieger M, Bretscher A, Ploegh H, Amon A & Scott MP. 2012. *Molecular Cell Biology*. W. H. Freeman.

Sambrook J, Russel D. 2001. *Molecular Cloning: A Laboratory Manual*. 3rd Ed Cold Spring Harbor Laboratory Press.

Surzycki S. 2000. *Basic Techniques in Molecular Biology*. Springer Berlin Heidelberg

Voet D, Voet JG & Pratt CM. 2004. *Fundamentals of Biochemistry*. 2nd Ed. New York: Wiley.

Walker JM & Rapley R. 2000. *Molecular Biology and Biotechnology*. 4th Ed. The Royal Society of Chemistry.

Watson JD, Bakee TA, Bell SP, Gann A, Levine M & Losick R. 2008. *Molecular Biology of the Gene*. 6th Ed. Pearson Education International.

6. Recombinant DNA Technology 2+1

Theory

UNIT I

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

UNIT II

Competent cells; Gene isolation and cloning; Genetic transformation of *E. coli*; Gel electrophoresis; Preparation of probes; Southern blotting; Northern blotting; Western blotting; PCR and gene amplification.

Practical

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

Suggested Readings

Brown TA. 1998. *Genetics: A Molecular Approach*. 3rd Ed. Stanley Thornes.

Singer M & Berg P. 1991. *Genes & Genome*. University Science Books.

Winnacker EL. 2003. *From Genes to Clones: Introduction to Gene Technology*. 4th Ed. Panima Publishers.

Watson JD & Zoller M. *Recombinant DNA*. 3rd Ed. Panima Publishers

7. Introductory Bioinformatics 2+1

Theory

UNIT I

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

UNIT II

Primary databases: Nucleotide sequence databases (GenBank, EMBL), protein sequence databases; Secondary databases: SwissProt/TrEMBL, conserved domain database, Pfam;

Structure databases: Protein Data Bank (PDB), MMDB, SCOP, CATH; File formats: Genbank, EMBL, Fasta, PDB, Flat file, ASN.1, XML.

UNIT III

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

Practical

Basic computing: Introduction to UNIX, LINUX; Nucleotide information resource: EMBL, GenBank, DDBJ, Unigene; Protein information resource: SwissProt, TrEMBL, Uniprot; Structure databases: PDB, MMDB; Search Engines: Entrez, ARSA, SRS; Similarity Searching: BLAST and interpreting results; Multiple sequence alignment: ClustalW; Structure visualization of DNA and proteins using Rasmol.

Suggested Readings

Baxevanis AD. & Ouellette BFF. 2001. *Bioinformatics: A practical guide to the analysis of genes and proteins*. John Wiley and Sons.

Mount DW. 2001. *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor.

Xiong J.2006. *Essential Bioinformatics*. Cambridge University Press.

8. Plant Genetic Transformation 2+1

Theory

UNIT I

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

UNIT II

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

Practical

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

Suggested Readings

Green & Sambrook. 2014. *Molecular Cloning: A Laboratory Manual*. 4th Ed. 3 Vol Sets. Cold Spring Harbor Laboratory Press.

Grierson D. 2012. *Plant Genetic Engineering*. Springer Netherlands.

Primose SB & Twyman RM. 2006. *Principles of Gene Manipulation and Genomics*, 7th Ed. Black Well Publishing.

Sambrook J, Russel D. 2001. *Molecular Cloning: A Laboratory Manual*. 3rd Ed Cold Spring Harbor Laboratory Press.

Stewart NC Jr. 2008. *Plant Biotechnology and Genetics: Principles, Techniques and Applications*. John Wiley & Sons Inc.

9. Fundamentals of Electronics and Instrumentation in Biotechnology 1+1

Theory

UNIT I

Electronics

PN junction diode, diode forward and reverse characteristics; Diode as a circuit element; Application of PN junction diode such as: half wave, full wave bridge rectifier, clipper, clamper and voltage multiplier circuit; Construction and working of bipolar transistor,

load line concept, analysis and design of various biasing methods of NPN transistor with common emitter configuration; AC model and analysis of small signal NPN transistor with common emitter configuration; Concept of generalized instrumentation system; Transducers for the measurement of temperature using thermometer and thermocouple, linear displacement measurement using LVDT; Force measurement using the strain gauge.

UNIT II

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

Practical

To familiarize laboratory equipment and its equipment working; Forward and reverse VI Characteristics of a PN junction diode; To study half wave, full wave and bridge rectifier using diode; Clipper, Clamper and Voltage multiplier circuit; To determine input V-I Characteristics of bipolar transistor for common emitter configuration; To determine output V-I Characteristics of bipolar transistor for common emitter configuration; To analyse a biasing circuits for CE transistor; To design and test a biasing circuits for CE transistor; To study the measure of temperature using the available sensor; To measure displacement with the available sensor; To study force with the available sensor.

Suggested Readings

Edward William Golding & Frederick Charles Widdis. 1969. *Electrical Measurements and Measuring Instruments*. Pitman.

Gupta JB.2009. *Basic Electronics*. S. K. Kataria & Sons.

Malvino. 2007. *Electronics Principles*. Tata McGraw-Hill Education.

Manhas P. & Thakral S. 2010. *Digital Electronics*. S. K. Kataria & Sons.

Sharma Sanjay. 2012. *Electronics Devices & Circuits*. S. K. Kataria & Sons.

10. Classical and Molecular Cytogenetics 2+1

Theory

UNIT I

Introduction and history; Mitosis and meiosis; Structure of chromatin; Chromosome structure and chromosome landmarks; Specialized chromosomes; Differential staining of the chromosomes- Q-banding, G banding, C banding, R banding; *In situ* hybridization- FISH, GISH.

UNIT II

Changes in chromosome number: aneuploidy- monosomy, trisomy and tetrasomy, haploidy and polyploidy- autopolyploidy and allopolyploidy; Methods of doubled

haploid production; Structural aberrations of chromosomes: deletions, duplications, inversions and translocations; Locating genes on chromosomes; Genome analysis.

Practical

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

Suggested Readings

Becker K & Hardin. 2004. *The World of Cell*. 5th Ed. Pearson Edu.

Carroll M. 1989. *Organelles*. The Guilford Press.

Charles B. 1993. *Discussions in Cytogenetics*. Prentice Hall.

Gupta PK. 2007. *Cytogenetics*. Rastogi publications.

Khush GS. 1973. *Cytogenetics of Aneuploids*. Academic Press.

Mahabal Ram. 2010. *Fundamentals of cytogenetics and genetics*. PHI Learning Pvt. Ltd.

Yao-Shan Fan. 2002. *Molecular Cytogenetics: Protocols and Applications*. Humana Press.

11. Immunology 2+1

Theory

UNIT I

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

UNIT II

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

Practical

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

Suggested Readings

Murphy K. 2012. *Janeway's Immuno Biology*. 8th Ed. Garland Science/ Taylor & Francis Group.

Owen JA, Punt J, Kuby J & Sharon A. 2013. *Kuby Immunology*. 7th Ed. W.H. Freeman

12. Molecular Genetics 2+0

Theory

UNIT I

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

UNIT II

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

Suggested Readings

Allison LA. 2011. *Fundamental Molecular Biology*. Wiley Global Education.

Brown TA. 1998. *Genetics: A Molecular Approach*. 3rd Ed. Stanley Thornes.

Lewin B. 2009. *Genes 9*. Jones & Bartlett Learning.

Tropp BE. 2014. *Principles of Molecular Biology*. Jones & Bartlett Learning.

Tropp BE. 2012. *Molecular Biology Genes to Proteins*. 4th Ed. Jones & Bartlett Learning.

13. Nanobiotechnology 2+0

Theory

UNIT I

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

UNIT II

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

Suggested Readings

David E. Reisner. 2009. *Bionanotechnology: Global Prospects*. CRC Press.

Gabor L. Hornyak, John J. Moore, Tibbals HF., Joydeep Dutta. 2008. *Fundamentals of Nanotechnology*. CRC Press.

Jesus M. de la Fuente, V. Grazu. 2012. *Nanobiotechnology: Inorganic nanoparticles Vs Organic nanoparticles*. Elsevier.

Yubing Xie. 2012. *The Nanobiotechnology Handbook*. CRC Press.

14. Animal Biotechnology 3+1

Theory

UNIT-I

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

UNIT II

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

UNIT III

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

Practical

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

Suggested Readings

Aberle Elton D, Forrest John C, Gerrard David E & Mills Edward W. 2012. *Principles of Meat Science*. 5th Ed. Kendall Hunt Publishing.

Lawrie & Ledward. Lawrie's. 2006. *Meat Science*. 7th Ed. Woodhead Publishing.
Sukumar De. 1997. *Outlines of Dairy Technology*. Oxford University Press-New Delhi.

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

Varnam A & Jane P. 1994. *Milk and Milk Products: Technology, Chemistry and Microbiology*. Sutherland Springer Science & Business Media.

15. Molecular Marker Technology 2+0

Theory

UNIT I

Types of molecular markers- RFLP; PCR based markers like RAPD, SCAR, SSR, STS, CAPS, AFLP, SNP and their variants; Uses of molecular markers: Application as a genetic tool for genotyping and gene mapping; Mapping populations: F₂, DH, RILs, NILs; Bulk segregant analysis; Linkage maps; Physical maps.

UNIT II

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

Suggested Readings

Huges S. & Moody A. 2007. *PCR: Methods Express*. Royal College of General Practitioners.

16. Genomics and Proteomics 3+0

Theory

UNIT I

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

UNIT II

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

UNIT III

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

Suggested Readings

Branden C & Tooze J. 1999. *Introduction to Protein Structure*. 2nd Ed. Garland Science.

Connor DO & Hames BD. 2007. *Proteomics: Methods Express*. Royal College of General Practitioners.

Pennington S R & Dunn M J. 2001. *Proteomics from protein sequence to function*. BIOS Scientific Publishers Ltd.

Singer M & Berg P. 1991. *Genes & Genome*. University Science Books.

Tropp BE. 2012. *Molecular Biology Genes to Proteins*. 4th Ed. Jones & Bartlett Learning

17. IPR, Biosafety and Bioethics 2+0

Theory

UNIT I

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

UNIT II

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

Suggested Readings

Singh BD. 2007. *Biotechnology: Expanding Horizon*. Kalyani Publishers.

<http://patentoffice.nic.in>

www.wipo.org

www.dbtindia.nic.in

www.dbtbiosafety.nic.in

18. Computational Biology 2+1

Theory

UNIT I

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

UNIT II

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

UNIT III

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

Practical

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

Suggested Readings

Creighton TE. 1993. *Proteins: Structures and Molecular Properties* 2nd Edition. W.H Freeman.

- DovStekel. 2003. *Microarray Bioinformatics*. 1st Ed. Cambridge University Press.
- Mount D. 2001. *Bioinformatics: Sequence and Genome Analysis*, 2nd Ed. Cold Spring Harbor Laboratory Press.
- Malcolm Campbell A. & Laurie J. Heyer. 2007. *Discovering Genomics, Proteomics and Bioinformatics*. 2nd Ed. Benjamin Cummings.
- Setubal Joao & Meidanis Joao. 2004. *Introduction to Computational Molecular Biology*, PWS Publishing Company.

19. General Biochemistry 3+1

Theory

UNIT I

Introduction and importance; Cell structure; Bio molecules: Carbohydrates, lipids, proteins and nucleic acids - structure, functions and properties; Enzymes: Classification, factors affecting activity; Structure and role of water in biological system; Acids, bases and buffers of living systems; The pK of biomolecules; Vitamins and hormones.

UNIT II

Bioenergetics; Metabolism - basic concept: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Oxidative phosphorylation, Fatty acid oxidation; General reactions of amino acid degradation; Biosynthesis - carbohydrates, lipids, proteins, nucleic acids.

UNIT III

Secondary metabolites: Terpenoids, alkaloids, phenolics and their applications in food and pharmaceutical industries.

Practical

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

Suggested Readings

- Berg JM, Tymoczko JL, & Stryer L. 2002. *Biochemistry*. 5th Ed. W.H. Freeman & Co.
- Com EE & Stumpf PK. 2010. *Outlines of Biochemistry*. 5th Ed. John Wiley Publications.
- Goodwin, TW & Mercer EI. 1983. *Introduction to Plant Biochemistry*. 2nd Ed. Oxford, New York. Pergaman Press.
- Murray RK, David B., Botham KM & Kennelly PJ. 2012. *Harper's Illustrated Biochemistry*. 29th Ed. Lange Medical Books/Mc. Graw Hill.
- Nelson DL & Cox MM. 2000. *Lehninger Principles of Biochemistry*. 5th Ed. C.B.S Publilshers, Prentice Hall.

Wilson K & Walker J. 1994. Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed. Cambridge University Press.

20. Enzymology and Enzyme Technologies 2+1

Theory

UNIT I

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

UNIT II

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

Practical

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

Suggested Readings

Bisswanger H. 2011. *Practical Enzymology*. 2nd Ed. Wiley-Blackwell.

Cook PF & Cleland WW. 2007. *Enzyme Kinetics and Mechanism*. Garland Publishing Inc.

Cornish-Bowden A. 2012. *Fundamentals of Enzyme Kinetics*. 4th Ed. Wiley-Blackwell.

Price NC & Stevens L. 1999. *Fundamentals of Enzymology: Cell and Molecular Biology of Catalytic Proteins*. 3rd Ed. Oxford University Press.

21. Biodiversity and its Conservation 2+0

Theory

UNIT I

Concepts of biodiversity, bioresource and wildlife management, conservation strategies: *in situ* and *ex situ* conservation; Wild life conservation projects in India; Protection of biodiversity for its suitable utilization; Threats to biodiversity; WCU Red data book; Biodiversity hotspots in India; National bureaus of genetic resources.

UNIT II

Sustainable development; Diversification of cropping system; Diversity of indigenous livestock; Vulnerability and extinction of flora and fauna; Endangered species in various

ecosystems; Germplasm banks; Environmental impact assessment; Bioremediation and biosafety; Introduction to regulatory agencies and legislation.

Suggested Readings

Das MK & Choudhury BP. 2008. *A Text book on Plant Nomenclature and Biodiversity Conservation*. Kalyani Publishers.

Hopsetti BB. & Venketashwarlaru M. 2001. *Trends in Wild Life Conservation and Management*. Vol. 2, Daya Publishing House.

Singh MP & Singh BS. 2002. *Plant Biodiversity and Taxonomy*. Daya Publishing House, Delhi.

22. Microbiology 2+1

Theory

UNIT I

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

UNIT II

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

UNIT III

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

Practical

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

Suggested Readings

Brock TD. 1961. *Milestones in Microbiology*. Infinity Books.

Pelczar MJ, Chan ECS & Kreig NR. 1997. *Microbiology: Concepts and Application*. Tata McGraw Hill.

Stainier RY, Ingraham JL, Wheelis ML & Painter PR. 2003. *General Microbiology*. MacMillan.

Tauro P, Kapoor KK & Yadav KS. 1996. *Introduction to Microbiology*. Wiley Eastern.

23. Microbial Genetics 2+1

Theory

UNIT I

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

UNIT II

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

UNIT III

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

Practical

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

plasmid; Identification of plasmid by electrophoresis / antibiotic plates.

Suggested Readings

Birge EA. 1981. *Bacterial and Bacteriophage Genetics*. Springer Verlag.

Gardner JE, Simmons MJ & Snustad DP. 1991. *Principles of Genetics*. John Wiley & Sons.

Lewin B. 1999. *Gene*. Vols. VI-IX. John Wiley & Sons.

Maloy A & Friedfelder D. 1994. *Microbial Genetics*. Narosa.

Scaife J, Leach D & Galizzi A 1985. *Genetics of Bacteria*. Academic Press.

William Hayes 1981. *Genetics of Bacteria*. Academic Press.

Student READY programme

Student READY - In-house Skill Development Modules 0+20

Four Modules (Only one to be opted as per chosen elective)

1. Plant Biotechnology
2. Animal Biotechnology
3. Microbial and Environmental Biotechnology
4. Bioinformatics

Evaluation Criteria:

Activity within each Module	Marks Distribution (%)
Attendance	10
Mid-term	25
Practical Assignments	15
Final Exam for Practical Skill Assessment	40
Oral Examination	10

Student READY - Project Formulation, Execution and Presentation 0+10

Evaluation Criteria:

Parameter	Marks Distribution (%)
Project Formulation and Implementation	20
Work Performance	30
Regularity, General Conduct and Discipline	10
Initiative and Creativity	10
Final Presentation	15
Final Project Report	15

Student READY - Entrepreneurial Development in Biotechnology 0+10

Micropropagation; DNA fingerprinting; Genetic purity for maintenance breeding; Marker assisted selection; Haploid production; Database Management skills; Molecular Diagnostics; Recombinant protein production; Animal cell culture and maintenance; Fermentation, Biopharma production; Bioprocess enrichment; Bioremediation; Biofuels, etc.

Evaluation Criteria:

Parameter	Marks Distribution (%)
Project Planning, Writing and Presentation	20
Regularity	10
Monthly Assessment	10
Output Delivery	15
Technical Skill Development	15
Entrepreneurial and Business Networking Skills	10
Report Writing	10
Final Presentation	10

ELECTIVES (Semester VI): 18 Credit hours

Four electives each of 18 credit hours will be offered to B.Tech. Biotechnology students during VI semester of the degree programme. The students will have to choose only one out of the four electives.

ELECTIVE I

PLANT BIOTECHNOLOGY

1. Plant Tissue Culture and its Applications 2+1

Theory

UNIT I

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

UNIT II

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

Practical

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

Suggested Readings

- Bhojwani SS & Razdan MK. 1996. *Plant Tissue Culture: Theory and Practice*. Elsevier.
- Debergh PC & Zimmerman RH. 1991. *Micropropagation: Technology and Application*. Kluwer Academic.
- Dixon RA & Gonzales RA. 2003. *Plant Cell Culture: A Practical Approach*. Oxford University press.
- George EF, Hall MA & Klerk GJD. 2007. *Plant Propagation by Tissue Culture*. 3rd Ed. Volume 1. Springer Science & Business Media.

2. Principles and Applications of Plant Genetic Transformation 2+1

Theory

UNIT I

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

UNIT II

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

Practical

Gene isolation and gene cloning; Gene constructs and their maintenance; *Agrobacterium* mediated genetic transformation; Particle gun mediated genetic transformation.

Histochemical GUS assays; PCR screening of putative transgenic plants; Raising transgenic under containment and field conditions.

Suggested Readings

Bhojwani SS & Dantu PK. 2013. *Plant Tissue Culture: An Introductory Text*. Springer
Brown TA. 2007. *Gene Cloning & DNA Analysis: An Introduction*. 6th Ed. Wiley-
Blackwell Publishing.

Grierson D. 2012. *Plant Genetic Engineering*. Springer Netherlands.

Lal R & Lal S. 1990. *Crop Improvement Utilizing Biotechnology*. CRC Press.

Primose SB & Twyman RM. 2006. *Principles of Gene Manipulation and Genomics*. 7th
Ed. Wiley-Blackwell Publishing.

3. Applications of Genomics and Proteomics 2+1

Theory

UNIT I

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

UNIT II

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

Practical

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

Suggested Readings

Connor DO & Hames BD. 2007. *Proteomics: Methods Express*. Royal College of
General Practitioners.

Pennington S R, Dunn M J. 2001. *Proteomics from protein sequence to function*. BIOS
Scientific Publishers Ltd.

Singer M & Berg P. 1991. *Genes & Genome*. University Science Books.

Tropp BE. 2012. *Molecular Biology Genes to Proteins*. 4th Ed. Jones & Bartlett
Learning.

Verma PS & Agarwal VK. 2014. *Cell Biology, Genetics, Molecular Biology, Evolution
and Ecology*. S. Chand & Company Pvt. Ltd.

4. Molecular Breeding in Field Crops 2+1

Theory

UNIT I

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

UNIT II

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

UNIT III

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

Practical

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

Suggested Readings

Nagat T, Lorz H & Widholm JM. 2008. *Biotechnology in Agriculture and Forestry*. Springer.

Trivedi PC. 2000. *Plant Biotechnology: Recent Advances*. Panima Publishers.

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

Theory

UNIT I

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

UNIT II

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

Practical

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

Suggested Readings

- J S Bal. 2013. *Fruit Growing*. Kalyani Publishers.
- Kumar N. 2006. *Breeding of Horticultural crops: Principles and Practices*. New India Publishing Agency.
- K. L. Chada. 2012. *Handbook of Horticulture*. ICAR.
- Kumar J. Prasad. 2010. *Handbook of Fruit Production*. Agrobios.
- Schnell RJ & Priyadarshan PM. 2012. *Genomics of Tree Crops*. Springer.
- Singh Jitender. 2014. *Basic Horticulture*. Kalyani Publishers.
- Singh Ranjit. 2012. *Fruits*. National Book Trust.
- Spangenberg G. 2001. *Molecular Breeding of Forage Crops*. Kluwer Academic Publishers.
- Victor Ray Garden, Frederick Charles Bnaford, Herry & Daggett HoDlor Ir. 1992. *Fundamentals of Fruit Production*. Mc Graw Book Company.

6. Epigenetics and Gene regulation 2+1

Theory

UNIT I

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

UNIT II

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

Practical

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

Suggested Readings

Green & Sambrook. 2014. *Molecular Cloning: A Laboratory Manual*. 4th Ed. Vol I, II & III Cold Spring Harbor Laboratory Press.

Mohanpuria P, Kumar V, Mahajan M, Mohammad H & Yadav SK. 2010. *Gene Silencing: Theory, Techniques and Applications: Genetics-Research and Issues*. Nova Science Publishers.

ELECTIVE II

ANIMAL BIOTECHNOLOGY

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

Practical

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

Suggested Readings

Butler M. 2003. *Animal Cell culture & Technology*. Garland Science.

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

2. Animal Genomics 2+1

Theory

UNIT I

Genome organization in eukaryotes; Satellite DNA: VNTRs & families, LINE & 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, Chromosomal aberrations and evolution.

UNIT II

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

Practical

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

Suggested Readings

Brown TA. 2006. *Genomes*. 5th Ed. Wiley-Blackwell.

Dale JW, Schantz MV & Plant N. 2012. *From Genes to Genomes: Concepts and Applications of DNA Technology*. John Wiley & Sons.

Green & Sambrook. 2014. *Molecular Cloning: A Laboratory Manual*. 4th Ed. Vol I, II & III. Cold Spring.

Reece RJ. 2004. *Analysis of Genes & Genomes*. Wiley.

3. Embryo Transfer Technologies 2+1

Theory

UNIT I

History, advantages, limitations and scope of embryo transfer technology; Estrus cycle and its detection in animals; Methodology of super ovulation; Ovum pick up (OPU);

Preparation of sperm for *in vitro* fertilization (IVF); Embryo grading and culture; Micromanipulation and immuno-modulation for enhancement of fecundity.

UNIT II

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

Practical

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

Suggested Readings

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

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

4. Transgenic Animal Production 3+0

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

Suggested Readings

Ramadass P. 2008. *Animal Biotechnology: Recent Concepts and Developments*. MJP Publishers.

Ranga MM. 2007. *Animal Biotechnology*. Agrobios.

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

Singh B. Gautam SK & Chauhan MS. 2014. *Textbook of Animal Biotechnology*. The Energy and Resources Institute, TERI.

5. Molecular Diagnostics

2+1

Theory

UNIT I

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

UNIT II

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

Practical

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

Suggested Readings

Debnath M, Prasad GBKS & Bisen PS. 2010. *Molecular Diagnostics: Promises and Possibilities*. Springer Science & Business Media.

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

Viljoen, GJ, Nel LH & Crowther JR. 2005. *Molecular Diagnostic PCR Handbook*. Springer Science & Business Media.

Wilson K & Walker J. 2010. *Principles and Techniques of Biochemistry and Molecular Biology*. Cambridge University Press.

6. Molecular Virology and Vaccine Production 2+1

Theory

UNIT I

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

UNIT II

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

Practical

Processing of clinical specimens for isolation of viruses; Cultivation of viruses in cell cultures and embryonated eggs; Harvesting of virus; Study of cytopathic effects; Titration of virus and estimation of TCID₅₀; Haemagglutination and Haemagglutination Inhibition test; Detection of virus by SNT, AGID and ELISA.

Suggested Readings

- John Carter J & Saunders V. 2007. *Virology: Principles and Applications*. 2nd Ed. Wiley.
- Morrow WJW, Sheikh NA, Schmidt CS, Davies DH. 2012. *Vaccinology: Principles and Practice*. John Wiley & Sons.
- Sharma S & Adlakha S. 1996. *Textbook of Veterinary Microbiology*. Vikas Publishing House Pvt Ltd.
- Stephenson J & Warnes R. 1998. *Diagnostic Virology Protocols*. Springer Science & Business Media.

ELECTIVE III

MICROBIAL AND ENVIRONMENTAL BIOTECHNOLOGY

1. Microbial Biotechnology 2+1

Theory

UNIT I

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

UNIT II

Biotransformation and biodegradation of pollutants, biodegradation of lignocelluloses and agricultural residues; Biotechnological treatment of waste water, sewage and sludge;

Industrial production of alcohols, ethanol, acids (citric acid, acetic acid), solvents (glycerols, acetone, butanol), antibiotics (penicillin, streptomycin, tetracycline), amino acids (lysine, glutamic acid), single cell proteins; Recombinant and synthetic vaccines.

Practical

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

Suggested Readings

Glaze AN & Nikaido H. 2007. *Microbial Biotechnology: Fundamentals of Applied Microbiology*. 2nd Ed. Cambridge University Press.

Mohapatra PK. 2006. *Text Book of Environmental Biotechnology*. International Publishing House Pvt. Ltd.

2. Bio-prospecting of Molecules and Genes 3+0

Theory

UNIT I

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

UNIT II

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

UNIT III

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

Suggested Readings

Mohapatra PK. 2006. *Text Book of Environmental Biotechnology*. International Publishing House Pvt. Ltd.

Sharma PD. 2012. *Ecology and Environment*. 11th Ed. Rastogi Publications.

3. Molecular Ecology and Evolution 3+0

Theory

UNIT I

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

UNIT II

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

UNIT III

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

Suggested Readings

Beebe T & Rowe G. 2008. *An Introduction to Molecular Ecology*. 2nd Ed. Oxford University Press.

Brown TA. 2007. *Genome 3*. Garland Science Publishing.

Carvalho GR. 2002. *Advances in Molecular Ecology*. IOS Press Netherland.

4. Molecular Pharming and Biopharmaceuticals 2+1

Theory

UNIT I

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

UNIT II

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

Practical

Isolation & purification of proteins from microbes and plants; Production of recombinant proteins in prokaryotes; Analysis of proteins by one and two dimensional gel

electrophoresis; Affinity chromatography; Immunoblotting; Cell culture and immobilization techniques. Visit to biopharmaceutical industry.

Suggested Readings

Brown TA. 2010. *Gene Cloning and DNA analysis: An Introduction*. 6th Ed. Wiley-Blackwell Publishing.

Kirkosyan A & Kaufman PB. 2009. *Recent Advances in Plant Biotechnology*. Springer.

Primrose SB & Twyman RM. 2013. *Principles of Gene Manipulation and Genomics*. John Wiley & Sons.

5. Food Biotechnology 2+1

Theory

UNIT I

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

UNIT II

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

Practical

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

Suggested Readings

Hui YH & Khachatourians GG. 1995. *Food Biotechnology: Microorganisms*. Wiley-VCH

Shetty K, Paliyath G, Pometto A. & Levin RE. 2006. *Food Biotechnology*. 2nd Ed. CRC Press.

6. Green Biotechnology 2+1

Theory

UNIT I

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

UNIT II

Carbon sequestration; Methanogenic microbes for methane reduction; Microbes for phytic acid 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.

Practical

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

Suggested Readings

Kirkosyan A & Kaufman PB. 2009. *Recent Advances in Plant Biotechnology*. Springer.

Kumar A. 2004. *Environmental Biotechnology*. Daya Publishing House.

Murray DC. 2011. *Green Biotechnology*. Dominant Publishers and Distributors.

ELECTIVE IV BIOINFORMATICS

1. Programming for Bioinformatics 2+2

Theory

UNIT I

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

UNIT II

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

Practical

UNIT I

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

UNIT II

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

Suggested Readings

Balagurusamy. 2008. *Programming in ANSI C*. Tata McGraw-Hill Education.

James Tisdall. 2003. *Mastering Perl for Bioinformatics*. O'Reilly Media.

Tom Christiansen, Brian D Foy, Larry Wall & Jon Orwant. 2012. *Programming Perl*. 4thEd. O'Reilly Media.

Kanetkar Yashavant. 2013. *Let Us C*. BPB Publications.

2. Bioinformatics Tools and Biological databases 2+1

Theory

UNIT I

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

UNIT II

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

UNIT III

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

Practical

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

Suggested Readings

Baxevanis AD, Ouellette BFF. 2001. *Bioinformatics: A practical guide to the analysis of genes and proteins*. John Wiley and Sons.

Mount DW. 2001. *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor.

Xiong J. 2006. *Essential Bioinformatics*. Cambridge University Press.

3. Structural Bioinformatics 2+1

Theory

UNIT I

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

UNIT II

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

UNIT III

Structure prediction: Basics of protein folding, protein folding problem, molecular chaperons; Secondary structure prediction methods and algorithms: Homology, *ab initio* and folding based tertiary structure prediction; Structure validation tools, energy minimization techniques; Introduction to molecular dynamics and simulation, Monte-Carlo methods, Markov chain and HMM; Structure visualization and comparison methods.

Practical

Protein structural classification databases, 3D-Structural databases searching and retrieval, Ramchandran Plot, Structural visualization tools, Tools for protein secondary and tertiary structure prediction; RASMOL, Cn3D, CHIMERA, SWISSPDBviewer, CPH, MODELLER, SWISS Model, EasyModeler, Procheck; GROMAC; SANJIVNI; BHAGIRATH.

Suggested Readings

- A.Malcolm Campbell & Laurie J.Heyer. 2007. *Discovering Genomics, Proteomics and Bioinformatics*. Benjamin Cummings.
- Allan Hinchcliffe. 2008. *Modeling for Beginners*. Wiley.
- Creighton TE. 1993. *Proteins: Structures and Molecular Properties*. W.H. Freeman
- Mount DW. 2001. *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor.
- Setubal Joao & Meidanis Joao. 1997. *Introduction to Computational Molecular Biology*. PWS Publishing Company

4. Pharmacogenomics 2+1

Theory

UNIT I

Basic concepts of pharmacogenomics, clinical application and challenges in pharmacogenomics; Human Genome Project, genetic diseases, personalized medicine and pharmacogenomics necessity in drug designing; Prediction of structural changes among

sequence variants and genetic analysis; Microsatellites for studying genetic variations; Drug databanks; Gene therapy.

UNIT II

Drug Design: Study of important drug targets and their variations; Pharmacophore designing, prediction of ADME properties; Computational tool for toxicity prediction; SAR and QSAR techniques in drug designing; Drug receptor interactions; Structural based drug design; Lipinski's rule in drug design.

Practical

Receptor-Ligand interactions, Pharmacophore development; OSDD; DrugBank; PubChem; molecular representation using SMILES; ChemsKetch: 2D and 3D structure; Structure analyses using Chimera/VMD; Detection of active site of proteins using various software; bioavailability using Mol inspiration; Docking using HEX and AUTODOCK.

Suggested Readings

Allan Hinchcliffe. 2008. *Modeling for Beginners*. Wiley- Blackwell Publishing.

Gerd Folkers, Wolfgang Sippl, Didier Rognan & Hans Dieter. 2003. *Molecular Modeling : Basic Principles and applications*. Science.

Gupta S.P. 1996. *Quantum Biology*. New Age.

Lisa B. *Combinatorial Library Methods and Protocols*

5. Metabolomics and System Biology 2+1

Theory

UNIT I

Metabolomics overview, major metabolic pathways: Glycolysis, Krebs's cycle, oxidative phosphorylation, amino acid, fatty acid and nucleotide metabolism, their control and integration; Metabolic flux and metabolic profiling; Catalytic mechanisms and enzyme kinetics, Michaelis-Menton kinetics; Conformational change, allosteric regulations, regulation of metabolic pathways; Signal transduction: Inter and intra cellular communications; Receptor ligand interaction; Structural components of signal pathways: G-protein, Jak-stat, receptor tyrosine kinase.

UNIT II

Signal Flow: Pathway to networks, small scale system biology experiments; System analysis of complex diseases, system pharmacology; Assembling large data sets in genomics and proteomics, computational analysis of large data sets, building networks; Mathematical representation of cell biological system, time and space.

Practical

Metabolic pathway databases KEGG, BRENDA, Biosilico, Protein-protein interaction databases, Swiss 2D PAGE, E-PCR; Creating networks using Cytoscape, DAVID, MAS3; in silico functional annotation using GO, AGRIGO, PANTHER, BLAST2GO.

Suggested Readings

Berg JM, Tymoczko JL & Stryer L. 2002. *Biochemistry*. 5th Ed. W.H. Freeman and Company.

Fersht A. 1999. *Structure and Mechanism of protein science*. W.H. Freeman and Company.

Klipp E, Herwig R, Kowald A, Wierling C, Lehrach H. 2006. *Systems Biology in practice. Concepts, implementation and Application*. Wiley VCH.

Vaidynathan S, Harrigan GG, Royston Goodacre. 2005. *Metabolome analysis: Strategies for system biology*. Springer.

Voet D & Voet J. 2002. *Biochemistry* 3rd Ed. John Wiley and Sons.

6. Computational Methods for Data Analysis 1+1

Theory

UNIT I

Introduction to UNIX/LINUX operating system; Knowledge discovery and data mining techniques; Machine learning and pattern recognitions, hidden markov models; Artificial neural networks, Support vector machines.

UNIT II

Principal component analysis, ANOVA; AMOVA and different clustering methods; Gene Prediction algorithms and Phylogeny algorithms; Basics of R statistical package.

Practical

Gene prediction: FGENESH; R statistical package installation and configuration, GUI for R: R-commander, R-studio, Rkward; Analysis of gene expression using R; GNU PSPP, Scilab, QtiPlot.

Suggested Readings

Gareth James, Daniela Witten, Trevor Hastie & Robert Tibshirani. 2013. *An Introduction to Statistical Learning: with Applications in R*. Springer

Mathur K Sunil. 2010. *Statistical Bioinformatics with R*. Elsevier.

Agriculture Courses

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

1. Crop Production Technology 2+1

Theory

UNIT I

Soil and its components; Soil morphological, physical, chemical and biological properties; Acidic, saline and alkali soils and their reclamation; Essential plant nutrients:

Functions and deficiency symptoms; Soil micro-organisms; Rhizosphere and its domain in soil; Organic manures and inorganic fertilizers.

UNIT II

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

UNIT III

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

Practical

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

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

Suggested Readings

- Acquaah G. 2005. *Principles of Crop Production: Theory, Techniques and Technology*. Prentice Hall.
- Alexander M. 1977. *Introduction to Soil Microbiology*, 2nd Edition. John Wiley & Sons.
- Balasubranianyan P & Palaniappan SP. 2010. *Principles and Practices of Agronomy*. Agrobios.
- Brady NC & Well RR. 2002. *The Nature and Properties of Soils*, Thirteenth Edition. Pearson Prentice Hall.
- Chandrasekaran B, Annadural K & Samasundaram E. 2010. *A Text Book of Agronomy*. New Age International (P) Limited Publishers.
- Das DK. 2011. *Introductory Soil Science*. Third Revised Edition, Kalyani Publishers.
- Reddy SR. 2011. *Principles of Agronomy*. Kalyani Publishers.

2. Production Technologies for Horticultural Crops 2+1

Theory

UNIT I

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

UNIT II

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

UNIT III

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

Practical

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

Suggested Readings

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

Bal JS. 2013. *Fruit Growing*. Kalyani Publishers.

Chadha KL. 2012. *Handbook of Horticulture*. ICAR

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

3. Basics of Plant Breeding

2+1

Theory

UNIT I

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

UNIT II

Methods of breeding: Introduction and Acclimatization; Selection: Mass selection, Johannesen's pure-line theory, genetic basis, pure-line selection; Hybridization: Aims and objectives, types of hybridization; Methods of handling segregating generations: Pedigree method, bulk method, back cross method; Heterosis, inbreeding depression, various theories of heterosis, exploitation of hybrid vigor, Hardy Weinberg law, selection in cross pollinated crops; Population improvement programmes; Synthetics and composites; Methods of breeding vegetatively propagated crops.

UNIT III

Chopra VL 2001. *Breeding Field Crops*. Oxford and IBH Publishing Co.

Fehr WR. 1987. *Principles of Cultivar Development, Vol. II Crop Species*. MacMillan Publishing Co.

Sleper DA & Poehlman JM. 2006. *Breeding Field Crops*. Wiley-Blackwell.

5. Fundamentals of Crop Protection 2+1

Theory

UNIT I

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

UNIT II

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

Practical

Familiarization with generalized insect's body structure and appendages; Life stages; Acquaintance with insect diversity; Identification of important insect-pests of cereals, cotton, oilseeds, pulses, sugarcane, fruit and vegetables crops and stored-grains, and their symptoms of damage; Acquaintance with useful insects: predators, parasitoids, pollinators, honey bees and silk worms; Acquaintance with various pesticidal formulations; Principles and working of common plant protection appliances; Calculation for preparing spray material; Acquaintance to plant pathology laboratory equipment; Preparation of culture media for fungi and bacteria; Demonstration of Koch's postulates; Study of different groups of fungicides and antibiotics and methods of their evaluation; Diagnosis and identification of important diseases of cereals, cotton, oilseeds, pulses, sugarcane, fruit and vegetables crops and their characteristic symptoms.

Suggested Readings

Agrios, GN. 2010. *Plant Pathology*. Acad. Press.

Atwal AS & Dhaliwal GS. 2002. *Agricultural Pests of South-Asia and Their Management*. Kalyani Publishers.

Dhaliwal GS & Arora R. 1996. *Principles of Insect Pest Management*. National Agriculture Technology Information Centre.

- Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology*. Kalyani Publishers.
- Mehrotra RS & Aggarwal A. 2007. *Plant Pathology*. 7th Ed. Tata Mc Graw Hill Publ. Co. Ltd.
- Singh H. 1984. *House-hold and Kitchen Garden Pests - Principles and Practices*. Kalyani Publishers.
- Singh RS. 2008. *Plant Diseases*. 8th Ed. Oxford & IBH. Pub. Co.
- Singh RS. 2013. *Introduction to Principles of Plant Pathology*. Oxford and IBH Pub. Co.
- Stakman EC & Harrar JG. 1957. *Principles of Plant Pathology*. Ronald Press, USA.
- Tarr SAJ. 1964. *The Principles of Plant Pathology*. McMillan, London.
- Vander Plank, JE. 1975. *Principles of Plant Infection*. Acad. Press.

Animal Science Courses

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

1. Anatomy and Physiology of Livestock 3+0

Theory

UNIT I

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

UNIT II

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

UNIT III

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

Suggested Readings

Keith Dyce & Wolfgang Sack & Wensing CJG. 2009. *Textbook of Veterinary Anatomy*, 4th Edition. Elsevier Health Sciences.

Rowen D. Frandson, W. Lee Wilke & Anna Dee Fails. 2009. *Anatomy and Physiology of Farm Animals*. 7th Edition. Wiley–Blackwell.

William O, Reece. 2004. *Duke's Physiology of Domestic Animals*. 12th Edition. Comstock Publishing Associates.

2. Introduction to Animal Breeding 2+1

Theory

UNIT I

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

UNIT II

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

UNIT III

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

Practical

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

Suggested Readings

Brah GS. 2014. *Animal Genetics: Concepts and Implications*. 2nd Ed. Kalyani Publishers.

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

Richard M. Bourdon. 1999. *Understanding Animal Breeding*. 2nd Ed. Prentice Hall.

3. Livestock Production and Management 2+1

Theory

UNIT I

Livestock history in India: Vedic, medieval and modern era; Demographic distribution of livestock and role in economy; Introductory animal husbandry; Breeds of livestock; Cattle, Buffalo, Sheep, Goat and Pig; Important traits of livestock; General management and feeding practices of animals; Handling and restraining of animals; Housing systems. Importance of grasslands and fodders in livestock production; Common farm management practices including disinfection, isolation, quarantine and disposal of carcass; Common vices of animals and their prevention; Diseases and parasite control & hygiene care.

UNIT II

History and economic importance of poultry; Poultry breeds; Reproductive system of male and female birds; Formation and structure of eggs; Important economic traits of poultry, Egg production, Egg weight, Egg quality; Fertility and Hatchability, Plumage characteristics and comb types.

Care and management of chicks, grower and layers/broiler; Brooding management; Hatchery practices; Poultry Diseases, control and hygiene care;

Practical

Visit to livestock farms/demonstration centres; Breeds of cattle, buffalo, sheep, goat and Pigs; Familiarization with body parts of animals; Handling and restraining of cattle, buffalo, sheep, goat and swine; Male and female reproductive system and Artificial Insemination; Feeding of livestock; Methods of identification: marking, tattooing, branding, tagging; Milking methods; Record Keeping

Visit to the Poultry farm; Poultry breeds; Body parts of chicken, duck, quail and turkey; Housing, equipment, nesting and brooding requirements; Male and female reproductive system; Methods of identification and sexing; Hatchery layout and equipment; Identification of diseases and control of parasites, Vaccination; Maintenance of farm records;

Suggested Readings

Banerjee GC. 1989. *Text Book of Animal Husbandry*. Oxford and IBH.

ICAR. 1962. *Handbook of Animal Husbandry*. ICAR Publication.

Parsad Jagdish. 2001. *Poultry Production and Management*. Kalyani Publishers.

Sastry NSR & Thomas CK. 1991. *Dairy Bovine Production*. Kalyani Publishers.

Singh RA. 1990. *Poultry Production*. Kalyani Publishers.

Thomas CK & Sastry NSR. 2013. *Livestock Production Management*. Kalyani Publishers.

4. Livestock Product Technology 2+1

Theory

UNIT I

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

UNIT II

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

Practical

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

Suggested Readings

Aberle ED, Forrest JC, Gerrard DE & Mills EW. 2012. *Principles of Meat Science*. 5th Eds. Kendall Hunt Publishing

Ledward DA & Lawrie RA. 2006. *Lawrie's Meat Science*, 7th Eds. Woodhead Publishing
Sharma BD. 1999. *Meat and Meat Products Technology: Including Poultry Products Technology*. Jaypee Bros. Medical Publishers

Sukumar De. 2001. *Outlines of Dairy Technology*. Oxford University Press.

Varnam A & Sutherland JP. 2001. *Milk and Milk Products: Technology, Chemistry and Microbiology*. Springer Science & Business Media

5. Animal Health Care 2+1

Theory

UNIT I

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

UNIT II

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

Practical

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

Suggested Readings

Blood DC & Henderson JA. 1968. *Veterinary Medicine*. Bailliere Tindall publishers.

Bradford P & Smith DVM. 2014. *Large Animal Internal Medicine*. 5th edition. Mosby Publishers.

Chakrabarti Amalendu. 2007. *Textbook of Clinical Veterinary Medicine*. Kalyani Publishers.

Stephen J, Ettinger DVM, Edward C & Feldman DVM. 2010. *Textbook of Veterinary Internal Medicine Expert Consult*. 7th edition. Saunders Publishers.