B. Tech. (Biotechnology) Syllabus

The curriculum has a total of **177 credit hours** including **5 non-credit hours**.

1. General courses (8 Nos.) Total credit hours= 11+9= 20

Sl. No.	Course Code	Course Title	Credit hours	Department
1	BECO 2101	Economics and marketing	2+1	Agril. Econ.
2	BEXT 1101	Effective communication and personality development	1+1	Agril. Extn.
3	BEXT 1102	Human ethics	1+0	Agril. Extn.
4	BEXT 2203	Entrepreneurship development and business management	1+1	Agril. Extn.
5	BCOM 3101	Food science and processing	1+1	Community Science
6	BSAC 2203	Environmental studies and disaster management	2+1	SS&AC
7	BSTA 2103	Information and communication technology	1+1	Agril. Stat.
8	BSTA 3106	Agricultural informatics	1+2	Agril. Stat.
9	BENG 3102	Renewable energy and green technology	1+1	Agril. Engg.

2. Biotechnology Core Courses (24 Nos.) Total credit hours = 41 + 19=60

Sl. No.	Course Code	Course Title	Credit hours	Department
1	BENG 2201	Electronics and instrumentation in biotechnology	1+1	Agril. Engg. /Plant Biotech.
2	BMIC 1201	Fundamentals of microbiology	2+1	Agril. Micro.
3	BMIC 2202	Microbial genetics	1+1	Agril. Micro.
4	BPBG 1101	Basic genetics	2+1	Pl. Breed. & Gen.
5	BPBG 1102	Cell biology and cytogenetics	2+1	Pl. Breed. & Gen.
6	BPBG 1203	Biodiversity and bioprospecting	2+0	Pl. Breed. & Gen.
7	BPBG 3106	Molecular marker technology	1+1	Pl. Breed. & Gen.
8	BPBT 1101	Introduction to biotechnology	2+1	Plant Biotech.
9	BPBT 1202	Molecular biology	2+1	Plant Biotech.
10	BPBT 2103	Recombinant DNA technology	1+1	Plant Biotech.
11	BPBT 2104	Plant tissue culture	2+1	Plant Biotech.
12	BPBT 2105	Introductory bioinformatics	2+1	Plant Biotech.
13	BPBT 2206	Plant genetic transformation	1+1	Plant Biotech.
14	BPBT 2208	Animal biotechnology	2+1	Plant Biotech.
15	BPBT 2209	Molecular genetics	2+0	Plant Biotech.
16	BPBT 2210	Nanobiotechnology	2+0	Plant Biotech.
17	BPBT 2211	Genomics and proteomics	2+0	Plant Biotech.
18	BPBT 3112	Immunology	1+1	Plant Biotech.

19	BPBT 3113	Biosafety and IPR in biotechnology	2+0	Plant Biotech.
20	BPBT 3114	Computational biology	2+1	Plant Biotech.
21	BPBT 3115	Bioprocess engineering in biotechnology	2+1	Plant Biotech.
22	BSAC 1101	Principles of analytical chemistry	1+1	SS& AC
23	BSAC 1202	General biochemistry	2+1	SS & AC
24	BSAC 3104	Enzymology and enzyme technology	2+1	SS & AC

3. *Elective Courses in Biotechnology (one to choose) Total Credit Hours = 18

Sl. No.	Course Code	Course Title	Credit hours	Department
Elective I. Plant Biotechnology Total credit hours = 12 + 6 = 18				
1	BELB 3201	Commercial micropropagation of crop plants	2+1	Plant Biotech.
2	BELB 3202	Epigenetics and gene regulation	2+1	Plant Biotech.
3	BELB 3203	Omics in plant biotechnology	2+1	Plant Biotech.
4	BELB 3204	Principles and applications of plant genetic transformation	2+1	Plant Biotech.
5	BELG 3201	Molecular breeding of crop plants	2+1	Pl. Breed. & Gen.
6	BELP 3201	Molecular diagnosis of plant pathogens	2+1	Plant Path.
Elective II. Animal Biotechnology Total credit hours 13 + 5 = 18				
	BELB 3205	Principles and Procedures of Animal cell culture	2+1	Plant Biotech.
2	BELB 3206	Animal genomics	2+1	Plant Biotech.
3	BELB 3207	Embryo transfer technologies	2+1	Plant Biotech.
4	BELB 3208	Transgenic animal production	3+0	Plant Biotech.
5	BELP 3202	Molecular diagnostics	2+1	Plant Path.
6	BELP 3203	Molecular virology and vaccine production	2+1	Plant Path.
Elective III. Bioinformatics Total credit hours= 11 + 7 = 18				
1	BELB 3209	Programming for bioinformatics	2+2	Plant Biotech.
2	BELB 3210	Bioinformatics tools and biological databases	2+1	Plant Biotech.
3	BELB 3211	Structural bioinformatics	2+1	Plant Biotech.
4	BELB 3212	Pharmacogenomics	2+1	Plant Biotech.
5	BELB 3213	Metabolomics and system biology	2+1	Plant Biotech.
6	BELB 3214	Computational methods for data analysis	1+1	Plant Biotech.
Elective IV. Microbial and Environmental Biotechnology Total credit hours 14 + 4 = 18				
1	BELM 3201	Microbial biotechnology	2+1	Agril. Micro.
2	BELM 3202	Bio-prospecting of molecules and genes	3+0	Agril. Micro.
3	BELM 3203	Molecular ecology and evolution	3+0	Agril. Micro.

4	BELM 3204	Fundamentals of molecular pharming and biopharmaceuticals	2+1	Agril. Micro.
5	BELM 3205	Food biotechnology	2+1	Agril. Micro.
6	BELM 3206	Green biotechnology	2+1	Agril. Micro.

***Will be offered based on the availability of faculty and facility**

4. Basic Science Courses (8 Nos.) Total Credit hours = 13 + 6=19

Sl. No.	Course Code	Course Title	Credit hours	Department
1	BAHB 1101	Basic zoology	2+1	Animal Hus
2	BPBG 1204	Introduction to agricultural botany	2+1	Plant Breed. & Gen.
3	BPBT 2207	Biophysics	2+0	Plant Biotech.
4	BPHY 2101	Crop physiology	2+1	Plant Physiol.
5	BSTA 1101	Basic mathematics	2+0	Agril. Stat.
6	BSTA 1202	Basic statistics	1+1	Agril. Stat.
7	BSTA 2104	Biomathematics	1+1	Agril. Stat.
8	BSTA 3105	Biostatistics	1+1	Agril. Stat.

5. Agriculture & Allied Courses (6Nos.) Total Credit Hours = 10+ 5=15

Sl. No.	Course Code	Course Title	Credit hours	Department
1	BAGR 1101	Basic agronomy and production technology of major crops	2+1	Agronomy
2	BHOR 2101	Production technology for horticultural crops	2+1	PCS/VS/FS/FLA
3	BPBG 1205	Basics and methods of plant breeding	2+1	Pl. Breed. & Gen.
4	BPEN 1201	Fundamentals of crop protection	2+1	Plant Path. & Agril. Ento.
5	BPHT 2101	Postharvest technology	2+1	PHT

6. Student READY Programme (3 Nos.) Total Credit hours =0+40= 40

Sl. No.	Catalogue No.	Course Title	Credit hours	Department
1	BSRP 4101 BSRP 4102 BSRP 4103 BSRP 4104	In-house Skill Development Modules 1. Plant biotechnology (0+20) 2. Animal biotechnology (0+20) 3. Bioinformatics (0+20) 4. Microbial and environmental biotechnology (0+20)	0+20	
2	BSRP 4205	Project formulation, execution and presentation	0+4	
3	BSRP 4206	Entrepreneurial development in biotechnology (on-campus /off campus)	0+16	

7. Non-Credit Courses (5 Nos.) **Total Credit hours = 0+5=5**

Sl. No.	Catalogue No.	Course Title	Non-Credit hours
1	BEGL 1101	Comprehension and communication skills in English	0+1
2	BNSS 1101	NCC/NSO/NSS	0+1
3	BPED 1201	Physical education and yoga practices	0+1
4	BSTR 3201	Educational tour I (All India)	0+1
5	BSTR 4102	Educational tour II (All Kerala)	0+1

Name of Departments

Animal Hus. - Department of Animal Husbandry
Agril. Econ. - Department of Agricultural Economics
Agril. Engg. - Department of Agricultural Engineering
Agril. Ento. - Department of Agricultural Entomology
Agril. Extn. - Department of Agricultural Extension Agril.
Micro. - Department of Agricultural MicrobiologyAgril.
Stat. - Department of Agricultural Statistics
Agron. - Department of Agronomy
COM - Department of Community Science
FLA - Department of Floriculture, Landscape and Architecture
FS - Department of Fruit Science
PCS - Department of Plantation Crops and Spices
PHT - Department of Postharvest Technology
Plant Biotech. - Department of Plant Biotechnology
Pl. Breed. & Gen. - Department of Plant Breeding and GeneticsPlant
Path. - Department of Plant Pathology
Plant Physiol. - Department of Plant Physiology
SS & AC - Department of Soil Science and Agricultural Chemistry
VS - Department of Vegetable Science

Semester-wise Distribution of Courses

Semester I		
Catalogue No.	**Course Title**	**Credit hours**
BAGR 1101	Basic agronomy and production technology of major crops	2+1
BAHB 1101	Basic zoology	2+1
BEXT 1101	Effective communication and personality development	1+1
BEXT 1102	Human ethics	1+0
BPBG 1101	Basic genetics	2+1
BPBG 1102	Cell biology and cytogenetics	2+1
BPBT 1101	Introduction to biotechnology	2+1
BSAC 1101	Principles of analytical chemistry	1+1
BSTA 1101	Basic mathematics	2+0
BEGL 1101	Comprehension and communication skills in English (NC)	0+1
BNSS 1101	NCC/NSO/NSS (NC)	0+1
	Total **15 + 7 + 2 NC = 24**	

Semester II		
Catalogue No.	**Course Title**	**Credit hours**
BMIC 1201	Fundamentals of microbiology	2+1
BPBG 1203	Biodiversity and bioprospecting	2+0
BPBG 1204	Introduction to agricultural botany	2+1
BPBG 1205	Basics and methods of plant breeding	2+1
BPBT 1202	Molecular biology	2+1
BPEN 1201	Fundamentals of crop protection	2+1
BSAC 1202	General biochemistry	2+1
BSTA 1202	Basic statistics	1+1
BPED 1201	Physical education and yoga practices (NC)	0+1
	Total **15 + 7 + 1 NC = 23**	

Semester III		
Catalogue No.	**Course Title**	**Credit hours**
BECO 2101	Economics and marketing	2+1
BHOR 2101	Production technology for horticultural crops	2+1
BPBT 2103	Recombinant DNA technology	1+1
BPBT 2104	Plant tissue culture	2+1
BPBT 2105	Introductory bioinformatics	2+1
BPHT 2101	Postharvest technology	2+1
BPHY 2101	Crop physiology	2+1
BSTA 2103	Information and communication technology	1+1
BSTA 2104	Biomathematics	1+1
	Total **15 +9 = 24**	

Semester IV		
Catalogue No.	**Course Title**	**Credit hours**
BENG 2201	Electronics and instrumentation in biotechnology	1+1
BEXT 2203	Entrepreneurship development and business management	1+1
BMIC 2202	Microbial genetics	1+1
BPBT 2206	Plant genetic transformation	1+1
BPBT 2207	Biophysics	2+0
BPBT 2208	Animal biotechnology	2+1
BPBT 2209	Molecular genetics	2+0
BPBT 2210	Nanobiotechnology	2+0
BPBT 2211	Genomics and proteomics	2+0
BSAC 2203	Environmental studies and disaster management	2+1
	Total **16 + 6 = 22**	

Semester V		
Catalogue No.	**Course Title**	**Credit hours**
BENG 3102	Renewable energy and green technology	1+1
BPBG 3106	Molecular marker technology	1+1
BPBT 3112	Immunology	1+1

BPBT 3113	Biosafety and IPR in biotechnology	2+0
BSTA 3106	Agricultural Informatics	1+2
BPBT 3114	Computational biology	2+1
BPBT 3115	Bioprocess engineering in biotechnology	2+1
BCOM 3101	Food science and processing	1+1
BSAC 3104	Enzymology and enzyme technology	2+1
BSTA 3105	Biostatistics	1+1
	Total **14 +10= 24**	

Semester VI		
Catalogue No.	**Course Title**	**Credit hours**
Optional courses listed	Optional/Elective courses **Only one can be chosen**	18
	1. Plant biotechnology	12+6
	2. Animal biotechnology	13+5
	3. Bioinformatics	11+7
	4. Microbial and environmental biotechnology	14+4
BSTR 3201	Educational tour I (All India) (NC)	0 +1
	Total **18 + 1 NC = 19**	

Semester VII		
Catalogue No.	**Course No.**	**Credit hours**
BSRP 4101 BSRP 4102 BSRP 4103 BSRP 4104	Student READY - In-house Skill development modules Four Modules (Only one to be opted as per chosen elective) 1. Plant biotechnology (0+20) 2. Animal biotechnology (0+20) 3. Bioinformatics (0+20) 4. Microbial and environmental biotechnology (0+20)	0+20
BSTR 4102	Educational tour II (All Kerala)	0+1
	Total **0 + 20 + (1 NC) = 21**	

Semester VIII		
Catalogue No.	**Course Title**	**Credit hours**
BSRP 4205	Student READY –Project formulation, execution and presentation (Four Weeks)	0 + 4
BSRP 4206	Student READY - Entrepreneurial development in biotechnology (On-campus/Off-Campus)	0 +16
	Total **0 + 20 =20**	
	Grand Total **172 + 5 (NC) = 177 credits**	

SYLLABUS

B. Tech. Biotechnology

BAGR 1101 Basic agronomy and production technology of major crops (2+1)Theory

UNIT I

Fundamentals and Definition of agriculture and agronomy - Factors affecting crop growth - climatic factors - tillage and tilth - objective and principles - different kinds of tillage - seeds - sowing - and planting - methods - crop geometry.

Unit II

Soil fertility and productivity; Concept of essentiality of plant nutrients; Essential plant nutrients: Functions and deficiency symptoms. Manures and fertilizers - methods of application - bio fertilizers.

Unit III

Irrigation - principles and methods of irrigation; Weed management in crops- cropping systems - monoculture and multiple cropping - inter, mixed, relay, strip and multitier cropping.

Unit - IV

Cultivation practices for important field crops - rice, Pulses – Cowpea, red gram, black gram, green gram, groundnut, gingelly and cassava- Postharvest value addition in Rice

Practical

Identification of crops, seeds and planting materials of field crops -Identification of manures and fertilizers- Studyof primary, secondary tillage implements. Study of tools and implements special operations-Fertilizer recommendations and calculations-Methods of fertilizer applications-broadcasting, placement, foliar application and fertigation-Computation of seed rate and plant population-Seed testing – germination test, viability test- Identification and study of tillage implements and implements for special operations-Study of wet land environment-Practicing nursery seed bed preparation in Rice-Study of weeds in crops-herbicides and herbicide calculation-Study of Yield attributes and yield estimation of field crops- Irrigation Scheduling

Study of Wetland environment and identification of field crops. Identification of seeds, manures and fertilizers. Practicing nursery seed bed preparation in rice.

Lecture Schedule

Theory

1. Agronomy – definition and scope and principles
2. Classification of crops -Ontogenic, agrarian, botanical
3. Special classification of crops
4. Factors affecting crop growth
5. Methods of sowing/planting- direct seeding: broadcasting, dibbling and drilling, seed drills and otherimpliments-transplanting
6. Tillage- definition- objectives – types of tillage- conservation tillage
7. Tillage implements-ploughs, harrows, cultivators, hoes and special purpose implements

8-9. Crop nutrition - Soil productivity and fertility-– classification of nutrients- Functions and deficiencysymptoms of major and secondary nutrients

10. Manures and fertilizers – classification - organic manures

11-12. Fertilizers and fertilizer use- Management of fertilizers - Integrated Nutrient Management

13. Biological nitrogen fixation – biofertilizers

14-15. Weeds – definition – classification. Crop – weed association and competition – critical stages of crop weedcompetition.

16-17. Weed control methods – physical, cultural, biological, chemical, allelopathy

18-19. Irrigation- definition- agricultural water management- water management and watershed management-rainfed agriculture and irrigated agriculture- Role of water in soil and plants

Mid-term exaamonation

20-21. Water resources- surface and ground water resources- Nature of ground water-Conjunctive use of water-hydrologic cycle- virtual water- integrated water resources management

22-24. Soil moisture constants- classification of soil water- Water requirement of crops- Irrigation scheduling

25-26. Methods of irrigation- surface irrigation-flooding, border and basin irrigation, furrow and surgeirrigation-Micro irrigation

27-28. Cropping systems - monoculture and multiple cropping - inter, mixed, relay, strip and multitier cropping.

29. Integrated farming systems in Kerala

30-31. Cultivation practices for important field crops – rice

32-33. Cultivation practices for important Pulses – Cowpea, black gram, green gram

34. Cultivation practices for important Tuber crops- cassava

35-36. Cultivation practices of important oil seed crops- groundnut, gingelly

Practical

1. Visit to crop museum and identification of field crops
2. Identification of seeds and planting materials of field crops
3. Identification of manures and fertilizers
4. Fertilizer recommendations and calculations
5. Methods of fertilizer applications- broadcasting, placement, foliar application and fertigation
6. Computation of seed rate and plant population
7. Seed testing – germination test, viability test
8. Identification and study of tillage implements and implements for special operations
9. Visit to wetland of CoA, Vellayani and study of wet land environment
10. Practicing nursery seed bed preparation in Rice11-13. Identification of weeds in crops

14-15. Identification of herbicides and herbicide calculation

16. Yield attributes and yield estimation of field crops17-18. Irrigation Scheduling

Suggested Reading

1. KAU [Kerala Agricultural University]. 2016. Package of Practices Recommendations:Crops (14th Ed.).Kerala Agricultural University, Thrissur, 401p.
2. Reddy, Y and Reddy, G. H. S. 2010. Principles of Agronomy. Kalyani Publishers, 527p
3. Balasubramaniyan, P. and Palaniappan, S.P. 2001. *Principles and Practices of Agronomy*. AgroBios(India) Ltd., Jodhpur.
4. Brady, N.C. and Well, R.R. 2002.*The Nature and Properties of Soils* (13th ed.). Pearson Education, Delhi.
5. Gupta, O.P. 2000. *Weed Management - Principles and Practices*. Agrobios (India) Ltd., Jodhpur
6. Acquaah, G. 2005. Principles of Crop Production: Theory, Techniques and Technology. Prentice Hall.
7. Chandrasekaran, B., Annadurai, K., and Somasundaram, E. 2010. *A Text Book of Agronomy*. New AgeInternational (P) Limited Publishers.
8. Reddy, S. R. 2011. *Principles of Agronomy*. Kalyani Publishers.

BAHB 1101 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

organizationof various systems of a mammal: digestive, circulatory, respiratory, excretory, nervous and reproductive; Laws ofinheritance; 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.

Lecture Schedule

1. Introduction to Zoology
2-4. Structure and functions of cell and cell organelles
5. Difference between prokaryotic and eukaryotic cell6-8. Cell division – mitosis and meiosis
9-13. Structure and function of biomolecules 14-16. Types of simple and compound tissues17-18. Binomial Nomenclature

Midterm Examination

19- 24. Classification and general survey of animal kingdom
25-30. Functional organization of various systems of a mammal: digestive, circulatory, respiratory, excretory,nervous and reproductive
31-32. Laws of inheritance
33-34. Multiple allelism - blood groups
35-36. Genetic disorders in human and their inheritance.

Practical Schedule

1-3. Study of animal cell structure and cell division
4-8. Histological preparation of simple and compound tissues
9-13. General survey of animal kingdom up to phyla in invertebrates and up to classes in vertebrates
14-15. Demonstration of mammalian anatomy
16-17. Blood grouping
18. Practical exam

Suggested Readings

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

BCOM 3101 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 anddehydration, 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 addedproducts 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. 236 237 Report of the ICARFifth Deans' Committee Report of the ICAR Fifth Deans' Committee
Vickie A., Vaclavik & Elizabeth W. Christian. 2003. Essentials of Food Science, 2ndEd. Kluwer Academic/Plenum Publishers, New York.

BECO 2101 Economics and marketing (2+1)Theory

UNIT I

Economics – Terms and definitions; Demand and supply; Factors of production; Gross Domestic Product; Agriculture in national GDP.**UNIT II**. Marketing – definition; Marketing process; Need for marketing; Role of marketing; Marketing functions; Classification of markets; Marketing through various channels; Supply Chain management, Price spread; Marketing efficiency; Constraints in marketing of agricultural produce; Market intelligence. **UNIT III.** Basic guidelines for preparation of project reports; Banking structure in India, Procedurein getting loans; Insurance; SWOT analysis.

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; Visit to different markets, market institutions; Study of SWC, CWC and STC; Analysis of information on prices; Computation of Marketed and marketable surplus.

Theory

Lecture schedule

1-2. Economics: Meaning, scope and subject matter, definitions
3. Basic concepts: Goods and services, desire, want, demand, utility – forms
4. Demand-meaning, demand schedule and demand curve, law of demand
5. Supply, law of supply, supply schedule, supply curve, Price determination6-7 Factors of production- Land, Labour, capital and organization
8-9. Forms of business organization
10-11 National income: Meaning and importance, circular flow, concepts of national income accounting andapproaches to measurement,
12. Marketing – definition; Marketing process; Role of marketing; Constraints in marketing of agriculturalproduce
13. Grading and Standardization, types of grading, quality control and labelling (Agmark); international qualitystandards
14. Marketed and Marketable surplus- Marketing channels meaning and definition of marketing channel;factors affecting length.
15. Meaning, definition and types of market integration;
16-17. Marketing efficiency; definition, Types, factors affecting efficiency, approaches to the assessment,methods of evaluating efficiency
18. Marketing margins and; concepts of marketing margin, Estimation of marketing margin.

Mid Term Examination

19. Marketing costs factors affecting cost of marketing; price spread and other concepts, computation of pricespread
20. Concept of International Trade and its need, theories of absolute and comparative advantage. Leonteif'sparadox.
21. GATT and WTO; Agreement on Agriculture (AoA)
22. APMC Regulated Markets, Direct Marketing
23-24 Contract farming - Supply Chain Management-Value Chain Management
25. Marketing Management- Market segmentation- basis of segmentation26-27. Marketing mix- 4Ps of Marketing-

28. Product-Product life cycles. Product life cycle (PLC) strategies in different stages of PLC
29. History of Agricultural Financing in India – Taccavi loans – Co-operative Credit Act – RBI Act – Social Control –Nationalization –Formation of RRBs.
30-31. Sources of Agricultural credit – non institutional sources-and Institutional sources - Commercial Banks-Lead Bank Scheme-Service Area Approach-, Small Banks
32. Types of projects- Phases in Project cycle33-34 Investment analysis
35. Basic guidelines for Preparation of Detailed project reports
36. Types of Insurance, SWOT analysis

Practical Schedule

1. Techno-economic parameters for preparation of projects;2-3. Discounted measures in Project Appraisal
4-5. Preparation of Detailed Project Report for various biotechnology/ agricultural products and value-addedproducts;
6. Field visit for Identification of marketing channels of various agricultural Commodities7-
8. Calculation of Marketing cost Marketing margin and price spread;
9. Computation of Marketed and marketable surplus.
10. Visit to Agricultural online marketing agencies
11-12. Advertisement – Methods for the advertisement of agricultural commodity- Prepare a strategy foradvertising a new product
13. Sources of Agricultural Prices in India
14. Construction of Index Numbers
15. CPI and WPI computation in India
16. Trends in GDP growth in India
17. Banking Structure in India
18. Visit to FCI/CWC/SWCPractical Examination

Suggested Readings

1. Acharya SS & Aggarwal NL. 2011. Agricultural Marketing in India. Fifth Edition. Oxford and IBH PublishingCompany Pvt. Ltd.
2. Ahuja HL. 2007. Advanced Economic Theory. S Chand and Company.
3. Chandra P.1984. Projects: Preparation, Appraisal & Implementation. McGraw Hill Inc.
4. Dewett KK. 2005. Modern Economic Theory. S Chand and Company.
5. Gupta RD & Lekhi RK. 1982. Elementary Economic Theory. Kalyani Publishers.
6. Kotler, P and Armstrong, G .2006. Principles of Marketing. Pearson Education Inc
7. Sampath Mukherjee. 2002. Modern Economic Theory. New Age International.

BENG 2201 Electronics and instrumentation in biotechnology (1+1)Theory

UNIT I

Electronics - PN junction diode, diode forward and reverse characteristics; Diode as a circuit element; Applicationof 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 methodsof NPN transistor with common emitter configuration; AC model and analysis of small signal NPN transistor withcommon 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 equipment: 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 PNjunction diode; To study half wave, full wave and bride rectifier using diode; Clipper, Clamper and Voltage multiplier circuit; To determine input V-I Characteristics s of bipolar transistor for common emitter configuration; To determine output V-I Characteristics s 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 oftemperature using the available sensor; To measure displacement with the available sensor; To study force with the available sensor.

Lecture schedule

1-2. Electronics - PN junction diode, diode forward and reverse characteristics-Diode as a circuit element
3-4 Application of PN junction diode such as: half wave, full wave bridge rectifier, clipper, clamper and voltagemultiplier circuit
5-6 Construction and working of bipolar transistor, load line concept, analysis - design of various biasing methodsof NPN transistor with common emitter configuration;
7-8 AC model and analysis of small signal NPN transistor with common emitter configuration-Concept ofgeneralized instrumentation system
9 Transducers for the measurement of temperature using thermometer and thermocouple

Midterm Examination

10. linear displacement measurement using LVDT- Force measurement using the strain gauge.
11-12 Principles and working of laboratory equipment: Table top, refrigerated and ultra-centrifuges; Laminar airflow; Autoclaves, pH meter; Fermenters; Temperature control shakers, BOD shakers
13. Principles and working of laboratory equipment Gel electrophoresis, 2-D gel electrophoresis, geldocumentation, gel driers
14. Principles and working of laboratory equipment ELISA readers; Freeze driers/lyophilizers;Spectrophotometers; Gene pulser
15. Principles and working of laboratory equipment Particle gun; Plant growth chambers;
16-17. Principles and working of laboratory equipment Thermal cyclers; Realtime PCR, DNA synthesizer; DNASequencer
18. Principles and working of laboratory equipment: Microscopes: Light, stereo, phase contrast and inverted.

Practical Schedule

1-5. To familiarize laboratory equipment and its equipment working Microscope, particle gun, centrifuge etc6-7. Forward and reverse VI Characteristics of a PN junction diode
8-9. To study half wave full wave and bride rectifier using diode; Clipper, Clamper and Voltage multiplier circuit
10. To determine input V-I Characteristics s of bipolar transistor for common emitter configuration
11. To determine output V-I Characteristics s of bipolar transistor for common emitter configuration
12. To analyse a biasing circuit for CE transistor
13. To design and test a biasing circuit for CE transistor
14. To study the measure of temperature using the available sensor
15. To measure displacement with the available sensor16-17. To study force with the available sensor.
18. Practical Examination.

Suggested Readings

1. Edward William Golding & Frederick Charles Widdis. 1969. ElectricalMeasurements and Measuring Instruments. Pitman.
2. Gupta JB.2009. Basic Electronics. S. K. Kataria& Sons.
3. Malvino. 2007. Electronics Principles. Tata McGraw-Hill Education.
4. Manhas P. & Thakral S. 2010. Digital Electronics. S. K. Kataria & Sons.
5. Sharma Sanjay. 2012. Electronics Devices & Circuits. S. K. Kataria& Sons.

BENG 3102 Renewable energy and green technology (1+1) Theory

Classification of energy sources, contribution of these sources in the agricultural sector, Familiarization with biomass utilization for biofuel production and their application, Familiarization with types of biogas plants and gasifiers, biogas, bio-alcohol, bio-diesel and bio-oil production and their utilization as bio-energy resource, introduction of solar energy, collection and their application, Familiarization with solar energy gadgets: solar cooker, solar water heater, application of solar energy: solar drying, solar pond, solar distillation, solar photovoltaic system and their application, introduction of wind energy and their application.

Practical

Energy input in agricultural production - biogas plant – different types, design of biogas plant. Biomass gasifier,Study of production process of biodiesel, study of the production process of biofuel, study of briquetting, solar water heating, solar cookers, solar pumping, solar dryers, Design of solar driers, solar photovoltaic cell characteristics, study of types of windmills.

Lecture schedule

1. Sources of energy - Classification, renewable and non-renewable energy.
2. Properties of different types of renewable energy sources
3. Energy from bio-mass – types. Biogas production and utilization.
4. Types and construction of biogas plants.
5. Agricultural wastes, principles of combustion, pyrolysis and gasification of biomass
6. Types of gasifiers, producer gas and its utilization.
7. Briquettes, types of Briquetting, uses of briquettes, shredders.
8. Solar energy – solar collectors - flat plate and focussing plate collectors
9. Solar air heaters, solar space heating and coolingMid Term Examination
10. Solar energy applications/solar energy gadgets, solar cookers, solar water heating systems
11. Solar graindryers, solar refrigeration system, solar ponds
12. Solar photovoltaic systems, solar lantern, solar street lights, solar fencing
13. Solar pumping systems
14. Wind energy, types of windmills
15. Construction details and application of windmills
16. Liquid biofuels -Biodiesel and ethanol from agricultural produce17-18. Production of bio diesel

Practical schedule

1. Estimation of energy input in agricultural production
2. Study of biogas plant – fixed dome type
3. Study of biogas plant – floating dome type
4. Design of biogas plant
5. Study of a biomass gasifier
6. Study of production process of bio diesel
7. Study of the production process of biofuel

8. Study of briquetting
9. Study of solar water heating system
10. Study of solar cookers
11. Visit to solar energy plants
12. Study of solar pumping system
13. Study of solar dryers
14. Solar drying experiment
15. Design of solar driers
16. Study of solar photovoltaic cell characteristics
17. Visit to a wind farm
18. Practical Examination

Suggested Readings

1. Kumar, S., Kumar, V. and Sahu, R.K. 2016. Fundamentals of Agricultural Engineering. Kalyani Publishers,New Delhi.
2. Mathur, A.N. and Rathore, N.S. 1992. Biogas production, management and utilization. HimanshuPublication. Delhi.
3. Ojha, T.P. and A.M. Michael. Principles of Agricultural Engineering, Vol.I. Jain Brothers New Delhi.
4. Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.
5. Rathore N. S., Kurchania, A. K., Panwar, N. L. 2007. Renewable Energy, Theory and Practice, HimanshuPublications.
6. Sukhatme, S.P. and Nayak, J.K. 2012. Solar Energy: Principles of Thermal Collection and Storage, Tata Mc-Graw Hill Education Pvt. Ltd., New Delhi
7. Tiwari, G.N. and Ghoshal, M.K. 2005. Renewable Energy Resources: Basic Principles and Applications.Narosa Pub. House. Delhi.

BEXT 1101 Effective communication and personality development (1+1)Theory

UNIT I

Communication skills: Meaning and process of communication; Basics of communication, Models of communication, Levels and types 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; 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 recordedpractical to evaluate change in confidence level; Team work exercises; Time management.

Lecture scheduleTheory

1. Communication: Meaning and process of communication; Elements of communication
2. Models of communication– an analysis of models of Berlo, Leagans, Shannon and Weaver, Schramm andcommunication flow model.
3. Levels of communication- interpersonal, intrapersonal, group, public and mass communication.
4. Organizational communication–definitions; Importance; meaning and types.
5. Communication skills - concept, meaning and types of communication skills; Verbal and non-verbalcommunication.
6. Listening and note taking; Writing skills; Oral presentation skills
7. Field diary and lab record; indexing, foot note and bibliographic procedure.
8. Reading and comprehension of general and technical articles – tips. Summarizing and abstracting.
9. Individual and group presentations; Impromptu presentation; Public speaking.

Midterm Examination

10. Group discussion and interviews; Organizing seminars and conferences.
11. Voice modulation basics and their usage for meaningful impact on people
12. Leadership – Types; Attributes of an effective leader; Importance of leadership in agricultural extension
13. Time management - meaning and importance; Time logs; Personal organization, prioritizing and balancing.
14. Stress management - meaning definition and importance. Levels and stages of stress. Stress managementstrategies.
15. Conflict management- concept, meaning and strategies for conflict management.
16. Non-verbal communication – Types of non-verbal communication; Impact of non-verbal communication
17. Team work – Meaning; Process; Importance; Improving team work skills
18. Barriers in communication and overcoming the barriers. Cosmopolitan culture – Meaning; Importance; Prosand cons.

Practical schedule

1. Practical exercises on listening and note taking
2-3. Practical exercises on writing and oral presentation skills
4. Preparation of field diary and lab records
5. Practice sessions on indexing and bibliographic procedures
6. Reading and comprehension of general and technical articles
7. Practice session on precise writing, summarizing and abstracting8-9. Individual and group presentations
10-11. Video recorded mock group discussions and interviews
12. Practical session on attitude management
13. Setting and achieving a short-term goal; Creating a personal vision statementof life
14. Voice modulation; Practical exercise on non- verbal communication skills.
15. Practical exercises on team work;
16-17. Practical session on time and stress management, Video recorded practical toevaluate change in confidence level
18. Practical Examination

Suggested Readings

1. Applebaum, R.L., Anaatol, K.W.E., Hays, E.R., Jensan, O.O., Porla, R.E. and Mandel, J.E. 1973. Fundamentalconcepts in human communication. Harper & Row, New York.
2. Barun, K.M. 2011. Personality Development and Soft Skills. Oxford publishers
3. Carnegie, Dale. 2012. How to Win Friends and Influence People in the Digital Age. Simon & Schuster.
4. Covey Stephen R. 1989. The Seven Habits of Highly Successful People. Free Press.
5. Flesche, R. 1997. How to write, speak and think more effectively. Harpper& Row, New York.
6. Joseph, E.H. and Alan, G. 2010. The Craft of Scientific Communication. Chicago guides to writing, editing,and publishing, 240p.
7. Lewis, A. 1990. Beyond the facts- guide to the art of feature writing. Surjeet publication, Delhi.
8. Ray,G.L. 1991. Extension communication and Management. Naya Prakash, Calcutta.
9. Spitzberg B, Barge K &Morreale, Sherwyn P. 2006.Human Communication: Motivation, Knowledge & Skills.Wadsworth.
10. Verma, KC. 2013. The Art of Communication. Kalpaz.

BEXT 1102 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.

Theory Schedule

1. Course orientation and visit to library
2. Familiarization of human ethics terminologies
3. Annotated bibliography
4. Universal human aspirations: Happiness and prosperity
5. Human values and ethics: Concept, definition, significance and sources
6. Fundamental values: Right conduct, peace, truth, love and non-violence
7. Ethics: professional, environmental, ICT

8-9. Sensitization towards others particularly senior citizens, developmentally challenged and gender

Mid-Term Examination

10. Spirituality, positive attitude and scientific temper
11. Team work and volunteering
12. Rights and responsibilities
13. Road safety
14. Human relations and family harmony
15. Modern challenges and value conflict: Sensitization against drug abuse and other social evils16-17. Developing personal code of conduct (SWOT Analysis)
18. Management of anger and stress

Suggested Readings:

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

3. Sharma RA. 2011. Human Values and Education -Axiology, Inculcation and Research. R. Lall BookDepot.
4. Sharma RP & Sharma M. 2011. Value Education and Professional Ethics. Kanishka Publishers.
5. Srivastava S. 2011. Human Values and Professional Ethics. S K Kataria & Sons.
6. Srivastava S. 2011. Environmental Science. S K Kataria & Sons.
7. Tripathi A.N. 2009. Human Values. New Age International (P) Ltd Publishers.

BEXT 2203 Entrepreneurship development and business management (1+1)Theory

UNIT I

Concept of entrepreneur; Entrepreneurship development; Assessment of entrepreneurship skills; SWOT analysisand achievement motivation; Entrepreneurial behavior; 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; Functions 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 viable project proposal or business plan by individual students Interface with successful entrepreneurs; 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.

Lecture Schedule

1. Concept of entrepreneur and entrepreneurship development process
2. Assessment of entrepreneurship skills& SWOT analysis
3. Characteristics of entrepreneur and entrepreneurial behaviour- achievement motivation
4. Government policy and plan for entrepreneurship development-setting up of a new entrepreneurialventure
5. Environmental factors influencing entrepreneurship
6. Constraints in setting up of agro-based industries
7. Definition of business-value chain concept in business
8. Stakeholders in business & stages of Indian business
9. Importance of agribusiness in Indian economy-opportunities and challenges to Indian agribusiness

Midterm

10. Factors transforming Indian Agribusiness Government as a regulatory body in agribusiness
11. Management : Definition-levels of management-importance and functions
12. Planning: Definition-steps in planning-types of plan
13. Organizing : Meaning of organizing and organization
14. Leadership : Definition and types-developing leadership skills
15. Encoding and decoding communication skills
16. Developing organizational and managerial skill-problem solving skill

17. Supply chain management and total quality management
18. Project planning, formulation and report preparation

Practical schedule

1-4. Preparation of viable project proposal or business plan by individual students 5-6. Preparation of project report for various business ventures
7. Preparation of complete marketing plan of selected product/service8-12. Interface with successful entrepreneurs
13-15. Case studies of successful entrepreneurs, analysis and discussion
16. Case studies related to project management
17. Visits to industrial and agri-business houses
18. Practical Examination

Suggested Readings

1. Harold Koontz & Heinz Weihrich. 2004. Essentials of Management: An International Perspective, 2ndEd. Tata Mc-Graw Hill Publishing Pvt Ltd.
2. Mukesh Pandey & Deepali Tewari. 2010. The Agribusiness Book. IBDCPublishers.
3. Nandan H. 2011. Fundamentals of Entrepreneurship. PHI Learning Pvt LtdIndia.
4. Philip Kotler, Kavin Lane Keller, Abraham Koshy &Mithileshwar Jha.2012. Marketing Management: ASouth Asian Perspective. Pearson Education
5. Poornima Charantimath.2006. Entrepreneurship Development: Small Business Enterprise. PearsonEducation
6. Stephans P. Robbins & Mary Coulter. 2003. Management. PearsonEducation

BHOR 2101 Production technology for horticultural crops (2+1)Theory

UNIT I - Horticulture - definition, importance, division and classification of horticultural crops. Importance of Horticulture in India and Kerala. Sexual and Asexual methods of Plant Propagation- Planting systems - Plant growth regulators in horticulture - natural and synthetic regulators - preparation and methods of application

UNIT II-Importance and scope of fruit cultivation, Classification of fruit crops; Climatic requirement, Site selection and layout, Production technology of following fruit crops- Mango, Banana, Papaya, Pineapple, Guavaand Sapota

UNIT-III - Floriculture- Importance, Classification of Ornamental plants, Production technology of following flower crops – Rose, Jasmine, Tuberose, Anthurium, Orchids, Marigold

UNIT-IV- Importance of vegetable cultivation for nutritional security, Classification- Production technology of following vegetable crops- Tomato, Chilli, Brinjal, Snake gourd, Bitter Gourd, Cucumber, Pumpkin, Cowpea, Okra, Amaranthus

UNIT V- Plantation crops- importance-classification-production technology- of following plantation crops- Coconut, Rubber, Cashewand Cocoa; Spices, Importance- Classification –production technology of the followingcrops –Black Pepper, Small Cardamom, Ginger, Turmeric; Medicinal and Aromatic Plants: Importance- Classification- varieties, production technology- active principles and uses- *Aloe vera, Piper longum*, Brahmi, Ashwaganda, Lemongrass, Vetiver, Mint, Ocimum

Practical

Identification of different fruit, vegetables, ornamentals, flower crops, plantation crops, spices,

medicinal and aromatic plants, Propagation- budding, layering, grafting; Rooting of cuttings; Propagation of various horticulturalcrops-Visit to commercial nurseries

Lecture ScheduleTheory

1. Horticulture - definition, importance, division and classification of horticultural crops. Importance ofhorticulture in India and Kerala.
2. Sexual and Asexual methods of Plant propagation
3. Planting systems
4. Plant growth regulators in horticulture - natural and synthetic regulators - preparation and methods ofapplication.
5. Importance and scope of fruit cultivation, classification of fruit crops
6. Production technology of mango
7. Production technology of banana
8. Production technology of papaya
9. Production technology of pineapple
10. Production technology of guava
11. Production technology of sapota
12. Importance of floriculture, classification of ornamental plants
13. Production technology of rose
14. Production technology of jasmine
15. Production technology of tuberose
16. Production technology of marigold
17. Production technology of anthurium and orchids
18. Importance of vegetable cultivation for nutritional security, classification of vegetables
19. Production technology of tomato
20. Production technology of chilli
21. Production technology of brinjal
22. Production technology of snake gourd and bitter gourd
23. Production technology of cucumber and pumpkin
24. Production technology of cowpea, okra and amaranthus
25. Plantation crops- importance and classification
26. Production technology of coconut
27. Production technology of cashew and cocoa
28. Production technology of rubber
29. Spices, importance and classification
30. Production technology of black pepper
31. Production technology of small cardamom
32. Production technology of ginger and turmeric
33. Production technology of *Aloe vera* and brahmi
34. Production technology of *Piper longum* and ashwagandha
35. Production technology of lemon grass and vetiver
36. Production technology of mint and *Ocimum*

Practical

1. Seed Propagation; vegetative propagation- budding, grafting, layering; rooting of cuttings
2. Identification and familiarisation with fruit crops
3. Propagation of fruit crops- Banana and Pineapple
4. Layering in Sapota and Guava
5. Visit to orchard

6. Identification and familiarisation of ornamental crops
7. Propagation of important flower crops and ornamentals
8. Identification and familiarisation of vegetables
9. Protray vegetable seedling production
10. Visit to vegetable seed production unit
11. Identification and familiarisation of plantation crops and spices
12. Visit to coconut seedling production unit
13. Propagation of cashew
14. Propagation of Black Pepper
15. Propagation of Ginger and Turmeric
16. Identification and familiarisation of medicinal and aromatic plants
17. Propagation of medicinal and aromatic plants
18. Visit to a commercial nursery

Suggested readings

1. Bhattacharjee,S.K.(ed). 2006. Advances in Ornamental Horticulture Vol. I to VI. Pointer Publishers, Jaipur
2. Bose, T.K. and Mitra,S.K. 1985. Fruits of India – Tropical and Subtropical. Nayaprakash publications,Culcutta.
3. Bose, T.K., Parthasarathy,V.A. and Chattopadhyay, P.K. 2006. Plantation Crops Vol 1 & 2. NayaudyogPublication, Kolkata, India.
4. Chadha, K.L., Reddy, B.M.C. and Sikhamony, S.D. 1998. Pineapple. ICAR, New Delhi.
5. Farooqi, A. A. and Sreeramu, B.S. 2004. Cultivation of medicinal and aromatic crops. Universities press(India) Pvt. Ltd., Hyderabad, 647p
6. Gopalakrishnan, T. R. 2007. Vegetable Crops. New India Publishing Agency, New Delhi.
7. Hartmann, HT. and Kester, D.E.1986. Plant propagation - Principles and practices. Prentice Hall, New Delhi.
8. Hazra, P. and Som, M. G. 1999. Technology for vegetable Production and Improvement. Naya Prokash,Calcutta
9. John, P.J. 2008. A hand book on PostHarvest management of Fruits and Vegetables. Daya Publishing House.Delhi.
10. Peter, K. V. and Hazra, P. 2012. Handbook of vegetables. Studium Press LLC, USA
11. Peter, K. V. Basics of Horticulture. New India Publishing Agency, New Delhi.
12. Peter, K.V. 2011. Plantation crops. National Book Trust, New Delhi,
13. Radha, T. and Mathew, L. 2007. Fruit Crops, Vol. 2. Horticulture Science Series. New India PublishingAgency, New Delhi
14. Randhawa. G.S. and Mukhopadhyay. A. 1986. Floriculture in India. Allied Publishers, New Delhi. 656p.
15. Ravindran, P.N (Ed). 2003. Black Pepper (Piper nigrum L.), CRC Press
16. Ravindran, P.N and Madhusudanan, K.J (Eds). 2003. Cardamom – The Genus Elettaria, CRC Press
17. Ravindran, P.N. and Babu, K.N (Eds). 2004. Ginger - The Genus Zingiber, CRC Press
18. Ravindran, P.N., Babu, K.N. and Sivaraman, K (Eds). 2002.Turmeric – The Genus Curcuma, CRC Press
19. Sidhu, S.S. 2016.Ornamental Horticulture. New India Publishing Agency,New Delhi.
20. Sudheer, K.P. and Indira ,V. 2007. PostHarvest Technology of Horticultural Crops. New India. Publ. Agency.

21. Webster, C.C. and Banoknill.W.J.1989. Rubber. John Wiley, London

BMIC 1201 Fundamentals of 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, Archaebacteria, Rickettsias and Chlamydia; Preservation of microorganisms; Microbial repositories at national and international level.

UNIT II Bacterial growth; Metabolism in bacteria- ATP generation, chemoautotrophy, photo autotrophy,respiration, fermentation; Viruses: Bacteriophages - structure and properties, lytic and lysogenic cycles; viroid, prions.

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

Practical

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

Lecture Schedule

1. Introduction to Microbiology- applications
2-4. History of Microbiology -Germ theory of diseases and protection
5. Microorganisms and their role in fermentation 6-7. Introduction to eukaryotic and prokaryotic cell
8. Major groups of eukaryotes- fungi, algae and protozoa;
9. Major groups of prokaryotes – Actinomycetes, Cyanobacteria, Archaebacteria,Rickettsias and Chlamydia;
10. Preservation of microorganisms; Microbial repositories at national andinternational level.
11-12. Bacterial growth
13-16. Metabolism in bacteria- ATP generation, chemoautotrophy,photo autotrophy, respiration, fermentation
17-18. Viruses: Bacteriophages - structure and properties, lytic and lysogeniccycles; viroid, prions.

Midterm Examination

19-20. Microbial groups in soil
21. Microbes in biotic and abiotic stressed environments
22-23. Microbial transformation of carbon, nitrogen and Sulphur
24. Biological nitrogen fixation
25-26. Plant microbe interaction -Beneficial microorganisms in agriculturebiofertilizers
27. Microbial pesticides
28-29. Microbes in composting and biodegradation30-32. Microbiology of water
33-36. Microbiology of food.

Practical

1. Use and care of microscope – focusing
2. Familiarization with instruments, glassware and other materials in amicrobiology laboratory
3. Preparation of media – nutrient broth – nutrient agar plates, slant *etc*. – differentsterilization techniques
4. Evaluation of aseptic techniques with nutrient broth tubes
5. Evaluation of aseptic techniques with nutrient agar plates
6. Enumeration of bacteria – pour plate and spread plate methods.
7. Purification of bacteria by streak plate method

8. Preservation of bacterial cultures
9. Identification of bacteria – staining techniques – simple staining10.Differential staining – Gram staining
11. Endospore staining
12. Measurements of bacterial cells using micrometer
13. Familiarization of biofertilizers and biocontrol agents14-15. Microbiological study of food
16-17. Microbiological study of water
18. Practical Examination

Suggested Readings

1. Brock TD. 1961. Milestones in Microbiology. Infinity Books.
2. Pelczar MJ, Chan ECS & Kreig NR. 1997. Microbiology: Concepts andApplication. Tata McGraw Hill.
3. Stainier RY, Ingraham JL, Wheelis ML & Painter PR. 2003. GeneralMicrobiology. MacMillan.
4. Tauro P, Kapoor KK & Yadav KS. 1996. Introduction to Microbiology. WileyEastern.

BMIC 2202 Microbial genetics (1+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 damageand 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.

Lecture schedule

1. Introduction to microbial genetics
2. Prokaryote genome
3. Eukaryote genome
4. Viral genome
5. Replication of prokaryotic DNA
6. Replication of eukaryotic DNA
7. Replication of viral DNA
8. Microorganisms as tools for genetic studies
9. Genetic variability
10. Genetic analysis of bacteria
11. Genetic analysis of fungi
12. Genetic analysis of virus
13. Chromosome mapping
14. Gene mapping by recombination
15. Gene mapping by complementation-intergenic
16. Gene mapping by complementation-intragenic
17. Bacterial plasmids
18. Bacteriophages- Structure, life cycle, mode of infection and their role in genetic

engineering

Midterm Examination

19. Genetics of bacteriophage: T4, lambda and M13 - fine structure of gene, life cycle, mode of infection
20. Transfer of genetic material in bacteria: Conjugation
21. Transformation
22. Transduction
23. Mutation-types
24. Mutagens
25. DNA damage and repair
26. Transposable elements
27-28. Regulation of gene expression- Lac operon
29. Yeast genetics
30. Random spore analysis and Tetrad spore analysis
31-33. Concept and application of recombinant DNA technology
34-36. Use of genetic tools to improve the microbial strains with respect to industry, agriculture and health.

Practical schedule

1.Spontaneous mutation by gradient plate technique2.Auxotrophic mutation by replica plating
3.Chemical mutagenesis in fungi
4.UV mutagenesis in fungi 5.Chemical mutagenesis in bacteria6.UV mutagenesis in bacteria
7-8. Conjugation in bacteria
9.10. Transformation in bacteria11-12. Complementation in fungi
13. Isolation of genomic DNA from E. coli
14. Isolation of plasmid
15. Curing of plasmid
16. Identification of plasmid by electrophoresis
17. Identification of plasmids by antibiotic plates.
18. Practical Examination

Suggested Reading

1. Birge EA. 1981. Bacterial and Bacteriophage Genetics. Springer Verlag.
2. Gardner JE, Simmons MJ & Snustad DP.1991. Principles of Genetics. John Wiley &Sons.
3. Lewin B.1999. Gene. Vols. VI-IX. John Wiley & Sons.
4. Maloy A & Friedfelder D. 1994. Microbial Genetics. Narosa.
5. Scaife J, Leach D & Galizzi A 1985. Genetics of Bacteria. Academic Press.6.William Hayes 1981. Genetics of Bacteria. Academic Press.

Courses in Elective IV - Microbial and Environmental BiotechnologyBELM 3201 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 wastewaterr, sewage and sludge; Industrial production of alcohols, ethanol, acids (citric acid, acetic acid), solvents (glycerol, 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.

Lecture Schedule

1. Microbial Biotechnology-Scope and techniques
2. Industrially important microorganisms
3. Genetic variability in microorganisms

4-7. Transformation, transduction, conjugation and recombination

8-11. Biotechnological tools to improve the microbial strains with respect to industry and agriculture.12-14. Biotransformation and biodegradation of pollutants

15-18. Biodegradation of lignocelluloses and agricultural residues

Midterm Examination

19-20. Biotechnological treatment of waste water, sewage and sludge

21. Types of Fermentation
22. Microbial Growth
23. Nutritional requirements
24. Production of Metabolites-primary and secondary metabolites25-26. Industrial production of alcohols

27-28. Industrial production of organic acids -citric acid, acetic acid29-30. Industrial production of solvents (glycerol, acetone, butanol),

31-32. Industrial production of antibiotics (penicillin, streptomycin, tetracycline).33-34. Industrial production of amino acids (lysine, glutamic acid)

35. Single cell proteins
36. Recombinant and synthetic vaccines.

Practical Schedule

1. Crowded plate technique
2. Purification of cultures
3. Preservation of cultures
4. Antibiotic susceptibility test
5. Isolation of yeast
6. Isolation of lactic acid bacteria
7. Isolation of cellulose degraders from soil
8. Solid state fermentation-mushroom cultivation
9. Alcoholic fermentation-grape wine
10. Fermenter
11. Production of biofertilizers using fermentation
12. Single cell protein production
13. Production and assay of microbial cellulose and chitinase
14. Production of lactic acid
15. Production of antimicrobial metabolites
16. Composting
17. Microbial cell immobilization
18. Practical Examination.

Suggested Readings

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

BELM 3202 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 livingspecies 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.

Lecture schedule

1-5. Concepts and practices of bioprospecting; Traditional and modern bioprospecting; Gene prospecting 6-9. Isolation, synthesis and purification of new bioactive chemicals for laboratory. clinical and field trials10-13. Intellectual property rights, mechanisms and the legal framework
14-16. Patenting of new genes and/or bioactive principles with novel antibiotic, insecticidal or anti-tumourproperties.
17-22. Principles of the Convention on Biological Diversity, biodiversity conservation and biotechnology
23-26. Development and management of biological, ecological, taxonomic, and related systematic information onliving species and systems.

Midterm Examination

27-28. Bioprospecting of microorganisms and their components29-30. Bioprospecting of biodiversity for new medicines:
31-32. Identification and collection of material by random and traditional (medicinal) approaches
33-34. Screening for particular bio-activities; Elucidation of novel molecular form, process technology
35-36. Development of techniques for large scale industrial production of the final bioactive product and its marketavailability and accessibility to the public.

Suggested Readings

1. Mohapatra PK. 2006. Text Book of Environmental Biotechnology. InternationalPublishing House Pvt. Ltd.
2. Sharma PD. 2012. Ecology and Environment. 11th Ed. Rastogi Publications.

BELM 3203 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.

Lecture schedule

1-2. Molecular Evolution: Concept and definition
3-4. molecular divergence and molecular clocks, Speciation and domestication
6-9 Evolution of earth and earlier life forms, Primitive organisms, their metabolic strategies and molecular coding 10-15. New approaches to taxonomical classification including ribotyping, Ribosomal RNA sequencing; Molecular tools in phylogeny, classification and identification.
16-18. Protein and nucleotide sequence analysis; Origin of new genes and proteins; Gene duplication and divergence

Midterm Examination

19-25. Genome evolution, components of genomes, whole genome duplications, chromosome rearrangements and repetitive sequence evolution.
26-30. Application of molecular genetics and genomics to ecology and evolution;
31-33Assessment of genetic diversity, phylogeny, inbreeding, quantitative traits using molecular tools34-36. Mutations, Regulations of gene expression.

Suggested Readings

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

BELM 3204 Fundamentals of molecular pharming and biopharmaceuticals (2+1)Theory

UNIT I Concept of molecular pharming and production of biopharmaceuticals; Mammalian cell culture manufacturing and microbial fermentation; Fermentation and cell culture processing; Protein purification and processing; Industrial fermentation: batch and continuous cultures, production of biopharmaceuticals, immobilization techniques.
UNIT II Biopharmaceutical analytical techniques; Biopharma drug discovery and development; production of specific vaccines and therapeutic proteins. Practical Isolation & purification of proteins from microbes and plants;Production of recombinant proteins in prokaryotes; Analysis of proteins by one- and two-dimensional gel electrophoresis; Affinity chromatography; Immunoblotting; Cell culture and immobilization techniques. Visit to biopharmaceutical industry.

Lecture Schedule

1. Introduction to molecular pharming2-5. Production of biopharmaceuticals 6-11. Cell culture and its applications
12. Microbial fermentation;
13. Fermentation and cell culture processing14-18. Protein purification and processing **Midterm Examination**

19-20. Industrial fermentation 21.Batch and continuous cultures
22-25. Production of biopharmaceuticals26-27. Immobilization techniques.
28-30. Biopharmaceutical analytical techniques
31-33. Biopharma drug discovery and development
34-36. Production of specific vaccines and therapeutic proteins.

Practical schedule

1-5. Isolation & purification of proteins from microbes and plants6-9. Production of recombinant proteins in prokaryotes
10-12. Analysis of proteins by one- and two-dimensional gel electrophoresis
13. Affinity chromatography14-15. Immunoblotting
16. Cell culture and immobilization techniques
17. Visit to biopharmaceutical industry
18. Practical Examination

Suggested Readings

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

BELM 3205 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 nonalcoholic beverages, food additives and supplements.

UNIT II

Industrial use of microorganisms; commercially exploited microbes: Saccharomyces, Lactobacillus, Penicillium, Acetobacter, Bifidobacterium, Lactococcus and Streptococcus; Dairy fermentation and fermented products; Prebiotics and probiotics; Genetic engineering for food quality and shelf-life improvement; Bioactive peptides; Labelling of GM foods. Practical Isolation, culture and maintenance of biotechnologically important micro- organisms; Use of laboratory and industrial scale shakers; Batch and continuous cultures; Use of fermenters; Detection of pathogens in food and feed; Detection of GM food; Visit to food processing industry.

Lecture Schedule

1. Introduction to Food biotechnology.
2. History and importance of Food biotechnology.
3. Application of biotechnology in food processing

4-5.Recent developments, risk factors and safety regulations of applications of food biotechnology.
6-7. Food spoilage - Important Factors in Microbial Food Spoilage
8-11. Microbial spoilage of Food
12-15. Food preservation: Principles and methods of food preservation16-17. Fermented food
18. Beverage Fermentation

Midterm Examination

19-21. Alcoholic and nonalcoholic beverages
22. Food additives and Food supplements
23. Industrial use of microorganisms in food
24-28. Commercially exploited microbes- Saccharomyces, Lactobacillus, Penicillium, Acetobacter, Bifidobacterium, Lactococcus and Streptococcus;
29-31. Dairy fermentation and fermented products
32. Prebiotics and probiotics;
33-34. Genetic engineering for food quality and shelf-life improvement35.Bioactive peptides
36.Genetically Modified Foods -Labelling of GM foods.

Practical Schedule

1. Different culture media and their preparation
2. Isolation of lactic acid bacteria from milk and milk products
3. Isolation of microorganisms from fermented rice dough4.Isolation of yeasts from grapes

5.Isolation of acetic acid bacteria from fermented fruit juice
6-8. Isolation of isolation of spoilage microorganisms from food samples9-10. Production of

fermented beverage
11.Fermenters, Batch and continuous cultures;12-13. Detection of pathogens in food
14-15. Detection of pathogens in feed16.Detection of GM food,
17. Visit to food processing industry.
18. Practical Examination

Suggested readings

1. Bibek Ray.1996. *Fundamentals of Food Microbiology*. CRC Press.
2. Frazier WC & Westhoff DC. 1991. *Food Microbiology*. 3 rd Ed. Tata McGraw Hill.
3. Hui YH & Khachatourians GG. 1995. Food Biotechnology: Microorganisms. Wiley- VCH
4. Shetty K, Paliyath G, Pometto A. & Levin RE. 2006. Food Biotechnology. 2nd Ed. CRC Press

BELM 3206 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.

Lecture schedule

1.Introduction to Green biotechnology: Definition, concept and implication2-3. Bio-fertilizers
4-5. Bio-pesticides
6.Plant growth promoting rhizobacteria
7-8. Production of biofuels, biodiesel and bioethanol 9.Biomass enhancement through biotechnological interventions10.Generation of alternate fuels in plants
11-12. Identification and manipulation of micro-organisms for biodegradation of plastics and polymers13-14. GMOs for bioremediation and phytoremediation, their roles
15-16. Strategies for detection and control of soil pollutants17-18. Strategies for detection and control of air pollutants **Midterm Examination**
19-21. Strategies for detection and control of water pollutants.22.Carbon sequestration
23-24. Methanogenic microbes for methane reduction25.Microbes for phytic acid degradation
26-30. Genetic Engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixationand nutrient uptake efficiency
31-33. Marker-free transgenic development strategies
34-36. Development of disease resistant and pest resistant crops through biotechnological tools.

Practical schedule

1-4. Isolation and efficiency assays of cellulolytic micro-organisms5-7. Isolation and efficiency

assays of lignolytic micro-organisms 8-10. Isolation and assay of pesticide degrading microorganisms

11. Isolation of *Bacillus thuringiensis* s
12. Isolation of nitrogen fixers from rhizosphere soil
13. Isolation of phosphate solubilizers from rhizosphere soil
14. Production of biofertilizers
15. Production of biopesticides
16. Production of biofuel
17. Assays for removal of oil spillage.
18. Practical Examination

Suggested Readings

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

BPHT 2101Postharvest technology (2+1)

Theory

Indian fruit and vegetable processing industry- Importance, problems & prospects- Physiology of maturity, ripening and senescence in fruits and vegetables and their chemical composition, - Postharvest losses - Pre and postharvest factors causing loss and spoilage- Postharvest management techniques - Pre-cooling- grading and sorting- other operations- washing-sanitization- heat treatments- waxing- curing etc. Storage systems and storage disorders- Packaging technology Government policies, regulations and specifications Marketing systems- Exportpromotion agencies Principles and methods of preservation- drying and dehydration - Thermal processing- Preservation by ionizing radiations, chemical methods and fermentation- Recent advances in food preservation techniques- Postharvest technology of coconut, Arecanut, Oil palm, Rubber, Tea, Coffee, Cocoa & cashew, pepper, cardamom, ginger, turmeric, chillies, Tree spices, essential oil yielding crops and cut flowers- Industrial waste utilization Practical General guidelines for setting up of a small scale fruit and vegetable processing unit- FSSAI standards- Analytical methods in quality evaluation of raw material and product quality- TSS, Acidity, sugars, ascorbic acid etc. Preparation of important fruit and vegetable products- jams, jellies, pickles, candies, fermented and unfermented beverages, sauces- Commercial production of processed products- Preparation of coconut, pepper and ginger products- Estimation of spice essential oils, solvent extraction of spice oleoresins - Familiarization with different processed products from spices and plantation crops- Commercial grades of plantation and spices- Visit to processing units of horticultural crops.

Lecture schedule

1,2 State of Indian fruit and vegetable processing industry- Importance of postharvest management of fruits,vegetables and other horticultural produce, problems & prospects

2. Fruits and vegetables their chemical composition
3. Physiology of maturity, ripening and senescence in fruits and vegetables
4. Postharvest losses - Pre and postharvest factors causing loss and spoilage of fruits and vegetables

4,5 Postharvest management techniques for fruits and vegetables- Pre-cooling- methods-grading and sorting-other operations- washing-sanitization- heat treatments- waxing- curing etc.

6,7 Storage system- ambient, low temperature, modified and controlled atmosphere storage

systems- storagedisorders
8,9 Packaging technology - wholesale and retail packaging - packaging materials – advantages and disadvantages-consumer packaging.
10 Government policies, regulations and specifications for fresh and processed products- Marketing systems-Export promotion agencies and their role in export of fresh and processed products.
11 General principles and methods of preservation.
12 Principles of preservation by removal of water - pretreatments – blanching- sun drying, dehydration –methods.13,14 Principles of preservation by application of heat (Thermal processing) - pasteurization – sterilization- Stepsin canning and spoilage of canned products.
15,16 Principles of preservation by ionizing radiations, Principles of preservation by chemical methods- Role of sugar, brine, acid and other chemical, preservatives, other food additives.
17 Principles of preservation by fermentation- Alcoholic, acetic and lactic fermentation processes.
18. Recent advances in food preservation techniques. Mid Term Examination
19,20 Postharvest technology of coconut21 Postharvest technology of Arecanut. 22 Postharvest technology of Oil palm 23-24 Postharvest technology of Rubber25 Postharvest technology of Tea
26 Postharvest technology of Coffee
27, 28 Postharvest technology of Cocoa & cashew
29. Postharvest technology of spices- general aspects
30. Postharvest technology of pepper
31. Postharvest technology of cardamom
32. Postharvest technology of ginger, turmeric & chilies
33. Postharvest technology of Tree spices
34. Postharvest technology of essential oil yielding crops
35. Postharvest technology of cut flowers
36. Industrial waste utilization

Practical schedule

1. Guidelines for establishing fruit and vegetable processing unit- FSSAI standards
2. Preliminary processing of fruits
3. Determination of total soluble solids
4. Preparation of fruit beverages (squash/ syrup/ RTS beverage)
5. Cashew apple processing
6. Preparation of fruit jam
7. Preparation of guava jelly
8. Grape wine preparation
9. Preparation of pickle
10. Tomato processing
11. Determination of acidity
12. Estimation of sugars
13. Commercial production of unfermented beverages- calculation
14. White pepper production by traditional retting method
15. Determination of volatile oil (Modified Clevenger method)
16. Estimation of oleoresin in spices
17. Visit to processing units of horticultural crops,familiarization with different processed products from spicesand plantation crops
18. Practical Examination

Suggested Readings

1. John, P.J. 2008. A hand book on Post Harvest management of Fruits and Vegetables. Daya Publishing House.Delhi.
2. Kader, A.A. 2002. Postharvest Technology of Horticultural Crops. UCUCANR Publications. 535p.
3. Mitra, S. K. 1997. Postharvest Physiology and Storage of Tropical Fruits. CAB International, UK.

4. NIIR Board. 2012. Food Packaging Technology Handbook (2nd Rev.Ed). NIIR Project Consultancy Services.749 p.
5. Panda, H. 2010. Handbook on Spices and Condiments (Cultivation, Processing and Extraction). Asia PacificBusiness Press Inc. 640 P.
6. Rajarathnam, S. and Ramteke, R.S.2011. Advances in preservation and processing technologies of fruits andvegetables.New India Publishing Agency, New Delhi
7. Ranganna, S. 1986. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. Tata Mc.Graw Hill Publishing Company, New Delhi,1112p.
8. Sadasivam, S. and Manickam, A.1996. Biochemical methods. New Age International Pvt.Ltd. Publishers 256p.
9. Saraswathy, S., Preeti, J.L., Balasubramanyan, S., Suresh, J., Revathy, N. and Natarajan, S. 2008. Postharvestmanagement of horticultural crops. AGRIBIOS (India).
10. Sharma, S.K. 2010. Postharvest management and processing of fruits and vegetables-Instant Notes. NewIndia Publishing Agency. New Delhi.390. 70
11. Srivastava, R.P. and Sanjeev Kumar.2007. Fruit and vegetable preservation: Principles and Practices.International Book Distributing Company, Lucknow.
12. Sudheer, K.P. and Indira ,V. 2007. PostHarvest Technology of Horticultural Crops. New India. Publ. Agency.
13. Verma, L.R. and Joshi, V.K. 2000. Postharvest technology of fruits and vegetables-General concepts andprinciples. Vol I & II.

BPBT 1101 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 guidelinesfor 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.

Lecture schedule

1 History of biotechnology
2 Definitions, concepts of Biotechnology
3 Scope and importance of Biotechnology
4 Plant Biotechnology-Micropropagation, haploid culture, germ plasm conservation, secondary metaboliteproduction, genetically modified plants etc.
5 Microbial biotechnology- Biofertilizers, biopesticides, bioremediation, bioleaching etc.
6 Animal Biotechnology- diagnosis and disease management, vaccines, *in vitro* fertilization, geneticmodification etc.
7 Medical Biotechnology- vaccines, diagnostic tools and kits, monoclonal antibodies, stem cell culture, tissueengineering etc.
8 Environmental biotechnology- waste management, biosensors, biofuels, biomass

production etc.
9 Industrial Biotechnology- enzymes, phytochemicals, pharmaceuticals, biopolymers etc.
10 Marine Biotechnology- disease diagnosis and management, improved spawning, sex manipulation, ploidymanipulation, cryopreservation, value added products etc.
11 Agricultural and Food Biotechnology -biofortification, nutraceuticals, abiotic and abiotic stress tolerantplants etc.
12 Nanobiotechnology-synthesis of nanoparticles, properties, applications
13-14 Introduction to recombinant DNA technology and its applications-different steps15-16 Vectors-cloning and expression vectors
17-18 DNA restriction and modifying enzymes

Mid Term Examination

19 Gene cloning-steps, applications
20 Introduction to genomics-applications
21 Introduction to proteomics-applications22-24 Molecular markers-types, applications
25-27 DNA sequencing-principle, different methods
28-30 Genetic transformation and transgenic organisms-applications31-34 Bioinformatics-introduction, databases, tools, application
35-36 Biosafety guidelines

Practical schedule

1-3 Orientation to the lab: glass houses, screen houses, transgenic facilities & field area4-5 General guidelines for working in biotechnology laboratories
6-9 Familiarization with basic equipments used in biotechnology10-11 Selection of chemicals (different grade)
12-14 Buffer preparation
15-17 Calculations and scientific notations used in laboratories
18 Practical Examination

Suggested Readings

1. Brown T A. 2002.Genomes 2. 2nd ed. New York: Wiley-Liss.
2. Prave P, Faust U, Sittig W & Sukatsch D A.1987. Basic Biotechnology: A Student's Guide.VCHVerlagsgesellschaft.
3. Prave P, Faust U & Sittig W.1987. Fundamentals of Biotechnology. VCH Verlagsgesellschaft.Renneberg R. 2008. Biotechnology for Beginners. Academic Press Publishers.

BPBT 1202 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, trp operon 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 amplificationusing PCR, molecular markers.

Lecture Schedule

1-2) History of molecular biology3-4) Central dogma of life
5-6) Structure of DNA and RNA7-8) Gene structure and function
9) DNA replication
10) Transcription
11-12) Genetic code and translation
13-14) Structure of prokaryotic and eukaryotic nuclear and organelle genomes15-16) Gene regulation in prokaryotes
17) Lac operon concept
18) trp operon concept.

Mid Term Examination

19-20) Introduction to microbial genetics21-22) Conjugation
23-24) transformation and transduction25-27) Tools in molecular biology
28-29) Role of enzymes in molecular biology 30-31) Principles of Polymerase Chain Reaction32-33) Electrophoresis
34- 36) PCR and hybridization based molecular markers. \

Practical Schedule

1-2. Preparation of buffers and reagents required for molecular biology3-4. Preparation of media for bacterial cultures and inoculation
5-6. Preparation of bacterial competent cells7-8. Transformation;
9-10. Isolation and purification of plant DNA 11-12. Isolation and purification of animal DNA
13. Measurement of nucleic acid concentration using spectrophotometer.
14. Measurement of nucleic acid concentration using gel electrophoresis
15. Designing of primers
16-17. Polymerase chain reaction and checking the amplicons
18. Practical Examination.

Suggested Reading

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

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

BPBT 2103 Recombinant DNA technology (1+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; Preparationof 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.

Lecture schedule

1. Recombinant DNA technology- Definition, mechanism, Tools
2. Restriction endonucleases: Types and uses, mode of action
3. Other enzymes required in rDNA technology - DNA ligases etc
4. Vectors: plasmids, cosmids, phagemids, BACs, Characteristics
5. Vectors: PACs, YACs, transposon vectors

6-7 Vectors: Expression vectors, shuttle vectors, binary vectors, co-integrating vectors.8-9 Competent cells Gene isolation and cloning

Mid-Term Examination

10. Genetic transformation of *E. coli*
11. Gel electrophoresis
12. Preparation of probes

13-14 . Southern blotting- probe preparation, purification, hybridization, autoradiography

15. Northern blotting
16. Western blotting

17-18. PCR and gene amplification.

Practical schedule

1. Orientation to recombinant DNA lab, Familiarization of Equipments
2. Preparation of stock solutions and buffers
3. Plasmid DNA isolation 4-5 Genomic DNA isolation

6. Quality and quantity determination of DNA: Agarose gel electrophoresis7-8. Restriction digestion of DNA; Agarose gel electrophoresis
9-10 SDS-PAGE
11. PCR
12-14 Genetic transformation of *E. coli*
15-17 Screening of recombinant DNA clones in *E. coli.*
18. Practical Examination

Suggested Reading

1. Brown TA. 1998. *Genetics: A Molecular Approach*. 3rd Ed. Stanley Thornes.
2. Singer M & Berg P. 1991. *Genes & Genome*. University Science Books.
3. Winnacker EL. 2003. *From Genes to Clones: Introduction to Gene Technology*. 4th Ed. PanimaPublishers.
4. Watson JD & Zoller M. *Recombinant DNA*. 3rd Ed. Panima Publishers.

BPBT 2104 Plant tissue culture (2+1)Theory

UNIT I

History of plant tissue culture; Historical benchmarks of plant cell and tissue culture; concept of totipotency; Concept of aseptic culture practices; Components of in vitro culture media and role of different macro and micronutrients, vitamins, plant growth regulators and growth supplements; Plant growth regulators: mode of action, effects on in vitro culture and regeneration. Sterilization techniques.

UNIT II

Various plant cell, tissue and organ culture techniques and uses; Various types of culture: callus, suspension, nurse, root, meristem; In vitro differentiation: Organogenesis and somatic embryogenesis; Micropropagation: In vitro grafting, meristem culture; Anther, pollen, embryo, ovule, ovary culture; Protoplast culture and somatic hybridization; Soma clonal variation.

UNIT III

Applications: Micropropagation; Anther and microspore culture; soma clonal 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

Good laboratory practices; Media preparation and sterilization; Surface sterilization of explants; Establishment ofcallus/cell suspension cultures; Micropropagation – Explant establishment, shoot multiplication, root induction, Hardening and transfer to soil; Embryo culture; Anther and pollen culture; Monitoring of growth and differentiation of cells, Seed/Embryo culture; Ovary culture, Anther /pollen culture, Suspension cultures and production of secondary metabolites.

Lecture schedule

1. Historical benchmarks of plant cell and tissue culture: History of Plant tissue culture, Introduction, Scopeand Importance, Applications of Plant tissue culture

2-4. Culture media components and modifications: Different constituents of media (Inorganic nutrients, Carbon and energy sources, Organic supplements, Growth regulators, Solidifying agents, pH of mediumand their roles

5-6. MS basal medium and different types of medium

7. Sterilization techniques: Types of sterilization, Importance of sterilization

8-9. Various types of culture: callus, suspension, nurse, root, meristem: concept, principal, types,methodology and applications

10-11. In vitro differentiation: Organogenesis and somatic embryogenesis: Concept, Principle, types, methodsand importance and applications.

12-13. Plant growth regulators: Auxins and Cytokinins their mode of action, effects on in vitro culture andregeneration

14-15. Applications: Micropropagation; Anther and microspore culture

16. Somaclonal variation: Concept, Principle, Methods

17. Factors affecting and causes of Somaclonal variation

18. Importance and applications of Somaclonal variation along with examples. **Midterm Examination**

19-20. In vitro mutagenesis: Concept, type of mutagen, methods of in vitro mutagenesis, their confirmation, merit,demerits and applications.

21-23 Production of secondary metabolites: Concept, types, methods and applications.24-25 Synthetic seeds: Concept, Principle, Method, factors affecting, Importance & Applications

26-27 In vitro fertilization; Embryo rescue in wide hybridization: Principle, methodswith merits & demerits, Importance & Applications

28-29 Endosperm culture: Concept, principle, method, importance and applications30-31Protoplast

isolation, culture and regeneration: concept, Principle, Methods ofprotoplast isolation, culture methods, culture conditions, Importance and Applications

32-34 Somatic hybridization: concept, methods of somatic hybridization, selectionof hybrid cell and regeneration, merits, demerits and Applications.

35 Cybrid and asymmetric hybrid- concept, methodology and importance

36. In vitro germplasm conservation: cryopreservation, methods, limitations andapplications

Practical schedule

1. Good laboratory practices
2. Preparation of stocks

3-4. Media preparation and sterilization

5. Surface sterilization of explants

6-7. Establishment of callus/cell suspension cultures

8-11 Micropropagation- Establishment of explant, shoot multiplication, rootinduction

12. Micropropagation-somatic embryogenesis

13-15. Embryo culture; Anther and pollen culture

16. Hardening of tissue culture raised plants and transfer to soil
17. Production of synthetic seeds
18. Practical Examination

Suggested Readings

1. Bhojwani, S. S. & Razdan, M. K. 1996. *Plant Tissue Culture: Theory and Practice*. Elsevier.
2. Bhojwani, S. S. & Dantu, P. K. 2013. *Plant Tissue Culture: An Introductory Text*. Springer
3. Dixon, R. A. & Gonzales, R. A. 2003. *Plant Cell Culture: A Practical Approach*. Oxford University press.
4. Helgason, C. D. & Miller, C. L. 2005. *Basic Cell Culture Protocols*. 3rd Ed. Humana Press.
5. Debergh, P. C. & Zimmerman, R. H. 1991. *Micropropagation: Technology and Application*. KluwerAcademic.
6. George, E. F., Hall, M. A. & Klerk, G. J. D. 2007. *Plant Propagation by Tissue Culture.* 3rd Ed. Volume 1.Springer Science & Business Media.

BPBT 2105 Introductory bioinformatics (2+1)Theory

UNIT I

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

UNIT II

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

UNIT III

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

Practical

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

proteins using Rasmol.

Lecture schedule

1 Introduction to bioinformatics Definition and History
2 Development and scope of bioinformatics 3
3-4 Applications of computers in bioinformatics 5
5 Operating systems
6-7 Hardware and Software
8-9 Internet, www resources, FTP
10- 12 Biological Databases and their classification; Primary databases:Nucleotide sequence databases (GenBank, EMBL)
13-14 Protein sequence databases; Secondary databases: SwissProt/TrEMBL,conserved domain database, Pfam;
15-16 Structure databases: Protein Data Bank (PDB), MMDB, SCOP, CATH
17 Structure databases**:** Retrieving information from these databases. 518-19 File formats: Genbank, EMBL, Fasta, PDB, Flat file, ASN.1, XML.
Midterm Examination
20-21 Introduction to sequence alignment and its applications**:** Pair wise andmultiple sequence alignment,
22 Concept of local and global alignment 6
23-25 Algorithms: Dot Matrix method, dynamic programming methods (Needleman– Wunsch and Smith–Waterman) application of these algorithms in different biologicalproblems.
26-27 Tools of MSA: ClustalW, TCoffee; Use of these tools for MSA of DNA andprotein sequences. Save output file in phylip format.
28-32 Phylogeny; terminologies in phylogeny, applications, and methods ofphylogenetic analysis
32-36 Introduction to BLAST and FASTA. Different BLAST Programmes: their application in terms of nucleic acid and protein sequence. Significance of EValue.

Practical

1 To learn Basics computer operating System
2 To study UNIX, LINUX operating systems
3 To study the Primary nucleotide database: EMBL
4 To study the Primary nucleotide database: GenBank. DDBJ
5 To study the protein primary database: Unigene;
6. To study the Protein information resource: SwissProt, TrEMBL
7 To study the protein secondary databases: Uniprot, CATCH, SCOP
8 To study the protein Structural databases: PDB, MMDB
9 To study the information retrieval System using search engines: Entrez, ARSA, SRS10 BLAST analysis of unknown nucleotide sequence
11 BLAST analysis of unknown protein sequence12 Multiple Sequence alignment using ClustalW
13 Prediction of primary structure of protein: Translation
14 Prediction of primary structure of protein (amino-acid and atomic compositions, pI, extinction coefficient, etc.)15 Secondary structure prediction of protein sequence using APSSP: Advanced Protein Secondary Structure Prediction Server
16 Secondary structure prediction of protein sequence Ramachandran Plot
17 Tertiary structure prediction of protein sequence using Cn3D and swissPDB viewer, Molecular visualizationof protein structures
18. Practical Examination

Suggested Readings

1. Baxevanis AD. & Ouellette BFF.2001. Bioinformatics: A practical guide to the analysis of genes and proteins.John Wiley and Sons.
2. Mount DW.2001. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor.
3. Xiong J.2006. Essential Bioinformatics. Cambridge University Press.22

BPBT 2206 Plant genetic transformation (1+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 transformedbacterial colonies; *Agrobacterium tumefaciens* mediated and biolistic plant transformation; Colony hybridization.**Lecture schedule**

1. History of plant genetic transformation
2. Generation of gene construct and maintenance

3-5. Genetic transformation methods-Agrobacterium mediated
6. Genetic transformation method- Biolistics
7-8. Genetic transformation method -electroporation, liposome, Polyethyleneglycol, in planta methods.
9. selectable and reportable marker genes in transgenics

Midterm examination

10-15. Molecular characterization of transgenic plants methods PCR; qRT-PCR;Southern, Northern, ELISA and Western techniques;
16-17. Application of genetic transformation: for quality, yield, biotic, and abioticstress
18. Biosafety aspects of transgenic plants and regulatory framework.

Practical Schedule

1-2. Preparation of stock solutions
2. Preparation of competent cells of Agrobacterium tumefaciens
3. Preparation of *E coli* competent cells

4-5. Restriction mapping of plasmid- single digestion and double digestion
5. Bacterial transformation method
6-8. Confirmation of transformed bacterial colonies using different methods
9. Ligation
10. Transformation of binary vector into Agrobacterium11-13. cocultivation

14-16. biolistic plant transformation
17. Gus assay of transgenic plants
18. Practical examination

Suggested Readings

1. Green & Sambrook. 2014. Molecular Cloning: A Laboratory Manual. 4th Ed. 3 Vol Sets.Cold Spring Harbor Laboratory Press.
2. Grierson D. 2012. Plant Genetic Engineering. Springer Netherlands.
3. Primrose SB & Twyman RM. 2006. Principles of Gene Manipulation and Genomics,7thEd. Black WellPublishing.
4. Sambrook J, Russel D. 2001. Molecular Cloning: A Laboratory Manual. 3rd Ed Cold Spring Harbor Laboratory Press.

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

BPBT 2207 Biophysics (2+0)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 ina 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; Tunneling electron microscope; Atomic force microscope; Crystals and symmetries, crystal systems, point group and space groups; Growth of crystals of biological molecules; X-ray diffraction.

Lecture Schedule

1) Quantum mechanics
2) Electronic structure of atoms
3) The wave particle duality, wave length of de-Broglie waves
4) Phase and group velocity
5) Some basic concepts of quantum mechanics
6) Schrodinger's wave equations; Particle in a box
7) Quantum mechanical tunneling
8) Ist and IInd law of thermodynamics; Enthalpy; Entropy
9) Statistical and thermodynamic definition of entropy
10) Helmholtz free energy, Equilibrium thermodynamic; Near-equilibrium thermodynamic
11) Gibbs free energy
12) Chemical potential
13) Thermodynamic analysis of membrane transport.
14) Hydration of macromolecules
15) Role of friction; Diffusion; Sedimentation
16) The ultracentrifuge
17) Viscosity
18) Rotational diffusion

Mid Term Examination

19) Light scattering, small angle x-ray scattering
20) Ultraviolet and visible spectroscopy
21) Circular dichroism (CD) and optical rotatory dispersion (ORD)
22) Fluorescence spectroscopy
23) Infrared spectroscopy
24) Raman spectroscopy
25) Electron spin resonance
26) NMR spectroscopy
27) Light microscopy.

28) Electron optics
29) Transmission electron microscope (TEM)
30) Scanning electron microscope (SEM)
31) Preparation of the specimen for electron microscopy; Image reconstruction
32) Electron diffraction
33) Tunneling electron microscope; Atomic force microscope
34) Crystals and symmetries, crystal systems, point group and space groups
35) Growth of crystals of biological molecules
36) X-ray diffraction.

Suggested Readings

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

BPBT 2208 Animal biotechnology (2+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 inmeat 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 baseddetection of animal pathogens; PCR-RFLP; Immunohistochemical localization of protein marker in tissues/cells
– meat species identification by PCREDIT

Lecture schedule

1. History and development of animal biotechnology
2-4. Basic techniques in animal cell culture: oocyte collection and maturation; Sperm preparation;
5-6. In vitro fertilization; Cryopreservation of oocyte, sperm and embryos; Embryo transfer technology.
7. Breeds of livestock and their characteristics
8. Marker assisted breeding of livestock
8-10. Introduction to animal genomics: RFLP, RAPD, SSRs polymorphism
11-13. Introduction to animal genomics: QTL, SNP, STR, Mitochondrial DNA polymorphism
14-18. Rumen and its environment: Rumen microbes-manipulation of rumen microbes for better utilization offeed;

Midterm Examination

19-23. Introduction to nutrigenomics; Milk biome; Manipulation of lactation by biotechnological tools

24. Application of biotechnology in meat and meat products.

25-30. Genome and protein-based diagnostics of important animal diseases: FMD, brucellosis, PPR.

30-32 Genome and protein-based diagnostics of important animal diseases: Mastitis, Blue tongue, Newcastledisease

33-34. Introduction to vaccinology- History

35-36. Types of vaccines- live attenuated vaccines, killed vaccines, cell culture-based vaccines, recombinant vaccines.

Suggested Readings

1. Aberle Elton D, Forrest John C, Gerrard David E & Mills Edward W. 2012. Principles of Meat Science. 5thEd. Kendall Hunt Publishing.
2. Lawrie & Ledward. Lawrie's. 2006. Meat Science. 7th Ed. Woodhead Publishing. Sukumar De. 1997. Outlinesof Dairy Technology. Oxford University Press-New Delhi.
3. Sharma BD. 1999. Meat and Meat Products Technology: Including Poultry Products Technology. Jaypee Bros.Medical Publishers.
4. Varnam A & Jane P. 1994. Milk and Milk Products: Technology, Chemistry and Microbiology. SutherlandSpringer Science & Business Media.

BPBT 2209 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 RNAand proteins; Regulation of gene expression; Mutations and DNA repair.

UNIT II

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

Lecture schedule

1-2 Structures, properties and modification of DNA3-4. Molecular mechanisms of DNA replication
5-6. Mechanisms of DNA repair
7-9. Mechanisms of DNA mutation, and recombination10-11 Centromere and telomere sequences
12. DNA packaging;
13-15 Synthesis and processing of RNA 16-18 Synthesis and processing of proteins**Mid-Term Examination**
19-20 Regulation of gene expression, Mutations and DNA repair21-22 Repetitive DNA sequences
23-25 Transposable elements
26-27. Promoters and their isolation
28-30. Transcription factors – their classification and role in gene expression31-33. Epigenetic control of gene expression
34-36. Small RNAs, RNA interference and its applications.

Suggested Readings

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

BPBT 2210 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, Bio templating and de novo designed nanostructures and materials; DNA-Nanotechnology; Nanomanipulations, material design, synthesis and their applications, Application of nanotechnology in modern day agriculture practices- nano fertilizers, nanopesticides,nanobiosensors and nano-enabled remediation strategies for contaminated soils, shelf life of agricultural and food products, Diagnostics/Drug Delivery, therapeutics

Lecture schedule

1. Introduction to nanotechnology: Milestones in Nanotechnology effect of length scale on properties.
2. Overview of nanoscale material
3. Top-down and bottom-up approach of nanoparticle synthesis
4. Challenges and opportunities associated with nanoscale materials
5. Concepts and Terminology: list of terms used in a field
6. Nano-Bio Interface: Introduction, colloidal forces as well as dynamic bio physicochemical interactions
7. Designing of nanobiointerface
8. Biocompatible or bioadverse outcomes and applications
9. Biological based Nanosystems: Introduction; Butterfly wings; Lotus effect
10. Molecular motors: Introduction, Life is Motion; Cytoskeleton system
11. Applications of molecular motor in Nanotechnology
12. Biosensors: Definition, components, Principles of detection
13. Using Antibodies in Biosensors: Immunoassays, Cantilevers as Nano-Biosensors
14. Micro- and Nanosensors and Applications of Optical Nanosensors.
15. Other devices: Types-i) solid state devices (CMOS, quantum) 2
16. Molecular devices (electrochemical, electromechanical, photoactive, quantum)

17-19. Self-assembly of molecules for nanotechnology applications: Introduction, mechanism of self assemblyi) Self Assembly by Molecular Interactions- intermolecular interaction, Hamaker interaction, and some examples of self assembly

Midterm Examination

20-21. Externally Directed Self Assembly-electric and magnetic field, flow field, microscopic viscous flow, large amplitude oscillatory shear (LAOS), combination of fields.

22-23. Biomimetics: Biomimetic Design of Molecules, Some Key Principles of Biological Self-Assembly in nanotechnology 3 Biomimetic Nanomaterials- nonotubes, nanofibers etc

24. Biomimetic Nanoengineering- Nano-engineering of Colloidal Particles, antigen presenting cells,Synthetic Biomimetic Blood Cells, etc.
25. Biotemplating-definition, mechanism, materials, advantages, limitations, future perspectives
26. de novo designed nanostructures and materials: De Novo Designed α-Helix Coiled-Coil Nanofibers
27. DNA-Nanotechnology: Introduction; History, DNA nanostructure
28. Capabilities, possibilities and limitation of DNA nanostructure
29. DNA origami. Applications of DNA nanotechnology
30. Nano manipulations: Introduction; Types-AFM, STM, In situ SEM, In situ TEM manipulation,Applications

31. Material design: Techniques
32. Nanomaterial synthesis: Physical method 1) mechanical-high energy ball milling, melt mixing 2)Vapour-physical vapour deposition, laser ablation, sputter deposition, electric arc deposition, ion implantation
33. Chemical method-collide, sol gel method
34. Biological method of nanomaterial synthesis- Green synthesis by microorganisms, fungi, plant extracts
35. Advantages and drawbacks of each method
36. Applications: application of nanotechnology in Medical; Agriculture and food; in space, Defense and Engineering; Domestic appliances; in cosmetics; textiles; automobiles; energy

Suggested Readings

1. Hornyak, G.L., Moore, J.J., Tibbals, H. F. & Dutta, J. 2008. *Fundamentals of Nanotechnology.* CRCPress.
2. Xie, Y. 2012. *The Nanobiotechnology Handbook*. CRC Press
3. Kulkarni, S. K. 2014. *Nanotechnology: Principles and Practices*. CP publishing, New Delhi.
4. Murty, B.S., Shankar, P., Raj, B., Rath, B & Murday, J. 2012. *Textbook of Nanoscience andNanotechnology*. Springer
5. Chattopadhyay, K. K. & Banarjee, A. N. 2009. *Introduction to Nanoscience and Nanotechnology*. PHIPublication.
6. Goodshell, D. S. 2004. *Bionanotechnology-Lessons from nature*. John Wiley Publications.
7. Reisner, D. E. 2009. *Bionanotechnology: Global Prospects*. CRC Press.
8. Jesus, M., Fuente, D. & Grazu, M. 2012. *Nanobiotechnology: Inorganic nanoparticles Vs Organicnanoparticles*. Elsevier.
9. Poole, C. P., and Owens, F. J. 2003. *Introduction to Nanotechnology*. Wiley Inter science; 1 edition.
10. Trivedi, P. C. 2008. *Nanobiotechnology*. Pointer Publishers.
11. Ramsden, J. 2009. *Essentials of Nanotechnology*. Ventus Publishing ApS.
12. Emilio, A. Griffith, J. Klas, U. I. 2015. *Silver nanoparticles applications in the fabrication and designof medical and biosensing devices*, Springer.
13. YubingXie. 2012. The Nanobiotechnology Handbook. CRC Press.

BPBT 2211 Genomics and proteomics (2+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 analysisand gene annotation; Genome Projects: E. coli, Arabidopsis, Bovine, Human; Comparative Genomics: Orthologous and Paralogous sequences, Synteny, Gene Order, Phylogenetic foot printing.

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; Edman Degradation; Chromatographic techniques: HPLC, GC, Mass Spectrometry: MALDITOF, LC- MS; Post Translational modifications.

Lecture Schedule

1 Introduction to Genome and Genomics, terminology involved and History
2 Central dogma: Structure of genomics i.e., Functional Genomics, Structural genomics and

Comparative Genomics3 Techniques in genome analysis- DNA microarray, Nanopore technology, High - throughput sequencing,
Southern hybridization, Expressed sequence tag, DNA sequencing
4 cDNA library construction and development of BAC and YAC libraries, PCR Amplifications
5 Gene sequencing, Principles and types of sequencing (Next generation sequencing)
6 Genome mapping and different methods of mapping, Physical mapping of genomes and different techniquesinvolved in physical mapping
7 Gene sequence analysis and annotation by using annotation models
8 Case study: Genome Projects: *E. coli*
9 Case studies: Genome Projects: Arabidopsis, Bovine
10 Case study: Genome Projects: Human genome project, Brief about Comparative Genomics and techniquesinvolved in it and Synteny
11 Orthologous and Paralogous sequences 12 Gene Order, Phylogenetic foot printing.
13 Introduction to Functional genomics
14 Analogy for gene expression and involved techniques15 Principles and procedure of ESTs, cDNA-AFLP
16 Principle and types of microarrays and its application in functional genomics
17 Functional analyses of genome by Differential display techniques like SAGE, RNAseq, Real time PCR18 Principal, procedure and applications of SAGE RNAseq, Real time PCR

Midterm Examination

19 Principle, procedure and applications of Real time PCR
20 Introduction to proteome and proteomics terminology and history, Protein synthesis21 Protein isolation techniques i.e Chromatographic techniques: HPLC, GC
22 Protein Purification techniques from crude extract
23 Protein separation by Native PAGE, SDS PAGE, 2D PAGE and its Principles and procedure
24 Protein staining techniques i.e silver staining, Coomassie blue staining, Sypro Ruby staining25 Techniques of protein digestion i.e Edmann Degradation and peptide purification
26 Protein analysis by Mass Spectrometry: MALDI-TOF, LCMS, Electrospray ionization (ESI)27 Principles and procedure of MALDI-TOF
28 Peptide fingerprint analysis
29 Mass Spectrometric Identification of Proteins - Mapping
30 Protein identification: Peptide mass fingerprint, Tandem Mass Spectrometry (MS/MS)
31-34 Types Post Translational modifications: Methylation of cytidine residues in the DNA, The modificationsof the histones and of CpG methylation
35-36. Application of genomics and proteomics in crop development

Suggested Readings

1. Branden C & Tooze J. l999. Introduction to Protein Structure. 2nd Ed. Garland Science.
2. Connor DO & Hames BD. 2007. Proteomics: Methods Express. Royal College of General Practitioners.
3. Pennington S R & Dunn M J. 2001. Proteomics from protein sequence to function. BIOS Scientific Publishers Ltd.
4. Singer M & Berg P. 1991. Genes & Genome. University Science Books.
5. Tropp BE. 2012. Molecular Biology Genes to Proteins. 4th Ed. Jones & Bartlett Learning

BPBT 3112 Immunology (1+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; Immunologicalapplication 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, westernblotting; Raising of antisera in laboratory animals; Collection and preservation of antisera – separation, filtrationand aliquoting.

Lecture Schedule

1-2) History and scope of immunology
3-4) Components of immune system: organs, tissues and cells
5) Immunoglobulin structure and functions
6-7) Molecular organization of immunoglobulins and classes of antibodies8)Antibody diversity
9) antigens, haptens

Mid Term Examination

10) antigens antibody interactions
11) Immuno-regulation and tolerance.
12) Allergies and hypersensitive response
13) Immunodeficiency
14) Vaccines
15) Immunological techniques
16) Immunological application in plant science
17) monoclonal antibodies and their uses
18) Molecular diagnostics.

Practical Schedule

1-2) Preparation of buffers and reagents3-4) Precipitation and agglutination test5-6) HA, HI test
7-8) Immunoblotting
9-10) Immunoelectrophoresis and fluorescent antibody test11-12) Enzyme immunoassays including ELISA variants
13) Western blotting
14-15) Raising of antisera in laboratory animals
16-17) Collection and preservation of antisera – separation, filtration and aliquoting.
18) Practical Examination.

Suggested Readings

1. Murphy, K. 2012. *Janeway's Immuno Biology*. 8th Ed. Garland Science/ Taylor& Francis Group.
2. Owen, JA., Punt, J., Kuby, J. & Sharon, A. 2013. *Kuby Immunology*. 7th Ed. W.H. Freeman

BPBT 3113 Biosafety and IPR in biotechnology (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 Protocolof bio-safety, and risk management for GMO's; Bio-safety guidelines, rules and regulations and regulatory framework for GMOs in India.

Lecture schedule

1 Introduction to Intellectual Property, concepts and types2-4 Intellectual Property - types
5-7 International treaties for protection of IP's- WTO, WIPO, GATT, TRIPS
8-10 Indian Legislations for the protection of various types of Intellectual Property
11 Patent search
12 Patent filing process
13 Material transfer agreements
14-15 Biodiversity definition, importance and geographical causes for diversity16-18 Species and population biodiversity

Mid-Term Examination

19-20 Maintenance of ecological biodiversity hot spots in India21 -23 Convention on biological diversity
24-27 Cartagena Protocol of bio-safety, and risk management for GMO's28-32 Bio-safety guidelines
33-36 Rules and regulations and regulatory frame work for GMOs in India

Suggested Readings

1. Singh BD. 2007. *Biotechnology: Expanding Horizon*. Kalyani Publishers.
2. Goel D and Parashar S. 2013 *IPR, Biosafety and Bioethics*. Pearson Education India.
3. Ahuja V.K. 2017. *Law Relating To Intellectual Property Rights*. Lexis Nexis
4. http://patentoffice.nic.in
5. www.wipo.org
6. www.dbtindia.nic.in; www.dbtbiosafety.nic.in

BPBT 3114 Computational biology (2+1)Theory

UNIT I

Introduction to computational biology; Web based servers and software for genome analysis: Ensemble, UCSCgenome 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; Workingwith protein structural classification databases; SNP and SSR identification tools; PHYLIP.

Lecture schedule

1 Introduction to computational biology: Definition and application
2-4 Web based servers and software for genome analysis: Genome Analysis an overview: approaches and methodsof genome analysis, Web based servers for genome analysis: OBRC: Online Bioinformatics Resources Collection, Web based software for genome analysis: DNA Sequence Quality – Phred, EGassember, Tools at server genometools.org
5-6 Ensembl: Processing your data, Accessing Ensembl data, BLAST/BLAT, BIoMART. UCSC genomebrowser: analysis tools at server

7-9 MUMMER: Analysis genome data using this tool, components and its applications BLASTZ; Use of BLASTZ for analysis genome sequences, methods and output validation. Sequence submission: how to submit data throughBankIT and Sequin tools
10-12 Protein interaction databases: Introduction and overview of protein interaction.
BIND: To query, view and submit records, Functional Alignment DIP: Structure of The Database, State of The Database, The JDIP Visualization Tool, STRING: Search Protein sequences, by protein name, search protein multiple sequences. PRIDE: Submit data and browse the data in PRIDE.
13-15 Principles of Protein structure prediction: Primary, secondary and tertiary structure prediction, online toolsfor the protein structure prediction at EXPASY server
16-17-Fold Recognition (threading): Introduction, definition, methods and software for the threading and its applications
18-19 Homology modeling: Methods and tools for homology modeling for nucleotide and protein data

Midterm Examination

20-23 SCOP, CATH, PDB, PROSITE, PFAM: Introduction to these databases, how to retrieve information fromthese database and pattern searching from the database.
24-25 Methods for comparison of 3D structures of proteins: Sequence dependent vs. sequence-independent methods, Superimposition-based vs. superimposition independent methods, Distance-based measures of protein structure similarity: Root Mean Square Deviation (RMSD)
26-27 Phylogenetic analysis: Importance, different Methods of phylogenetic analyses and their application with biological data.
28-32 Evolutionary models:Models for DNA and protein evaluation, Continuous-time Markov chains. Deriving the dynamics of substitution.Ergodicity, Time reversibility. Scaling of branch lengths, JC69 model (Jukes and Cantor, 1969), K80 model (Kimura, 1980), F81 model (Felsenstein 1981). Tree construction methods, Statisticalevaluation of tree methods
32-34. PHYLIP, dendroscope, MEGA: introduction and its use to biological data analysis. 35-36. DNA barcoding database-BOLD: How to access the database and identify the species

Suggested Readings

1. Creighton TE. 1993. Proteins: Structures and Molecular Properties 2nd Edition. W.H Freeman.
2. DovStekel. 2003. Microarray Bioinformatics. 1st Ed. Cambridge University Press.
3. Mount D. 2001. Bioinformatics: Sequence and Genome Analysis, 2nd Ed. Cold Spring HarborLaboratory Press.
4. Malcolm Campbell A. & Laurie J. Heyer. 2007. Discovering Genomics, Proteomics and Bioinformatics.2nd Ed. Benjamin Cummings.
5. Setubal Joao & Meidanis Joao. 2004. Introduction to Computational Molecular Biology, PWS PublishingCompany.

BPBT 3115 Bioprocess engineering in biotechnology (2+1)Theory

UNIT I Overview of bioprocess engineering, Concept of material balance: types of material balance, growth stoichiometry and elemental balance, electron balance, maintenance coefficient and yield concept, Isolation, preservation, maintenance and screening of Industrial important microorganism.
UNIT II Principle of microbial nutrition, formulation of culture media, selective media, factors influencing the choice of various carbon and nitrogen sources, vitamins, minerals, precursors and antifoam agents, medium optimization. Microbial growth kinetics: growth, substrate utilization and production kinetics in Batch, Continuous and Fed-batch processes.
UNIT III Sterilization: concept and methods. Type of Sterilizations, Batch heat sterilization of liquids, Continuous heat sterilization of liquids, Sterilization of air: Methods &Mechanism, Design

of depth filter and estimation of its efficiency. Bioreactors: components and control of process parameters, Types of bioreactors: CSTR, Airlift, Fluidized bed, plug flow reactor. Concept of ideal and non-ideal reactors

UNIT IV Role of diffusion in Bioprocessing, Convective mass transfer, Gas-liquid mass transfer, Oxygen uptake in cell cultures, Factor affecting cellular oxygen demand, Oxygen transfer in bioreactors, Measurement of volumetric oxygen transfer coefficient, Oxygen transfer in large bioreactor. Concept of scale up and scale down in bioreactors.

UNIT V Fermentative production of Penicillin, Streptomycin, Tetracycline and other Antibiotics, Organic solvents, acetone, ethanol, butanol, Organic acids: lactic acid, citric acid and acetic acid, Enzymes (Proteases, Lipases and alpha-amylase), Amino acids (L- glutamic acid, phenylalamine and lysine).

Practical

Isolation of Pure culture; Maintenance and Preservation of Industrial important microorganism by different method; Monod Kinetics in batch culture; Carbohydrate fermentation test; Antibiotic production by Fungi; Ethanol production and its estimation; Media Sterilization in the Bioreactor; Thermal deactivation kinetics; KLa determination in the Bioreactor; Estimation of lactic acid in curd.; Study of parts of bioreactor; Study of continuous culture.

Lecture schedule

1. Overview of bioprocess engineering
2. Concept of material balance: Types of material balance

3 Growth stoichiometry and elemental balance, electron balance, maintenance coefficient and yield concept

4. Isolation, preservation, maintenance and screening of Industrial important Microorganism
5. Principle of microbial nutrition
6. Formulation of culture media, selective media
7. Factors influencing the choice of various carbon and nitrogen sources, vitamins, minerals, precursors and antifoam agents, medium optimization
8. Microbial growth kinetics: growth, substrate utilization and production kinetics in Batch, Continuous andFed-batch processes
9. Sterilization: concept and methods
10. Type of Sterilizations
11. Batch heat sterilization of liquids
12. Continuous heat sterilization of liquids
13. Sterilization of air: Methods &Mechanism
14. Design of depth filter and estimation of its efficiency
15. Bioreactors: components and control of process parameters
16. Types of bioreactors: CSTR, Airlift, Fluidized bed, plug flow reactor
17. Concept of ideal and non-ideal reactors
18. Role of diffusion in Bioprocessing

Mid-Term Examination

19. Convective mass transfer
20. Gas-liquid mass transfer
21. Oxygen uptake in cell cultures
22. Factor affecting cellular oxygen demand
23. Oxygen transfer in bioreactors
24. Measurement of volumetric oxygen transfer coefficient
25. Oxygen transfer in large bioreactor
26. Concept of scale up and scale down in bioreactors

27-30 Fermentative production of Antibiotics- Penicillin, Streptomycin, Tetracycline and other Antibiotic31-32 Fermentative production of Organic solvents, acetone, ethanol, butanol

33-34 Fermentative production of Organic acids: lactic acid, citric acid and acetic acid

35 Fermentative production of Enzymes (Proteases, Lipases and alpha-amylase)

36 Fermentative production of Amino acids (L-glutamic acid, phenylalamine and lysine

Practical schedule

1. Isolation of Pure culture
2-4 Maintenance and Preservation of Industrial important microorganism by different methods
5. Monod Kinetics in batch culture
6. Carbohydrate fermentation test
7. Antibiotic production by Fungi
8-9 Ethanol production and its estimation
10. Media Sterilization in the Bioreactor
11-12. Thermal deactivation kinetics ; KLa determination in the Bioreactor
13. Estimation of lactic acid in curd
14. Study of parts of bioreactor
15-17 Study of continuous culture
18 Practical Examination

Suggested Readings

1. J.M. Lee,1991. *Biochemical Engineering*, Prentice Hall.
2. M. Shuler and F. Kargi, 2002. *Bioprocess Engineering*, Pretice Hall.
3. J. Saxena, Mamta Baunthiyal, I. Ravi, 2005. *Laboratory Manual of Microbiology*, *Biochemistry and MolecularBiology*, Scientific Publishers.

Elective I - Plant BiotechnologyBELB 3201 Commercial micropropagation of crop plants (2+1)

Theory

UNIT I

Historical benchmarks of plant cell and tissue culture; Culture media components and modifications; Sterilizationtechniques; 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.

Lecture Schedule

1. Historical benchmarks of plant cell and tissue culture: History of plant tissue culture
2. Introduction, Scope and Importance,
3. Applications of Plant tissue culture
4-5. Culture media components and modifications: Different constituents of media (Inorganic nutrients, Carbonand energy sources, Organic supplements, Growth regulators, Solidifying agents, Ph of medium and their roles;
6. MS basal medium and different types of medium
7. Sterilization techniques: Types of sterilization, Importance of sterilization
8. Various types of culture: callus, suspension, nurse, root, meristem: concept, principal, types, methodology andapplications.

9-11 *In vitro* differentiation: Organogenesis and somatic embryogenesis: Concept, Principal, types, methods andimportance and applications.
12-13 Plant growth regulators: Auxins and Cytokinins their mode of action, effects on *in vitro* culture andregeneration
14 Applications: Micropropagation; Anther and microspore culture;15 Somaclonal variations: Concept, Principle, Methods
16 Factors affecting and causes of Somaclonal variation
17 Importance and applications of Somaclonal variation along with examples.
18-19 *In vitro* mutagenesis: Concept, type of mutagen, methods of *in vitro* mutagenesis, their confirmation, merit,demerits and applications.
Midterm Examination
20-21 Production of secondary metabolites: Concept, types, methods and applications.
22-23 Synthetic seeds: Concept, Principle, Method, factors affecting, Importance & Applications
24-25 *In vitro* fertilization; Embryo rescue in wide hybridization: Principle, methods with merits & demerits,Importance & Applications
26-28 Endosperm culture: Concept, principle, method, importance and applications
29-32 Protoplast isolation, culture and regeneration: concept, Principle, Methods of protoplast isolation, culturemethods, culture conditions, Importance and Applications
33-34 Somatic hybridization: concept, methods of somatic hybridization, selection of hybrid cell and regeneration, merits, demerits and Applications.
35 Cybrid and asymmetric hybrid- concept, methodology and importance
36 *In vitro* germplasm conservation: cryopreservation, methods, limitations and applications

Practical schedule

1-2 Establishment of callus/ cell suspension cultures3 Induction of plant regeneration
4-6 Micropropagation – Explant establishment, shoot multiplication, root induction7-9 Study of hardening and aftercare of tissue cultured plantlets
10-12 Monitoring of growth and differentiation of cells13 Seed/Embryo culture
14 Ovary culture
15 Study of Anther culture16 Study of pollen culture
17 Suspension cultures, Production of secondary metabolites
18. Practical Examination

Suggested readings

1. Bhojwani SS & Razdan MK. 1996. *Plant Tissue Culture: Theory and Practice*. Elsevier.
2. Debergh PC & Zimmerman RH. 1991. *Micropropagation: Technology and Application*.Kluwer Academic.
3. Chawla H.S. Introduction to Plant Biotechnology
4. Dey Kumar K. Plant Tissue Culture. New Central Book Agency (P) Ltd.

BELB 3202 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 DNAmethylation 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 nylonmembrane; 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.

Lecture Schedule

1-3. DNA methylation and histone modifications4-5.DNA methylases
6-9. methyl binding proteins and histone modifiers
10-11. Epigenetic changes in response to external stimuli leading to changes in gene regulation12-15. Role of DNA methylation in plant development
16-18. mutant case studies.

Mid Term Examination

19-20. Introduction to small RNAs: History21-22. Biogenesis
23-24. In silico predictions
25-26) target gene identification
27-28. methylation of heterochromatin by het associated siRNAs
29. Gene regulation by small RNA Other classes of siRNAs30-31. Role in epigenetics
32. Jacob Monod model33-34. RNA editing
35-36. Genome imprinting.

Practical Schedule

1-3. In silico study of structural components of histone modifiers and DNA methylases of model plants4-5. In silico prediction of siRNAs and miRNAs
6-7. Small RNAs electrophoresis using PAGE
8-9. Blotting of small RNAs on nylon membrane10-11. miRNA target finding
12-13. Detection of small RNAs using fluorescent labelled probes14-15. Bisulphite sequencing for methylation
16-17. qRT-PCR for quantitative analysis of small RNAs in developmental phases.
18. Practical Examination

Suggested Readings

1. Green & Sambrook. 2014. *Molecular Cloning: A Laboratory Manual*. 4th Ed. Vol I, II & III Cold Spring HarborLaboratory Press.
2. Mohanpuria, P., Kumar, V., Mahajan, M., Mohammad, H. & Yadav, SK. 2010. *Gene Silencing: Theory,Techniques and Applications: Genetics-Research and Issues.* Nova Science Publishers.

BELB 3203 Omics in plant biotechnology (2+1)Theory

UNIT I Structure of genomes: Arabidopsis, rice, tomato, pigeon pea, wheat. Assessing genomic variations DNAmarker systems. Hybridization based Marker system- – RFLP. PCR based marker system - RAPD, AFLP, CAPS,SCAR, SSRs. DNA Microarray based SNP detection techniques. Applications of DNA markers. DNA chips andtheir 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 modeling (Homology modeling, crystallography and NMR); Protein microarray. Proteome analysis; Protein- protein interaction: FRET, yeast two hybrid and co- immunoprecipitation. **UNIT III** Applications of genomics and proteomics in agriculture, human health and industry. Metabolomics and ionomics for elucidating metabolic pathways

Practical

Genomic DNA isolation- Analysis of genome using markers. Specialized crop based genomic resources: TAIR, Gramene, Maizedb, Phytozome, Cerealdb, Citrusdb; miRbase. Protein isolation and separation- SDS- PAGE.PAGE documentation and analysis.2D PAGE for proteome analysis. Protein 3D structure modeling. Homology modeling

Lecture Schedule

1. Genomics and its diversifications
2-4 Structure of genomes: Arabidopsis, rice,
5-8. Structure of genomes: tomato, pigeon pea, wheat
9-10. Assessing genomic variations-DNA marker systems
11. Hybridization based Marker system- – RFLP
12. PCR based marker system - RAPD, AFLP, CAPS, SCAR, SSRs
13. DNA Microarray based SNP detection techniques14-15 Applications of DNA markers
16-18.DNA chips and their use in transcriptome analysis

Midterm Exam

19. Mutants in functional genomics
20. RNAi in functional genomics
21. Site directed mutagenesis
22. Transposon tagging
23. Transient gene expression: VIGS and FACS based
22. Targeted genome editing technologies
23. Bio-informatics in proteomics: Protein 3D structure modeling (Homology modeling)
24. X-ray crystallography and NMR. Protein microarray
25. Applications of Mass Spectrometry (Peptide mass fingerprinting and Post translational modifications)
26. Proteome analysis- Interactomes and proteomic interactions. Protein- protein interaction: FRET27-28 Yeast two hybrid system and Co-immunoprecipitation
29-30 Applications of genomics and proteomics in agriculture, 31-32 Applications of genomics and proteomics in human health33-34 Applications of genomics and proteomics in industry
35-36. Metabolomics and ionomics for elucidating metabolic pathways.

Practical Schedule

1. Preparation of reagents for DNA and Protein isolation
2. Genomic DNA isolation
3-4. Analysis of genome using markers
5-9. Specialized crop based genomic resources: TAIR, Gramene, Graingenes, Maizedb, Phytozome, Cerealdb,Citrusdb; miRbase
10-11. Protein isolation and separation- SDS-PAGE
12. PAGE documentation and analysis13-14 2D PAGE for proteome analysis
15. Protein characterization through HPLC
16-17. Protein 3D structure modeling-Homology modeling
18. Final Practical Examination

Suggested Readings

1. Connor DO &Hames BD. 2007.Proteomics: Methods Express. Royal College of General Practitioners.
2. Pennington S R, Dunn M J. 2001. Proteomics from protein sequence to function. BIOS Scientific PublishersLtd.
3. Singer M & Berg P. 1991. Genes & Genome. University Science Books.
4. Tropp BE. 2012. Molecular Biology Genes to Proteins. 4th Ed. Jones & Bartlett Learning. 5. Verma PS & Agarwal VK. 2014. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand & CompanyPvt. Ltd

BELB 3204 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.

Lecture scheduleTheory

1-2. Concept of plant genetic transformation- nuclear and organellar transformation and applications3-4. Gene transfer methods: Direct

5-6. Gene transfer methods Indirect

7. Marker free transformation methods

8. In planta transformation

9-10. Vectors for plant transformation

11-12. molecular characterization of transgenic plants using PCR, real time PCR, Southern, Northern and westernanalysis

13-14. Bioassays with transgenic plants

15. Evaluation and selection of transgenic events for target trait

16-17. Genetic engineering of crop plants for useful traits -biotic stress 18-19. Genetic engineering of crop plants for useful traits -abiotic stress

20-24. Genetic engineering of crop plants for useful traits -increasing yield, biofortification, edible vaccine etc.

25. Over expression, inducible, tissue specific expression

26. Gene silencing systems

27. Biosafety concerns and regulatory mechanisms

28. Commercialization of transgenic products and GMO's

29-30. Transgenic plants for the production of biopharmaceuticals

31-33. Molecular farming of plants for applications in medicine systems

34-36. Heterologous protein production in transgenic plants; Successful case studies.

Practical schedule

1. Genomic DNA isolation

2. Designing primers

3. Ligation of gene in suitable cloning vector4-6. Bacterial transformation

7-8. Confirmation of recombinant clones

9-10. Transfer of gene construct to binary vectors and confirmation

11. Preparation of competent cells of Agrobacterium

12. Freeze thaw method of genetic transformation of Agrobacterium

13. Particle gun mediated genetic transformation.14-15. Cocultivation of tobacco explants
16-17. Histochemical GUS assays PCR screening of putative transgenic plants; Raising transgenic undercontainment and field conditions
18. Practical examination

Suggested Readings

1. Bhojwani SS & Dantu PK. 2013. Plant Tissue Culture: An Introductory Text. Springer
2. Brown TA. 2007. Gene Cloning & DNA Analaysis: An Introduction. 6th Ed. Wiley-Blackwell Publishing.
3. Grierson D. 2012. Plant Genetic Engineering. Springer Netherlands. Lal R & Lal S. 1990. Crop ImprovementUtilizing Biotechnology. CRC Press.
4. Primose SB & Twyman RM. 2006. Principles of Gene Manipulation and Genomics. 7th y Ed. Wiley-BlackwellPublishing

Elective II Animal Biotechnology (4 courses)BELB 3205 Principles and procedures of animal cell culture (2+1)

TheoryUNIT 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 andmaintenance 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 equipment 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.

Lecture schedule

1 History and importance of animal cell culture
2 Development of animal cell culture techniques: Primary cell culture, Secondary cell cultures,3 Cell Line and Monolayer cultures
4 Suspension cultures. Immobilized Cultures
5 Culture of Primary Chick Embryo Fibroblasts (CEF):
6. Formulations of Media and Solutions, Transfer of Cell Cultures,
7. Preservation of Cultured Cells by Freezing
8. Basic requirements for animal cell culture: Choice of materials: Cell type, Source of tissue, Subculture,
9. Selection of medium, Gas phase, Culture system, Substrate
10. Sterilization procedures for cell culture work: Sterilization of apparatus- Glasswares, Filter assembly

11. Sterilization of reagents and media- Water, BSS, Serum, media
12. Different types of cell culture media: Introduction, Serum media, Serum free media
13. Complete media, Synthetic media
14. Other cell culture reagents and growth supplements: Amino acid, Hydrolysates, Embryo extracts, Conditionmedium, Antibiotics and Antimycotics.
15. Different cell culture techniques including primary and secondary cultures:
Primary culture: Disaggregation of cells
16 Initiation of primary cell culture, Explant culture 3
17 Subculture of cells and secondary culture, cell lines Cell counting- viable count18 Continuous cell lines, suspension culture, Organ culture etc

Midterm Examination

19-20. 20 Commonly used animal cell lines: CHO, HeLa, BHK-21, VERO, Sf9, C636; their origin andcharacteristic
21 Growth kinetics of cells in culture- monolayer and suspension culture, Cell proliferation22 Differentiation of cells: Expression of the *in-vivo* phenotype, stages,
23 Cell lineage, cell strain, Markers of differentiation, Induction of differentiation
24 Characterization and maintenance of cell lines: Need, parameters, Cell morphology, Microscopy andChromosome content
25 DNA analysis, RNA and protein expression, antigenic markers
26 Applications of animal cell cultures: Basic application- Intracellular activity, Intracellular flux, Genomics,Proteomics, Cell-cell interaction etc.
27 Applied application- Cell products, Immunology, Pharmacology, Tissue engineering, Toxicology etc.28 Cryopreservation and revival of cells: Need and consideration for freezing, Principles
29 Methodology for cryopreservation. Vitrification and cell banks
30 Hybridoma technology: Historical background and methodology of hybridomas31 Scaling up methods: Scaling up in suspension, Scaling up in monolayer
32 Bioreactors: Controlled bioreactor- Stirred, Airlift, Hollo-fibre, Packed-bed,Fixed bed, Fluidized-bed reactor, large scale bioreactor, Wave bioreactor
33. Overview of insect cell culture: Cell growth- Characteristics and media development, small scale culture, Cellline development and its application
34 Stem cell culture and its application: Derivation, Subculture
35 Propagation of mouse and human embryonic stem cell Passaging hES cells.
36 Common cell culture contaminants and their management: Sources and types of microbial contamination, Monitoring of contamination, Disposal of contaminated culture, Eradiation of contamination, Cross contamination

Practical schedule

1 Study of basic equipments used in animal cell culture laboratories
2 Preparation of washing, packing and sterilization of glass and plastic wares for cell culture3 Preparation of media and filtration for cell culture
4 Preparation of chicken embryo fibroblast5 Subculture of cell culture
6 Isolation and preparation of lymphocyte culture
7 Viability assay by trypan blue dye exclusion method
8. DNA fragmentation assay
9 Preparation of inoculum for virus isolation10 Virus inoculation: Cell culture
11 Cryopreservation of cells12 Cytopathic effect staining13 PBMC culturing
14 Preparation of buffers and reagents for cell culture15 Extraction of RNA by Trizol method
16 Extraction of DNA by Chelax method
17 Quantitation of nucleic acid, Amplification of F gene segment of Newcastle disease virus by RT-PCR

18. Practical examination

Suggested Readings

1. Butler M. 2003. Animal Cell culture & Technology. Garland Science.
2. Freshney RI. 2011. Culture of Animal Cells: A manual of basic technique and specialized applications. 6thEd. John Wiley & Sons.

BELB 3206 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 Nondisjunction and Aneuploidy, Polyploidy,Induced Polyploidy, Syndromes, Structural aberrations, Robertsonian Translocations, Position Effect, Chromosomal Mosaics, Chromosomal aberrations and evolution.

UNIT II

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

Lecture Schedule

1-2) Genome organization in eukaryotes
3-4) Satellite DNA: VNTRs & families, LINE & SINE
5-6) Sex determination: Chromosomal basis of sex determination7)Molecular markers for sex determination
8) environmental sex determination
9) Chromosomal aberrations: Euploidy
10) Chromosomal Nondisjunction and Aneuploidy
11) Polyploidy, Induced Polyploidy12)Syndromes
13-14) Structural aberrations, Robertsonian Translocations15)Position Effect
16)Chromosomal Mosaics
17-18) Chromosomal aberrations and evolution.

Mid Term Examination

19) Molecular Markers: Markers
20) Genetic Markers: RAPD, STR
21) DNA fingerprinting
22) SSCP, RFLP, SNP, EST
23) SNP Analysis
24) karyotyping
25-26) Somatic cell hybridization
27) Radiation hybrid maps
28) FISH technique
29-30) Major Histocompatibility Complex: Concept and its relevance in disease resistance &

immune response
31) Quantitative trait Loci
32-33) Marker Assisted Selection: Concept, Linkage Equilibrium, Application in Animal
34) Sciences Genomic Selection: Concept, Linkage Disequilibrium, Methodologies of economic Selection35)Mitochondrial DNA analysis and its application in livestock
36) Applying DNA markers for breed characterization.

Practical Schedule

1-2) Extraction of genomic DNA from peripheral blood3-4) Analysis of DNA by agarose gel electrophoresis
5-6) Analysis of DNA by polyacrylamide gel electrophoresis7-8) Checking the quality of genomic DNA
9) Checking the quantity of genomic DNA
10) Restriction digestion & analysis
11) Sanger Sequencing data analysis
12-13) Extraction of mitochondrial DNA
14) Extraction of RNA from PBMC15)Quality checking of total RNA 16-17) cDNA synthesis.
18) Practical Examination

Suggested Readings

1. Brown, TA., 2006. *Genomes*. 5th Ed. Wiley-Blackwell.
2. Dale, JW., Schantz, MV. & Plant, N., 2012. *From Genes to Genomes: Concepts and Applications of DNA Technology*. John Wiley & Sons.
3. Green & Sambrook, 2014. *Molecular Cloning: A Laboratory Manual*. 4th Ed. Vol I, II & III. Cold Spring.
4. Reece, RJ. 2004. *Analysis of Genes & Genomes*. Wiley

BELB 3207 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. A

Lecture schedule

1-2. History, advantages, limitations and scope of embryo transfer technology3-5. Estrus cycle and its detection in animals
6-7 Methodology of super ovulation
8-9 Methodology of Ovum pick up (OPU)
10-12 Preparation of sperm for in vitro fertilization (IVF)13-14 Embryo grading and culture
15-18 Micromanipulation and immuno-modulation for enhancement of fecundity.

Mid-Term Examination

19-21 Different methods of gene transfer and their limitations22-24 Embryo splitting- methods

25-26 Embryo sexing by different methods
27-28 Production of transgenic livestock by nuclear transfer and its application
30-31 Production of transgenic livestock - Regulatory issues (social, ethical, religious and environmental)32 Cloning of domestic animals
33 Conservation of endangered species
34-36 Characterization of embryonic stem cells and applications.

Practical Schedule

1-2 Demonstration of estrus detection methods
3. Estrus synchronization
4. Superovulation
5-6. Oocyte collection from slaughterhouse ovaries 7-8. Grading of oocytes from slaughterhouse ovaries9-10 Collection and preparation of semen samples 11-12. *In vitro* fertilization
13 Collection of embryos using non-surgical procedures
14. Grading and culture of embryos
15. Embryo sexing by different methods
16. Embryo splitting
17. Embryo freezing.
18. Practical Examination

Suggested Readings

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

BELB 3208 Transgenic animal production (3+0)Theory

UNIT I

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

UNIT II

Production of gene knockouts: Cre-lox, zinc finger nucleases; CRISPR; TALENs; Production of chimericanimals; 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 intransgenesis 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 animalproduction.

Lecture schedule

1	History of transgenics
2.	Isolation of gene
3	Preparation of gene construct
4-5	Methods of transgenic animal production: - a. Calcium chloride mediated transfection: b. c. Electroporation: d. Microinjection

5-6	Nanodelivery:-Physico-chemical properties of the penetrant molecules (Partition coe conditions, Penetrant concentration). Physico-chemical properties of drug delivery systecharacteristic, Enhancement of transdermal permeation)
7-8	Physiological and pathological condition of skin (Reservoir effect of horny layer, Lipihydration, Skin temperature, regional variation, Pathological injuries to the skin, Cu metabolism) Routes of drug penetration through the skin
9-10	Production of gene knockouts: (1) Construction of the targeting vector (2) Gene targeting in embryo-derived stem (ES) cells 3) Selection of gene-targeted cells (inset).
11-1	Cre-lox: Conditional gene targeting, Cre (Cause recombination), Use in conditional ge Generation of a conditional knockout mouse using the Cre– loxP system
13	Chromosomal Engineering Using the Cre–loxP System, Cre-lox technology for targeted recombination of transgenes
14-1	Zinc finger nucleases: Definition of ZFN, Benefits, Target Applications, ZFN-Mediated Targeted Genome Editing
16-1	CRISPR: What is CRISPR?, Three types of CRISPR, Genome editing glossary, ApplicationTargeting Efficiency and Off-target Mutations, T7 Endonuclease I Targeting Efficiency A
	Midterm Examination
19-2	TALENs: What is transcription activator-like effector nucleases (TALENs), Overview o TALENs strategy for efficient and specific modifications of genome, *In vivo* genome editi
21-2	Production of chimeric animals: Culture of embryonic stem (ES) cells to Offspring deri germline chimera is either derived from the genetics of the ES cells or that of the host emb
23-2	Characterization: -Fluorescent labeling of cell membranes. -Tracking cell contribution to offspring. -Use of beta- galactosidase gene (beta-gal) -Transgenic reporter gene -Transgcontribution -The final proof that these cell lines are indeed ES cells
26-2	Gene silencing by lentivirus system: -Vectors for somatic cell gene therapy -Adv Disadvantages of lentivirus
28-2	Mechanism of RNA interference RNAi pathway triggered by the introduction into cells o double stranded RNA (dsRNA).
30-3	Stem cell technology: - Isolation of stem cell lines from different sources: - Embry Mesenchymal stem cell and its production from human bone marrow: Induced pluripoteCharacterization of stem cell lines
33-3	Introduction to animal cloning: - Definition of clone, cloning by embryo splitting, Special cloning by somatic cell nuclear transfer (SCNT), Why is cloning inefficient? Are clonprogeny healthy? Is the milk or meat from clones safe? Is it the same? Is the progeny of c eat? Other regulatory authorities confident that the progeny of cloned animals is safe.
36-3	Application of stem cells in transgenesis and animal cloning: - Clinical application of cul stem cells, Commercial benefits of domestic animal embryonic stem cells, Commercial us cloning technology, Transgenesis in mice
38-39	Fundamental assays of transgenic products: -PCR, Southern blotting, Western blotting, linked immunosorbent assay (ELISA) -Transgenic animal mutagenicity assays - Use of transin the detection of gene mutations in germ cells

40-41 Confirmation of integration of transgene: • PCR to determine the presence or absence of thquantitative PCR (q-PCR) to determine the number of copies of the transgene Fluore
hybridization (FISH)

42 Validation of transgenic products: - Isolation of transgenic protein from milk

43 Characterization: A. Genetic Stability B. Stability of expression Characterization of the transg

(F0) animal

44-46 Application of transgenics in production of disease resistance models and carcinogenesis: - Atransgenics: Improved growth rates (e.g., shrimp and lobster), Improved size or appearanc
nutrition (low cholesterol), Disease resistance

47 Chemical production (bioreactors), Biomedical research models (therapy and toxicity)

48 Application of Transgenic Models to Drug Development: Disease Models Description
determine disease causation or therapy development

49-50 Models to determine disease causation or therapy development on Breast cancer, neurologcardiac disease, Alzheimers/aging

51 Carcinogenicity testing- -Three different types of transgenic strains have been employed in th
of transgenic mice for carcinogenicity testing

52 Regulatory issues associated with transgenic animal production: - Principles include: Esta
standards for safeguarding human health and animal health and welfare

53 Developing clear technical standards and assessment guidelines, providing a sound scient
evaluating associated risk.

54 Consulting and involving stakeholders and the general public in the development of regulati
upon existing regulations and technical standards, maintaining genetic diversity and coenvironment.

Suggested Readings

1. Ramadass, P. 2008. *Animal Biotechnology*: *Recent Concepts and Developments*. MJP Publishers.
2. Ranga, M. M. 2007. *Animal Biotechnology*. Agrobios.
3. Singh, B.D. 2010. *Biotechnology expanding Horizons*. Kalyani Publishers.
4. Singh, B., Gautam, S. K. & Chauhan, M. S. 2014. *Textbook of Animal Biotechnology.* The Energy andResources Institute, TERI.

Elective IV Bioinformatics (6 courses)BELB 3209 Programming for bioinformatics (2+2)

TheoryUNIT 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 inputand 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.

Lecture schedule

1 Introduction to Operating System
2 Chronological events in the development of operating system
3 Operating System Overview: Definitions of Memory, device, processor and file management
4-5 Operating System types and Services
6-7 Operating System properties and Processes8 Introductory programming concepts
9-10 Introduction to algorithms and flow charts11-12 Introduction to programming languages 13-14 Compiler and interpreter
15-16 Computer number format: Decimal, Binary, Octal and Hexadecimal. Problems on interconversion ofnumber system
17 C-Language: History
18-19 Constant, variables and identifiers

Midterm examination

20-21 Character set, logical and relational operators22 Data input and output concepts
23-24 Decision making: if statement, if-else statement 625-26 For loop, While loop and Do-while loop 6
27-28 Arrays and Functions 6
29 File handling 6
30-31 Programs related to arithmetic operations, 432 Arrays and file handling in C
33 -34 Introduction to R
35-36 Introduction to Python

Practical schedule

1-2 Programs using simple scalar and array variables:
To transcribe DNA sequence to RNA, to concatenate sequences, To make reverse complement of sequence, Toreverse transcribe RNA to DNA sequence
3-7 Programs based on conditional statements and loops:
To search motifs in DNA or protein, To count nucleotides from given DNA and RNA sequences, To reportpercentage of hydrophobic amino acid in given protein, To write PERL script to report GC content of sequence,
To search a motif in DNA and Protein sequence using regular expression and print it on screen (use special variables '$&' if required), To focus using following PERL features for above mentioned programs:
(1) Open and unless calls (2) do-until loop (3) foreach loop (4) Perl built in functions like Split, Pop, Shift etc.
8-10 Programs based on Subroutines: To write a subroutine and calling it- Scoping a subroutine- Passing arguments to subroutine- Using Pass by value and Pass by reference-To demonstrate the Perl Debuggers Programslike starting a debugger,
setting breakpoints. Usage of 'use warnings' and 'use strict' utilities.11 Programs based on concept of randomization:
To write a program to simulate DNA mutation, To write programs calculating percent identity

between pairsof random DNA sequence
12-13 Introduction to hash datatype:
To write a program to manage Genetic code and redundancy in genetic
Code, To write program that translate DNA into protein, To write a program that Read FASTA file and extractthe sequence data, To read DNA sequence from FASTA file, translate to protein and report the formatted output,To work with reading frames. (Example: Writing programs that translate DNA in all six reading frames)
14-15 Working with Restriction Maps and Regular Expressions: To make programs for parsing REBASE datafile and creating a subroutine, to make restriction map from user input on names of restriction enzymes
16 Working with GenBank files
To program for separating Annotation from sequences from GenBank flat file, To programs for parsing annotation using arrays, To program for parsing FEATURE table data
17-19 Working with PDB files:
To program to extract sequence from PDB file, To program for extracting secondary structure information from PDB file. (Examples: HELIX, SHEET, TURN record types of PDB file)
20 Working with BLAST output: Parsing BLAST output. (Example: Extract annotation and Alignment), To use BIOPERL module
21-23 Getting Started with Shell Programming:
How to write shell script, Variables in shell, How to define User defined variables (UDV)
Rules for Naming variable name (Both UDV and System Variable), How to print or access value of UDV (Userdefined variables),
24 Getting Started with Shell Programming: Shell Arithmetic
25-27 Shells (bash) structured Language Constructs:Decision making in shell script (i.e. if command), test command or [expr], if...else...fi- Nested ifs- Multilevel if-then-else-, Loops in Shell Scripts, for loop- Nested for loop- While loop-
27-32 Getting Starting with awk
32-34 Sequence manipulations using shell scripting35-36 Getting started with R programming

Suggested Readings

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

BELB 3210 Bioinformatics tools and biological databases (2+1)Theory

UNIT I

Introduction: Biological data types, collection, classification schema of biological databases; Biological databasesretrieval 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, multiplesequence alignment, phylogenetic analysis, molecular visualization tools.

Practical

NCBI; Expasy: SwissProt; EBI; Search engines: ENTREZ and SRS; Perform local alignment

using all BLASTvariants; Multiple sequence alignment using ClustalW; T Coffee; phylogenetic analysis by PHYLIP; MEGA.

Lecture schedule

1) Introduction
2) Biological data types
3-4) collection, classification schema of biological databases
5) Biological databases retrieval systems 6-7) Sequence and molecular file formats.
8) Biological databases
9-10) Nucleotide database
11-12) protein database
13) structural database
14) genome databases
15-16) metabolic pathway database17-18) literature database

Mid Term Examination

19) chemical database
20-21) gene expression database
22-24) crop database with special reference to BTISNET databases.25-26) Bioinformatics Tools
27) Concept of alignment28-29) scoring matrices
30-31) alignment algorithms 32)heuristic methods 33)multiple sequence alignment
34) phylogenetic analysis
35-36) molecular visualization tools.

Practical Schedule

1) NCBI
2-3) Expasy
4-5)SwissProt6-7) EBI
8-9) Search engines: ENTREZ and SRS
10-11) Perform local alignment using all BLAST variants12-13) Multiple sequence alignment using ClustalW
14) T Coffee
15-16) phylogenetic analysis by PHYLIP
17) MEGA.
18) Practical Examination

Suggested Readings

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

BELB 3211 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, Ramachandran Plot, Structural visualization tools, Tools for protein secondary and tertiary structure prediction; RASMOL, Cn3D, CHIMERA, SWISSPDB viewer, CPH, MODELLER, SWISS Model, EasyModeler, Procheck; GROMAC; SANJIVNI; BHAGIRATH. A

Lecture schedule

1. Introduction to structural databases of macromolecules
2. Introduction to structural databases of natural and synthetic small molecules
3. Structure of amino acids

4-5 Protein structure classification

6. Ramachandran plot

7-8 Experimental structure determination methods - Motifs, domain, profiles

9-10 Experimental structure determination methods - fingerprint and protein family databases

11. Structural features of RNA

12-13 RNA secondary structure predictions

14 RNA folding

15-16 Small RNA prediction

17-18 Structure prediction: Basics of protein folding

Mid-Term Examination

19 Protein folding problem

20 Molecular chaperons

21-24 Secondary structure prediction methods and algorithms: Homology*, ab initio* and folding based tertiarystructure prediction;

25-26 Structure validation tools,

27 Energy minimization techniques

28-29 Introduction to molecular dynamics and simulation30-31 Monte-Carlo methods,

32-33Markov chain and HMM

34-36 Structure visualization and comparison methods.

Practical schedule

1-2. Protein structural classification databases,

3-4. 3D-Structural databases searching and retrieval, Ramachandran Plot,5-6. Structural visualization tools

7-8. Tools for protein secondary and tertiary structure prediction RASMOL,9-10.Cn3D, CHIMERA,

11-12. SWISSPDB viewer, CPH,

13-14. MODELLER, SWISS Model,

15-16. EasyModeler, Procheck;

17. GROMAC; SANJIVNI; BHAGIRATH.

18. Practical Examination

Suggested Readings

1. A. Malcolm Campbell & Laurie J. Heyer. 2007. *Discovering Genomics, Proteomics and Bioinformatics*.

Benjamin Cummings.

2. Allan Hinchkliffe. 2008. *Modeling for Beginners*. Wiley.
3. Creighton TE. 1993. *Proteins: Structures and Molecular Properties*. W.H. Freeman
4. Mount DW. 2001. *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor.
5. Setubal Joao & Meidanis Joao. 1997. *Introduction to Computational Molecular Biology*. PWS PublishingCompany

BELB 3212 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.

Lecture schedule

1	Basic concepts of pharmacogenomics
2	Definition and History of medical concepts in pharmacogenomics
3-4	Technical application and challenges in pharmacogenomics
5	Human Genome Project
6	Genetic diseases
7	Personalized medicine
8	Molecular basis of personalized medicine
9	Pharmacogenomics necessity in drug designing
10-12	diction of structural changes among sequence variants and genetic analysis
13-14	Microsatellites for studying genetic variations.
15-16	Drug databanks
17-18	ne therapy
	Midterm Examination
19-20	dy of important drug targets and their variations
21-22	armacophore modelling- Pharmocophore: Definition and classes (HBA, HBD, Aromatic)
23	ntification of pharmacophore features
24-25	diction of ADME properties
26-27	mputational tools for toxicity prediction
28-29	R and QSAR techniques in drug designing
30-31	ug receptor interactions
32-34	uctural based drug design
35-36	inski's rule in drug design

Practical schedule

1	Molecular Docking Using HEX and AUTODOCK: Docking Studies: Approaches in Target identification
2	Methods of Active site analysis: Ligand preparation and conformational analysis, Rigid and flexible docking, Structure based design of lead compounds
3	Library docking: Molecular vizualition of docked complexes
4	Interaction analysis: Preparing Publication quality molecular graphics and illustrations
5-6	Using Chemsketch: Chemical Structure representation: 1D, 2D and 3D structures
7-8	Molecular file formats (SMILES, WLN, SDF, MOL,PDBetc)
9	Compound library formatting and filtering (Physicochemical and substructure filters)
10	Browsing and searching by DrugBank and PubChem
11	Open Source Drug Discovery (OSDD)
2	Assignment on Community Developed Resources
13	Molecular representation using SMILES
14	Structure analyses using Chimera/VMD

15- Detection of active site of proteins using various
16- softwares
17 Bioavailability using MolInspiration
18. Practical Examination

Suggested Readings

1. Hinchkliffe, A. 2008. *Modeling for Beginners*. Wiley- Blackwell Publishing.
2. Folkers,G., Sippl, W., Rognan, D. & Dieter, H. 2003. *Molecular Modeling: Basic Principles andapplications*. Science
3. Gupta, S.P. 1996. *Quantum Biology*.New Age.
4. Lisa B. 2002. *Combinatorial Library Methods and Protocols.* Springer-Verlag.

BELB 3213 Metabolomics and system biology (2+1)Theory

UNIT I

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

UNIT II

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

Practical

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

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.

BELB 3214 Computational Methods for Data Analysis (1+1)Theory

UNIT I

Introduction to UNIX/LINUX operating system; Knowledge discovery and data mining techniques; Machinelearning 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 algorithmsand Phylogeny algorithms; Basics of R statistical package.

Practical

Gene prediction: FGENESH; R statistical package installation and configuration, GUI for R: R-

commander, R-studio, RK Ward; Analysis of gene expression using R; GNU PSPP, Scilab, QtiPlot.

Lecture Schedule

1-2) Introduction to UNIX/LINUX operating system
3-4) Knowledge discovery and data mining techniques
5) Machine learning and pattern recognitions
6) hidden markov models
7-8) Artificial neural networks
9) Support vector machines.

Mid Term Examination

10) Principal component analysis
11-12) ANOVA
13-14) AMOVA and different clustering methods
15-16) Gene Prediction algorithms and Phylogeny algorithms17-18) Basics of R statistical package.

Practical Schedule

1) Gene prediction2-3) FGENESH
4-5) R statistical package installation and configuration6-8) GUI for R: R-commander
9-10) R-studio
11) RK Ward
12-13) Analysis of gene expression using R14)GNU PSPP
15)Scilab
16-17) QtiPlot.
18) Practical Examination

Suggested Readings

1. Gareth James, Daniela Witten, Trevor Hastie & Robert Tibshirani. 2013. *An Introduction to StatisticalLearning: with Applications in R*. Springer
2. Mathur K Sunil. 2010. *Statistical Bioinformatics with R*. Elsevier.

BPBG 1101 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.

Lecture Schedule

1-2. History of Genetics3-5. Mendel's principles
6. Rediscovery of Mendel's principles
7. Cell division8.Mitosis
9. Meiosis
10-12. Chromosome structure
13. Function of chromosome
14-15. Chromosome theory of inheritance

16-17. Sex-linked, sex-limited and sex- influenced inheritance18.Sex determination and sex differentiation

Midterm

19-20. Multiple allelism
21. Linkage and crossing-over22-23. Gene-gene interaction
24-25. Genetic analysis in prokaryotes26-27. Genetic analysis in eukaryotes
28. Extra chromosomal inheritance29-30. Mutations
31. Hardy-Weinberg law
32-33. Quantitative inheritance
34-35. Introduction to Human genetics
36. Genetic basis of evolution.

Practical

1. Life cycle in model plants
2. Life cycle in model animals
3. Microscopy
4. Mitosis
5. Meiosis
6. Monohybrid crosses (segregation)
7. Dihybrid crosses (independent assortment)
8. Trihybrid crosses (independent assortment)9-11. Gene interactions

12. Probability and use of Chi-square13-14. Sex-linked inheritance
15-16. Multiple allelism
17. Detection and estimation of linkage
18. Practical exam

Suggested Readings

1. Gupta PK. 2014. Genetics 4th ed. Rastogi Publications.
2. Inbasekar P. 2009. Cell Biology and Genetics. Panima Publications.
3. Miglani GS. 2000. Basic Genetics. Narosa Publishing house, New Delhi.
4. Russell PJ. 2013. iGenetics: Pearson New International Edition: A Molecular Approach. Pearson.
5. Watson JD, Bakee TA, Bell SP, Gann A, Levine M & Losick R. 2008. Molecular Biology of the Gene. 6thEd. Pearson Education International.

BPBG 1102 Cell biology and cytogenetics (2+1)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. Cell growth, cell cycle andits control; Cell death and cell renewal.

UNIT II

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 III

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.

Lecture Schedule

1-2 Origin and evolution of cell

3-4 Introduction to microscopy – light microscopy and electron microscopy5-6 Sub-cellular structure of prokaryotic and eukaryotic cells

7-9 Membrane structure and function: plasma membrane, cell wall and extracellular matrix

10-14 Structural organization and function of intracellular organelles and organelle, biogenesis: Nucleus,mitochondria, endoplasmic reticulum, Golgi apparatus, lysosomes, peroxisomes, plastids, vacuoles.

15-16. Cell growth, cell cycle and its control17-18. Cell death and cell renewal

19-21. Introduction and history - Mitosis and meiosis

Mid Term Examination

22-24. Structure of chromatin, Chromosome structure and chromosome landmarks, Specialized chromosomes25-26. Differential staining of the chromosomes- Q-banding, G banding, C banding, R banding

27. In situ hybridization-FISH, GISH.

28. Changes in chromosome number: aneuploidy- monosomy, trisomy and tetrasomy

29-31 Haploidy and polyploidy- autopolyploidy and allopolyploidy; Methods of doubled, haploid production32-34. Structural aberrations of chromosomes: deletions, duplications, inversions and translocations

35-36. Locating genes on chromosomes; Genome analysis

Practical Schedule

1. Microscopes and types

2-4. Preparation of cell for cytological studies

5. Study of ultrastructure of plant/ animal cell6-7. Preparation of chromosome stains

8. Techniques for preparing squash and smear slides

9. Identification of mitotic stages

10. Preparation of mitotic slides of plant cells

11. Identification of meiotic stages

12. Preparation of meiotic slides of plant cells

13. Pollen fertility

14. Preparation of karyotypes

15. C/G banding of the chromosomes

16. Genomic in situ hybridization

17. Microphotography

18. Practical examination

Suggested Readings

1. Becker K & Hardin. 2004. The World of Cell. 5th Ed. Pearson Edu.
2. Charles B. 1993. Discussions in Cytogenetics. Prentice Hall.
3. Gupta PK. 2007. Cytogenetics. Rastogi publications.
4. Khush GS. 1973. Cytogenetics of Aneuploids. Academic Press.
5. Mahabal Ram. 2010. Fundamentals of cytogenetics and genetics. PHI Learning Pvt. Ltd.

6. Yao-Shan Fan. 2002. Molecular Cytogenetics: Protocols and Applications. Humana Press.
7. Lodish H, Berk A, Kaiser CA, Krieger M, Bretscher A, Ploegh H, Amon A & Scott MP. 2012. MolecularCell Biology. W.H.Freeman.
8. Sadava DE. 1993. Cell Biology: Organelle Structure and Function. Jones and Bartlett Publishers.

BPBG 1203 Biodiversity and bioprospecting (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; Threatsto 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; biosafety; Introduction to regulatory agencies and legislation.

UNIT III

Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemicspecies of India.

UNIT IV

Concepts and practices of bioprospecting; Traditional and modern bioprospecting; Bioactive compounds from microbes: bacteria, actinomycetes and fungi for antibiotics, antiviral compounds and anticancer agents; plant growth promoting bacteria, pharmacological potential of mushrooms, Bioactive Compounds from Marine and Animal Sources: Bioprospecting of plants for novel medicines; random and ethno botanical approach, plants for environmental clean up

Lecture Schedule

1-2. Concepts of biodiversity, bioresource and wildlife management3-4. Conservation strategies: in situ and ex situ conservation
5. Wild life conservation projects in India
6. Protection of biodiversity for its suitable utilization
7. Threats to biodiversity
8. WCU Red data book
9. Biodiversity hotspots in India
10. National bureaus of genetic resources
11. Sustainable development
12. Diversification of cropping system
13. Diversity of indigenous livestock
14. Vulnerability and extinction of flora and fauna
15. Endangered species in various ecosystems
16. Germplasm banks
17. Environmental impact assessment and biosafety
18-19. Introduction to regulatory agencies and legislation

Midterm Examination

20-22. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts23-24. Endangered and endemic species of India
25-26. Concepts and practices of bioprospecting
27. Traditional and modern bioprospecting
28-30. Bioactive compounds from microbes: bacteria, actinomycetes and fungi for antibiotics, antiviralcompounds and anticancer agents

31. Plant growth promoting bacteria
32. Pharmacological potential of mushrooms
33-34. Bioactive Compounds from Marine and Animal Sources: Bioprospecting of plants for novel medicines35-36. Random and ethno botanical approach, plants for environmental clean up

Suggested Readings

1. Das MK & Choudhury BP. 2008. A Text book on Plant Nomenclature and Biodiversity Conservation.Kalyani Publishers.
2. Hopsetti BB. & Venketashwarlaru M. 2001. Trends in Wild Life Conservation and Management. Vol. 2,Daya Publishing House.
3. Singh MP & Singh BS. 2002. Plant Biodiversity and Taxonomy. Daya Publishing House, Delhi.
4. Krishnan. S and Bhat. D.J. 2009. Plant and Fungal Biodiversity and Bioprospecting, Broadway Book Centre,India. P. 188
5. Reddy, S R and Charya M A S. 2012. Microbial Diversity: Exploration and Bioprospecting. ScientificPublisher; 1st ed.
6. Bull A. T. (ed.) 2004. Microbial Diversity and Bioprospecting, ASM Press, Washington DC. p. 496
7. Igor, P (ed.). 2011. Research in Biodiversity - Models and Applications, InTech publishers, p.364

BPBG 1204 Introduction to agricultural 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 Types of inflorescence; Types of flowers; Essential whorls of flower; Modes of pollination, genetic consequences, adaptations for pollination; differences between self- and cross-pollinated crops;

UNIT III Plant taxonomy, systems of classification; Characteristics and economic importance of important cropfamilies Poaceae, Fabaceae, Malvaceae, Solanaceae, Cucurbitaceae etc.

Practical: Description of one plant species from each crop family; Study of morphology and modifications of root, stem, leaf, flower; Types of inflorescence; Structure of various types of seeds and fruits; Structure of monocotand dicot root, stem and leaf; Floral biology and mode of reproduction in major crops-Rice, vegetables, fruits.

Lecture ScheduleTheory

1-2. Plant kingdom and features of each group3-4. Morphology of root, stem, leaf
5-6. Morphology of flower and inflorescence
7. Modifications and functions of root
8. Modifications and functions of stem
9. Modifications and functions of leaf
10-11. Modifications and functions of flower and inflorescence12.Pollination and fertilization
13. Fruit types
14-15. Structure of dicot seed
16-17. Structure of monocot seed
18. Seed germination

Midterm

19. Types of inflorescences
20. Types of flowers
21. Essential whorls of flower
22. Modes of pollination
23. Genetic consequences
24. Adaptations for pollination

25. Differences between self- and cross-pollinated crops26-27. Plant taxonomy
28-31. Systems of classification
32. Characteristics and economic importance of important crop families: Poaceae
33. Characteristics and economic importance of important crop families: Fabaceae
34. Malvaceae
35. Solanaceae
36. Cucurbitaceae and other families.

Practical

1-4. Description of one plant species from each crop family
5. Study of morphology and modifications of root
6. Study of morphology and modifications of stem
7. Study of morphology and modifications of leaf
8. Study of morphology and modifications of flower
9. Types of inflorescence
10. Structure of various types of seeds and fruits
11. Structure of monocot and dicot root
12. Structure of monocot and dicot stem and leaf
13. Floral biology
14. Mode of reproduction in major crops-Rice
15. Mode of reproduction in major crops- vegetables16-17. Mode of reproduction in major crops -fruits
18. Practical Exam

Suggested Readings

1. Bendre A & Kumar A. 1999. Textbook of Practical Botany. Vol. 2, 7th Ed.,Rastogi Publications.
2. Bendre AM & Pande PC. 2009. Introduction to Botany. Rastogi publications. yDutta AC. 1995.
3. A Class Book of Botany, 16th Edition. Oxford University Press. 230 231

BPBG 1205 Basics and methods 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, selection in cross pollinated crops; Methods of breeding vegetatively propagated crops. Mutation breeding; Ploidy breeding; Wide hybridization and its significance in crop improvement;

UNIT III

Application of genetic, cytogenetic and biotechnological techniques in breeding of rice, pulses, vegetables and coconut; major breeding achievements in these crops

UNIT IV

Classes of seed, Principles of seed production and seed quality analysis

Practical

Emasculation and hybridization techniques; Estimation of heterosis and inbreeding depression; Estimation ofheritability; Study of megasporogenesis and microsporogenesis; Fertilization and life cycle of an angiospermic

plant; Hybridization techniques and precautions to be taken; selfing, emasculation and crossing techniques in rice,pulses,vegetables and coconut ;Parentage of released varieties/hybrids; seed quality; seed viability; seed vigour; seed health testing; Visit to seed production plots.

Lecture schedule

1. History, aims and objectives of Plant breeding; Role of related sciencesin plant breeding
2-3. Modes of reproduction - sexual, asexual, apomixes: Significance in plant breeding 4-5. Modes of pollination, genetic consequences, differences between self-
and cross- pollinated crops
5. Germplasm resources and their utilization.
6. Methods of breeding: Introduction and Acclimatization
7-8. Selection: Mass selection, Johannesen's pure-line theory, genetic basis, pure-line selection
9-10. Hybridization: Aims and objectives, types of hybridization
11-13. Methods of handling segregating generations: Pedigree method, bulk method, back cross method
14. Heterosis, inbreeding depression, various theories of heterosis15-17. Selection in cross pollinated crops
18. Methods of breeding vegetatively propagated crops

Midterm Examination

19-21. Mutation breeding
22-24. Ploidy breeding
25. Wide hybridization and its significance in crop improvement
26-33. Application of genetic, cytogenetic and biotechnological techniques inbreeding of rice, pulses, vegetables and coconut; major breeding achievements in these crops
34-36. Classes of seed, Principles of seed production and seed quality analysis

Practical Schedule

1-2. Emasculation & Hybridization techniques in various self- and cross-pollinated crops
3. Estimation of heterosis and inbreeding depression
4. Estimation of heritability
5. Study of megasporogenesis and microsporogenesis
6. Fertilization and life cycle of an angiospermic plant
7. Floral biology, emasculation, hybridization techniques and parentage ofreleased varieties/ hybrids in rice
8-9. Floral biology, emasculation, hybridization techniques and parentage of released varieties in cowpea, green gram, black gram
10-11. Floral biology, emasculation, hybridization techniques and parentage ofreleased varieties in cucurbits
12-13. Floral biology, emasculation, hybridization techniques and parentage ofreleased varieties in chilli/ brinjal/ tomato
14. Floral biology, emasculation, hybridization techniques and parentage ofreleased varieties/ hybrids in Bhindi
15. Floral biology, emasculation, hybridization techniques and parentage ofreleased varieties/ hybrids in coconut
16. Seed quality, seed viability, Seed vigour and seed health testing
17. Visit to seed production plots
18. Practical Examination

Suggested Readings

1. Allard RW. 1960. Principles of Plant Breeding. John Wiley and Sons.
2. Phundan Singh. 2014. Essentials of Plant Breeding. Kalyani Publishers.
3. Singh BD. 2009. Plant Breeding: Principles and Methods. Kalyani Publishers, India.
4. Chopra VL 2001. Breeding Field Crops. Oxford and IBH Publishing Co.
5. Sleper DA & Poehlman JM. 2006. Breeding Field Crops. Wiley-Blackwell.

BPBG 3106 Molecular marker technology (1+1)Theory

UNIT I

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

UNIT II

Application of molecular markers: Assessing genetic diversity, variety protection; 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.

Practical

DNA extraction and PCR amplification and electrophoresis, Hybridization based markers, PCR based markers- RAPD, SSR, Gel scoring and data analysis for tagging and phylogenetic relationship,, Comparative analysis of plant genomes using molecular markers, Genetic map construction using molecular markers, Mapping major genes using molecular markers, QTL mapping in plants, Comparison across mapping populations, Genetic diversity analysis using different markers using available software, Scheme of using molecular markers to introgress dominant genes and recessive genes, Fore ground selection, Background selection and recombinant selection in MAS, Molecular markers for detecting GMOs, Molecular markers for detection of diseases in humans and animals, Molecular markers for paternity detection in plants and humans, molecular markers for forensic studies (case studies)

Lecture ScheduleTheory

1. Types of molecular markers- RFLP

2-4. PCR based markers like RAPD, SCAR, SSR, STS, CAPS, AFLP, SNP and their variants, Uses ofmolecular markers

5. Application as a genetic tool for genotyping and gene mapping

6-8. Mapping populations: F2, DH, RILs, NILs, Bulked segregant analysis,

9. Linkage maps Physical maps

Midterm Examination

10-11. Application of molecular markers: Assessing genetic diversity, variety protection

12-14. Marker-assisted breeding for accelerated introgression of trait/transgene and quantitative traits

15-16. Human and animal health: Association with genetic-based diseases, Paternity determinations

17-18. Forensic studies

Practical schedule

1. DNA extraction and PCR amplification and electrophoresis
2. Hybridization based markers
3. PCR based markers- RAPD, SSR
4. Gel scoring and data analysis for tagging and phylogenetic relationship
5. Comparative analysis of plant genomes using molecular markers
6. Genetic map construction using molecular markers
7. Mapping major genes using molecular markers
8. QTL mapping in plants

9. Comparison across mapping population
10. Genetic diversity analysis using different markers using available software
11. Scheme of using molecular markers to introgress dominant genes and recessive genes
12-13. Fore ground selection, Background selection and recombinant selection in MAS
14. Molecular markers for detecting GMOs
15. Molecular markers for detection of diseases in humans and animals
16. Molecular markers for paternity detection in plants and humans
17. molecular markers for forensic studies (case studies)
18. Practical Examination

Suggested Readings

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

Plant Breeding and Genetics ElectivesElectives I - Plant Biotechnology

BELG 3201 Molecular Breeding of crop plants (2+1)Theory

UNIT I

Principles of Plant Breeding – Breeding methods for self and cross pollinated crops- Heterosis breeding- Limitations of Conventional breeding -Principles of genetic linkage with suitable examples – Three point test cross and linkage mapping – Development of mapping population – F2s, RILs, NILs and DH lines and their utilityin the linkage mapping studies

UNIT II

Mapping major gene of interest and strategies – Fine mapping of the targeted genomic regions using saturated linkage map and high resolution map – map based cloning – QTL mapping using structured populations – Fine mapping of genes/QTL – QTL isolation and development of gene based markers.

UNIT III

SNPs genotyping methodologies – Sequencing genome for SNP identification – NGS platforms used for the SNPsmarker development – SNP analysis for major gene discovery – DArT markers – Recent trends in genotyping methods

UNIT IV

Marker Assisted selection – Foreground and background selection – MAS for major and minor genes – Markerassisted pyramiding – Marker assisted recurrent selection – Transgenic breeding – MAS for specific traits withexamples – Commercial applications of MAS

UNIT V

Target traits improvement in major crops through molecular breeding; Achievements in molecular breeding

Practical

Genotyping and phenotyping datasets for Linkage mapping using softwares such as Mapmaker, Map Disto and QTL Mapping softwares such as WinQTL cartographer- SNP marker data analysis - TASSEL software- pLink software - Use of gene based and closely linked markers for foreground selection for target traits in target crops
– Marker assisted detection of the transgene. Genetic diversity analysis using molecular markers. Marker assisteddetection of the transgene. Diversity analysis using UPGMA

Lecture schedule

1. Principles of Plant Breeding
2-4. Breeding methods for self and cross pollinated crops
5. Heterosis breeding
6. Limitations of Conventional breeding
7-8. Principles of genetic linkage with suitable examples - Three point test cross and linkage

mapping
9-10. Development of mapping population – F2s, RILs, NILs and DH lines and their utility in the linkagemapping studies
11. Mapping major gene of interest and strategies
12-13. Fine mapping of the targeted genomic regions using saturated linkage map and high resolution map
14. Map based cloning
15. QTL mapping using structured populations
16. Fine mapping of genes/QTL
17-18. QTL isolation and development of gene-based markers

Midterm examination

19. SNPs genotyping methodologies
20. Sequencing genome for SNP identification
21. NGS platforms used for the SNPs marker development
22. SNP analysis for major gene discovery
23. DArT markers
24. Recent trends in genotyping methods
25. Marker Assisted selection
26-27. Foreground and background selection28-29. MAS for major and minor genes
30. Marker assisted pyramiding
31. Marker assisted recurrent selection
32. Transgenic breeding
33. MAS for specific traits with examples – Commercial applications of MAS
34-36. Target traits improvement in major crops through molecular breeding; Achievements in molecularbreeding

Practical schedule

1-6. Genotyping and phenotyping datasets for Linkage mapping using softwares such as Mapmaker, Map Distoand QTL Mapping softwares such as WinQTL cartographer
7-8. SNP marker data analysis
9. TASSEL software
10. pLink software
11-12. Use of gene based and closely linked markers for foreground selection for target traitsin target crops
13-14. Marker assisted detection of the transgene
15-16. Genetic diversity analysis using molecular markers
17. Diversity analysis using UPGMA
18. Practical examination

Suggested Readings

1. Nagat T, Lorz H & Widholm JM. 2008. Biotechnology in Agriculture and Forestry. Springer.
2. Trivedi PC. 2000. Plant Biotechnology: Recent Advances. Panima Publishers.
3. J S Bal. 2013. Fruit Growing. Kalyani Publishers.
4. Kumar N. 2006. Breeding of Horticultural crops: Principles and Practices. New India Publishing Agency.
5. K. L. Chada. 2012. Handbook of Horticulture. ICAR.
6. Kumar J. Prasad. 2010. Handbook of Fruit Production. Agrobios.
7. Schnell RJ &Priyadarshan PM. 2012. Genomics of Tree Crops. Springer.
8. Singh Jitender. 2014. Basic Horticulture. Kalyani Publishers.
9. Singh Ranjit. 2012. Fruits. National Book Trust.

10. Spangenberg G. 2001. Molecular Breeding of Forage Crops. Kluwer Academic Publishers.
11. Victor Ray Garden, Frederick Charles Bnaford, Herry& Daggett HoDlor Ir. 1992.
12. Fundamentals of Fruit Production. Mc Graw Book Company.

BPEN 1201 Fundamentals of crop protection (2+1)Theory

UNIT I

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, Spiro plasmas, 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; Basic principles of plant disease management-chemicals for plant disease management- contact, systemic and new generation fungicides, antibiotics, plant defense activators, antiviral principles, plant protection equipment, Integrated Disease management-concepts and methods, Management of important diseases of major crops.

UNIT II

Insects - their general body structure; Importance of insects in agriculture; Insects diversity; Useful insects: Productive insects, parasitoids and predators. Concepts in population build-up of insects. General symptoms of insect's attack; Principles and methods of insect-pests management; Integrated Pest Management concept. Biotechnology for pest management.

Practical

Familiarization with generalized insect's body structure and appendages; Identification and major characters ofimportant orders of insects.
Acquaintance with useful insects: predators, parasitoids, honey bees and silk worms;
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 theirevaluation; Diagnosis and identification of important diseases of cereals, cotton, oilseeds, pulses, sugarcane, fruitand vegetables crops and their characteristic symptoms.

Lecture schedule

1. Importance and scope of plant pathology, Concept of disease in plants
2. History of Plant Pathology,
3. Nature and classification of plant diseases
4. Importance and general characters of fungi, bacteria, fastidious bacteria,
5. Importance and general characters of nematodes, phytoplasmas, spiroplasmas, viruses, viroids, algae,protozoa
6. Importance and general characters of phanerogamic parasites;
7. Pathogenesis due to obligate and facultative parasites;
8. Variability in plant pathogens
9. Factors of development of disease epidemics
10. Survival and dispersal of plant pathogens
11. Basic principles of plant disease management
12. Chemicals for plant disease management- contact, systemic and new generation fungicides
13. Antibiotics, plant defense activators, antiviral principles,
14. Plant protection equipments,
15. Integrated Disease management-concepts and methods,

16. – 18 Management of important diseases of major crops.

Midterm examination

19. Insects - their general body structure- segmentation of body – Appendages -
20. Importance of insects in Agriculture
21. Insects diversity
22. Economic classification of insects
23. Productive insects- honey bee silkworm
24. Parasitoids and predators
25. Concepts in population build-up of insects
26. Economic levels
27. Categories of pests

28-29. General symptoms of insect's attack

30. Principles of insect-pests management31-32. Methods of pest management

33. Integrated Pest Management concept

34-36. Bioecology and management of important pests of major crops and stored products.

Practical schedule

1. Familiarization of symptoms of important fungal diseases
2. Familiarization of symptoms of important bacterial and viral diseases3- 7 Identification of important diseases of major crops

8 Familiarisation with different plant protection equipments

9 Familiarisation of different biocontrol agents and their method of application

10. Familiarization with generalized insect's body structure and appendages

11-16. Identification of important insect-pests of major crops and stored-grains andtheir symptoms of damage

17. Acquaintance with useful insects: predators, parasitoids, honey bees and silk worms
18. Practical examination

Suggested Readings

1. Agrios, GN. 2010. Plant Pathology. Acad. Press.
2. Atwal AS & Dhaliwal GS. 2002. Agricultural Pests of South-Asia and Their Management. Kalyani Publishers.
3. Dhaliwal GS & Arora R. 1996. Principles of Insect Pest Management. National Agriculture TechnologyInformation Centre.
4. Dhaliwal GS, Singh R & Chhillar BS. 2006. Essentials of Agricultural Entomology. Kalyani Publishers.
5. Mehrotra RS & Aggarwal A. 2007. Plant Pathology. 7th Ed. Tata Mc Graw Hill Publ. Co. Ltd.
6. Singh H. 1984. House-hold and Kitchen Garden Pests - Principles and Practices. Kalyani Publishers.
7. Singh RS. 2008. Plant Diseases. 8th Ed. Oxford & IBH. Pub. Co.
8. Singh RS. 2013. Introduction to Principles of Plant Pathology. Oxford and IBH Pub. Co.
9. Stakman EC & Harrar JG. 1957. Principles of Plant Pathology. Ronald Press, USA.
10. Tarr SAJ. 1964. The Principles of Plant Pathology. McMillan, London.
11. Vander Plank, JE. 1975. Principles of Plant Infection. Acad. Press.Plant Pathology-ElectivesBELP 3201 Molecular diagnosis of plant pathogens (2+1)

TheoryUNIT I

Introduction to plant pathogens – fungi, bacteria, phytoplasma, virus, viroids etc., Principle and applications of molecular diagnostic tests; Nucleic acid based diagnostics for detection of plant pathogenic organisms: Application of restriction endonuclease analysis for identification of plant pathogens; Polymerase chain reaction(PCR) and its variants; Reverse transcriptase polymerase chain

reaction (RT PCR); isothermal amplification (LAMP); LCR, nucleic acid sequence-based amplification (NASBA); Real-Time PCR; DNA Probes; Southern blotting; Northern blotting; Protein based assays: SDS-PAGE, Western Blot, Dot-blot, ELISA
and lateral flow device.

UNIT II

Advantages of Molecular diagnostics of plant pathogens 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 plant samples for molecular detection of pathogens (fungal/bacteria/phytoplasma/virus); Extraction of nucleic acids (DNA & RNA)from the field specimens; Restriction endonuclease**,** e digestion and analysis using agarose gel electrophoresis; Polymerase chain reaction for detection of pathogens in plant tissues; RT-PCR for detection of RNA viruses; RCA for DNA viruses, PCR based detection of plant pathogens in different crops, plant parts, Lateral flow assay; ELISA.

Lecture schedule

1. Introduction to plant pathogens – fungi, bacteria, phytoplasma, virus, viroids etc.
2. Significance of detection in plant disease management

3-4. General characteristics of fungi, bacteria, viruses, Phytoplasma and viroids
5-10. Characteristics and properties of fungi, Characteristics and properties of bacteria, Characteristics and properties of Virus, viroids and phytoplasmagy
11-14. Genesis, importance and scope of molecular plant pathology, Principle andapplications of molecular diagnostic tests
15. Study of basic techniques like Electrophoresis, Immunoassay, Nucleic acidsequencing & hybridization, PCR, RAPD, RFLP
16-18. Detection and diagnosis of plant pathogens by various immuno- and molecularTechniques

Midterm Examination

19. Electron microscopy, ISEM
20. Western Blot, Dot-blot, ELISA and lateral flow device.

21-22. Protein based assays: SDS-PAGE, Nucleic acid-based diagnostics for detection of plant pathogenicorganism, Polymerase chain reaction (PCR) and its variants;

24. Reverse transcriptase polymerase chain reaction (RT PCR);Nested PCR, Multiplex PCRBio PCR, Quantitative PCR, Real-Time PCR; DNA Probes;
25. Isothermal amplification-based methods of detection: Loop Mediated Isothermal Amplification (LAMP), Rolling Circle Amplification (RCA)
26. LAMP, RCA, Nucleic acid sequence-based amplification (NASBA);
27. Southern blotting; Northern blotting;
28. Post Amplification Techniques-DNA Microarray, DNA microarray
29. DNA/RNA probe-based assays: *In situ* hybridization (ISH) technique, Fluorescent in situ hybridization (FISH)

30-31. Application of restriction endonuclease analysis for identification of plant pathogens32-33. Advantages of Molecular diagnostics of plant pathogens over conventional diagnostics; serodiagnosis

34. DNA array technology; Protein array; tissue array;
35. Biosensors and nanotechnology
36. Development and validation of diagnostic tests.

Practical schedule

1. Preparations of buffers and reagents

2. Identification of diseases based on external symptoms
3. Preparation of media
4. Isolation of plant pathogenic fungi
5. Isolation of plant pathogenic bacteria
6. Establishment of Koch's postulates
7. Mechanical transmission of plant viruses
8. Collection of plant samples for molecular detection of pathogens (fungal/bacteria/phytoplasma/virus);
9. SDS PAGE
10. Protein based detection of plant pathogens by western blotting
11. Extraction of nucleic acids DNA from the field specimens
12. Extraction of nucleic acids RNA from the field specimens
13. Polymerase chain reaction for detection of pathogens in plant tissues;
14. RT-PCR for detection of RNA viruses
15. Nested PCR
16. Serology based detection of plant pathogens in different crops, plant parts by ELISA.
17. Serology based detection of plant pathogens in different crops, plant parts by DIB
18. Practical examination

Suggested Readings

1. Debnath M, Prasad GBKS & Bisen PS. 2010. *Molecular Diagnostics: Promises and Possibilities*. Springer Science & Business Media.
2. Singh BD. 2010. *Biotechnology expanding Horizons*. Kalyani Publishers.
3. Viljoen, GJ, Nel LH & Crowther JR. 2005. *Molecular Diagnostic PCR handbook.* Springer Science & BusinessMedia.
4. Wilson K & Walker J. 2010. *Principles and Techniques of Biochemistry and Molecular Biology*. CambridgeUniversity Press.

BELP 3202 Molecular diagnostics (2+1)Theory

UNIT I

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

UNIT II

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

Practical

Preparations of buffers and reagents; Collection of clinical and environmental samples for molecular detection ofpathogens (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.

Lecture scheduleTheory

1-2 Introduction to pathogenic microbes – fungi, bacteria, phytoplasma, virus, viroids etc
3. History of detection in disease management
4. Significance of detection in disease management
5. General characteristics of fungi, bacteria, viruses, Phytoplasma and viroids
6. Characteristics and properties of fungi

7. Class 6 contd.
8. Characteristics and properties of bacteria
9. Class 8 contd.
10. Characteristics and properties of Virus, viroids and phytoplasma
11. Class 10 contd
12. Genesis, importance and scope of molecular diagnosis
13. Principle and applications of molecular diagnostic tests
14. Study of basic techniques like Electrophoresis, Immunoassay, Nucleic acid sequencing & hybridization,PCR, RAPD, RFLP
15. Detection and diagnosis of plant pathogens by various immuno- and molecular techniques
16. Electron microscopy, ISEM
17. Western Blot, Dot-blot, ELISA and lateral flow device.
18. Protein based assays: SDS-PAGE

Midterm Examination

19. Nucleic acid-based diagnostics for detection of plant pathogenic organisms
20. Polymerase chain reaction (PCR) and its variants;
21. Reverse transcriptase polymerase chain reaction (RT PCR);
22. Nested PCR, Multiplex PCR
23. Bio PCR, Quantitative PCR
24. Real-Time PCR; DNA Probes;
25. Isothermal amplification-based methods of detection: Loop Mediated Isothermal Amplification(LAMP), Rolling Circle Amplification (RCA)
26. LAMP, RCA
27. Class 24 contd.
28. Nucleic acid sequence-based amplification (NASBA);
29. Southern blotting; Northern blotting;
30. Post Amplification Techniques-DNA Microarray, DNA microarray
31. DNA/RNA probe-based assays: *In situ* hybridization (ISH) technique, Fluorescent in situ hybridization(FISH)
32. Application of restriction endonuclease analysis for identification of plant pathogens
33. Advantages of Molecular diagnostics of plant pathogens over conventional diagnostics; serodiagnosis
34. DNA array technology; Protein array; tissue array;
35. Biosensors and nanotechnology
36. Development and validation of diagnostic tests.

Practical

19. Preparations of buffers and reagents
20. Identification of diseases based on external symptoms
21. Preparation of media
22. Isolation of pathogenic fungi
23. Isolation of pathogenic bacteria
24. Confirming pathogenicity
25. Mechanical transmission of plant viruses
26. Collection of plant samples for molecular detection of pathogens (fungal/bacteria/phytoplasma/virus);
27. SDS PAGE
28. Protein based detection of plant pathogens by western blotting
29. Extraction of nucleic acids DNA from the field specimens
30. Extraction of nucleic acids RNA from the field specimens
31. Polymerase chain reaction for detection of pathogens in plant tissues;
32. PCR product analysis using agarose gel electrophoresis
33. RT-PCR for detection of RNA viruses
34. Nested PCR

35. Serology based detection of plant pathogens in different crops, plant parts by ELISA.
36. Serology based detection of plant pathogens in different crops, plant parts by DIB

Suggested Readings

1. Debnath M, Prasad GBKS & Bisen PS. 2010. Molecular Diagnostics: Promises and Possibilities. SpringerScience & Business Media.
2. Singh BD. 2010. Biotechnology expanding Horizons. Kalyani Publishers.
3. Viljoen, GJ, Nel LH & Crowther JR. 2005. Molecular Diagnostic PCR Handbook. Springer Science &Business Media.
4. Wilson K & Walker J. 2010. Principles and Techniques of Biochemistry and Molecular Biology.

Cambridge University Press.

BELP 3203 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; Newgeneration 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; Hemagglutination and Hemagglutination Inhibition test; Detection of virus by SNT, AGID and ELISA.

Lecture schedule

1-2. Properties of viruses
3-5. Classification of viruses
6-8. Virus replication; Cell transformations, Cultivation of viruses9-10. Assay techniques for detection/quantification
11-14. Important Animal viruses; Virus-Host interactions; Viral infections;
15-18. Immune responses to viruses: Interferon and other cytokines; Bio-safety and bio-security principles.

Midterm Examination

19-20. Properties of an ideal vaccine; Classification of vaccines21-22. Methods of inactivation and attenuation of viruses
23-26. New generation vaccines: subunit, synthetic, rDNA, marker and edible
27-30. Adjuvants and vaccine delivery systems; Novel immunomodulators and vaccine delivery usingnanotechnology
31-36. Vaccine preparation: Stabilizers, preservatives and vehicles; Quality control and testing of vaccines; Sero-surveillance and sero-monitoring.

Practical schedule

1-4. Processing of clinical specimens for isolation of viruses;
5-8. Cultivation of viruses in cell cultures and embryonated eggs

9. Harvesting of virus
10. Study of cytopathic effects
11-12. Titration of virus and estimation of TCID50
13-14. Hemagglutination and Hemagglutination Inhibition test;
15. Detection of virus by SNT, AGID and ELISA.
16. Detection of virus by AGID
17. Detection of virus by ELISA.
18. Practical Examination

Suggested Readings

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

BPHY 2101 Crop physiology (2+1)Theory

UNIT I

Plant physiology, its scope in agriculture; Osmosis, imbibition, water absorption, water translocation andtranspiration; Stomatal mechanisms; Physiological role and deficiency symptoms of major and minor elements,

Absorption and translocation of minerals.

UNIT II

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

UNIT IV

Cell membrane transport; Introduction to cell signalling

Practical

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

Lecture scheduleTheory

1: Introduction to Plant Physiology – its importance in Agriculture
2-4 Absorption of water - Diffusion and osmosis - Water potential and its components - Importance of waterpotential – Active and passive uptake of water
5 Stomatal complex – Transpiration – Water use efficiency – Factors affecting WUE
6–7: Introduction to mineral nutrition of plants- Classification -Functions and deficiency symptoms of major andminor elements in plants
8-9: Absorption and translocation of minerals -Nitrogen and Sulphur metabolism- Assimilation of mineralnutrients
10– 12: Photosynthesis – Reactions of photosynthesis – Energy synthesis – Principle of light absorption by plants
– Light reactions - Cyclic and non-cyclic photophosphorylation – CO2 fixation – C3, C4 and CAM pathways andtheir significance

13 – 16: Overview of Respiration-Pathways-ATP synthesis- Photorespiration - significance – Photosyntheticefficiency of C3, C4 and CAM plants
17: Factors affecting photosynthesis–Translocation of photo assimilates
18-19: Physiological aspects of growth and development –Dynamics of growth-Factors affecting growth

Midterm Examination

20-22: Impact of abiotic stress on plants –Developmental and physiological mechanisms of drought, heat, salt and flooding tolerance in plants.
23-27: Plant growth regulators – Occurrence, transport, biosynthesis, mode of action and physiological roles
28: Seed germination - Metabolic changes during seed germination-Factors affecting seed germination
29: Seed Dormancy – Types of dormancy – Advantages, disadvantages and causes of dormancy – Remedial measures for breaking seed dormancy
30-31: Senescence and abscission – Classification of senescence – Physiological and biochemical changes that occur during senescence - Prevention of leaf and flower senescence – Abscission and its relationship with senescence.
32-33: Perception of photoperiodic stimulus – Biological clock – Photoreceptors– Flowering - Vernalization
34-36: Cell membrane transport– Cell signalling in plants

Practical schedule

1. Demonstration of processes of diffusion
2. Demonstration of osmosis and plasmolysis
3. Demonstration of diffusion and imbibition
4. Experiment on ascent of sap and water potential
5. Measurement of transpiration rate
6. Estimation of Relative Water Content
7. Identification of deficiency symptoms of nutrients in crop plants and Hydroponics
8. Detection of N, P, K deficiencies in plants by Rapid Tissue Test
9. Plant growth analysis
10. Estimation of photosynthetic pigments
11. Measurement of CO_2 fixation by plants
12. Radiant energy (Radiation) and its measurements
13. Experiment on respiration
14. Estimation of Proline
15. Experiment on the effect of plant growth regulators on plant growth
16. Experiment on the effect of plant growth regulators on seed germination
17. Estimation of plant hormones / Bioassays, Experiment on seed dormancy.
18. Practical examination

Suggested Readings

1. Bhatia KN &Prashar AN. 1990. Plant Physiology. Trueman Book Company.
2. Salisbury FB. & Ross CW. 1992. Plant Physiology. Wordsworth Publishing Company.
3. Srivastava HN. 2000. Plant Physiology. Pradeep Publication
4. Taiz, L. and Zeiger, E. 2010. Plant Physiology 5th edition, Sinauer Associates, Sunderland, MA, USA.
5. Gardner, F.P., Pearce, R.B., and Mitchell, R.L. 1985. Physiology of Crop Plants. Scientific Publishers,Jodhpur.
5. Noggle, G.R. and Fritz, G.J., 1983. Introductory Plant Physiology. 2nd Edition. Prentice Hall Publishers,New Jersey, USA.

BSAC 1101 Principles of analytical chemistry (1+1)Theory

UNIT I

Principles of Analytical chemistry- Scope and Applications in Biotechnology- Preparations and expressions of Standard solutions- Normal, Molar, Molal solutions and basic computations, Laws – Law of equivalent proportions, Ohms law, Beer Lamberts law, Planck s Law, Nernst equation

UNIT II

Introduction to Volumetric analysis-Acidimetry- Alkalimetry- Redox reactions-Complexometry-potentiometric titrations, Precipitation reactions–Gravimetry

UNIT II

Introduction to instrumental methods of analysis-Potentiometry-Conductometry-Spectral methods of Analysis- Colorimetry Spectrophotometry and instrumentation – Emission Spectroscopy-

Flame photometry- atomic absorption spectrophotometry- Hollow cathode lamps-multielement lamps- electrodeless discharge lamps

UNIT IV

Chromatography-partition, column, paper, Thin, Gas, Gas-Liquid, HPLC- Principles and instrumentation andapplication in Biotechnology

Practical

Preparation of standard solutions, qualitative reagents and indications for various titrations of Acidimetry-Alkalimetry- Redox reactions-Complexometry-potentiometric titrations
Familiarization with pH and EC meter- measurement of pH and EC of various biological samples,
Familiarization with spectrophotometery, atomic absorption, flame-photometry, inductively coupled plasmaspectrometry;
Familiarization with column, paper, Thin, Gas, Gas-Liquid, HPLC-separation of biomolecules

Lecture Schedule

1. Principles of Analytical Chemistry - Scope and Applications in Biotechnology
2. Preparations and expressions of Standard solutions- Normal, Molar, Molal solutions and basic computations,
3. Laws –Law of equivalent proportions, Ohms law, applications in analytical techniques related tobiotechnology
4. Beer Lamberts law, Planck s Law, Nernst equation applications in analytical techniques related tobiotechnology
5. Introduction to volumetric analysis: Acidimetry-Alkalimetry-Redox reactions
6. Complexometry- potentiometric titrations
7. Precipitation reactions– Gravimetry
8. Introduction to instrumental methods of analysis and analytical techniques related to biotechnology

Midterm

9. Potentiometry-Nernest Equation- equipment and applications- conductometry- principles, methodology andapplications
10. Spectral methods of Analysis- Principle- Laws related to Colorimetry principles, methodology andapplications
11. Spectrophotometry- Emission spectroscopy principles, methodology and applications
12. Flame photometry principles, methodology and applications
13. Atomic absorption spectrophotometry- principles, methodology and applications -Hollow cathode lamps-multi element lamps electrodeless-discharge lamps

14. Introduction to Chromatography- Principles-types (partition, column, paper, TLC) methodology andapplications

15. Gas - Liquid Chromatography principles, methodology and applications

17-18. HPLC- Principles and instrumentation principles, methodology and application

Practical schedule

1. Introduction to quantitative estimation
2. Preparation of solutions for standard curves, analytical reagents, qualitative reagents.
3. Indicators and standard solutions for acid-base.
4. Volumetric analysis-acid-base titrations
5. Volumetric analysis- oxidation reduction
6. Volumetric analysis- complexometric titration
7. Potentiometric titrations
8. Collection of Processing of environmental samples (including plant samples) for analysis
9. Potentiometry measurement of pH of soil samples
10. Conductometry – Measurement of EC soil samples
11. Principles and familiarisation of visible, ultraviolet and infrared spectrophotometer.
12. Principles and familiarisation of visible, ultraviolet and infrared spectrophotometer contd.
13. Principles and familiarisation of flame-photometry
14. Principles and familiarisation atomic absorption
15. Inductively coupled plasma spectrometry
16. Chromatographic techniques
17. Chromatographic techniques contd.
18. Practical examination

Suggested Readings

1. Vogel AL. 1979. A Textbook of Quantitative Inorganic Analysis. ELBS Longman. Donald M West.1969. Fundamentals of Analytical Chemistry Holt, Rinehart and Winston, New York.
2. Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch .2013
3. Fundamentals of Analytical Chemistry Cengage Learning,
4. Kenneth Helrich 1990. Official Methods of Analysis. Association of Official Analytical Chemists.

BSAC 1202 General biochemistry (2+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 waterin 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 pharmaceuticalindustries.

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.

Lecture schedule

1. Review of biochemistry introduction – Biomolecules general groups – Importance
2. Characterization of biomolecules-techniques.
3. Plant cell organelles, structure and function of organelles
4. Carbohydrates –classification –properties and general reactions.
5. Important sugars structure –-
6. . Important sugar structure continued....
7. Amino acids and Proteins –classification, significance-general reactions-biological functions.
8. contd.. Amino acids and Proteins –classification, significance-general reactions-biological functions.
9. Structure, function and properties of nucleic acids
10. Contd. Structure, function and properties of nucleic acids
11. Lipids-chemistry-classification, properties
12. Contd.. lipids chemistry-classification, properties
13. Fatty acids –Classification-reaction
14. Structure and role of water in biological systems.
15. contd... Structure and role of water in biological systems
16. Enzymes-chemistry, Nomenclature –classification- functions17-18. Enzymes-Factors affecting activity

Mid Examination

19. Acids, bases and buffers of living system and pK of biomolecules
20. Vitamins-Definition, classification, source-
21. Fat and water soluble vitamins-structure and function
22. Hormone classification and significance
23. Metabolism – basic concepts – principles- metabolic energy –and its generalization –
24. Metabolism of carbohydrates – glycolysis
25. Respiration – citric acid cycle – pentose phosphate pathway,
26. Utilization of other monosaccharides and polysaccharides – bioenergetics
27. Oxidative phosphorylation, fatty acid oxidation28, Amino acid degradation general reactions
29. Biosynthesis of Structural Carbohydrates.
30. Formation of glucose, sucrose and starch
31. Biosynthesis of Fatty Acids and Protein.
32. Biosynthesis of lipids
33. Biosynthesis of nucleic acids
33. Secondary Metabolites-Classification, Properties
34. Biochemistry, significance of secondary metabolites

35-36. Uses and applications of secondary metabolites in food and pharmaceutical industries

Practical schedule

1. Separation of bio molecules by Electrophoresis.
2. Qualitative tests for Carbohydrates.
3. Mono and Disaccharides- Tests.
4. Polysaccharides-Qualitative Tests.
5. Estimation of Reducing and Non reducing sugars in sugarcane /jaggery.
6. Estimation of Starch.
7. Qualitative Test of Proteins and Amino acids –Precipitation reactions
8. Colour reactions of Amino acids.

9. Estimation of Amino acids, Proteins by colorimetry.
10. Extraction of oil.
11. Estimation of Fat constants.
12. Qualitative Tests for oils.
13. Chromatographic techniques of separation of Biomolecules.
14. Characterization of Lipids by TLC.
15. Estimation of Fatty Acids by GLC.
16. Determination of phenol.
17. Quantitative estimation of sugar by paper chromatography,
18. Practical Examination

Suggested Readings

1. 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.
2. Goodwin, TW & Mercer EI. 1983. Introduction to Plant Biochemistry. 2nd Ed. Oxford, New York. PergamanPress.
3. Murray RK, David B., Botham KM & Kennelly PJ. 2012. Harper's Illustrated Biochemistry. 29th Ed. Lange Medical Books/Mc. Graw Hill.
4. Nelson DL & Cox MM. 2000. Lehninger Principles of Biochemistry. 5th Ed. C.B.S `Publilshers, Prentice Hall.5.Wilson K & Walker J. 1994. Principles and Techniques of Biochemistry and Molecular, Biology. 7th Ed. Cambridge University Press.

BSAC 2203 Environmental studies and disaster management (2+1)Theory

Environmental studies: Multidisciplinary nature, definition, scope and importance. 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 overwater, 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 byagriculture 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. Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem. Ecological succession, Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems(ponds, streams, lakes, rivers, oceans, estuaries) Biodiversity and its conservation: - Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India. Value of biodiversity:consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Environmental Pollution: definition, cause, effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution
f. Thermal pollution g. Nuclear hazards. Solid Waste Management: causes, effects and control measures of urbanand industrial wastes. Role of an individual in prevention of pollution.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. dies. 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.
Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme. Environment and human health: Human Rights, Value 32 Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health. Disaster Management-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.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.Disaster Management- Effect to migratenatural 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. Central, state, district and local administration; Armed forces in disaster response;Disaster response; Police and other organizations.

Practical

Pollution case studies. Case Studies- Field work: Visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain, visit to a local polluted siteUrban/Rural/Industrial/Agricultural, study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc. -Collection, processing and storage of effluent samples; Physical, chemical and biological analysis of soil and water samples : Determinationof BioChemical oxygen demand (BOD) in effluent sample; Determination of chemical oxygen demand (COD) in effluent sample; Estimation of dissolved oxygen in effluent samples; Determination of total dissolved solids (TDS) in effluent samples; Estimation of species abundance of plants; Estimation of nitrate and heavy metals in ground water; Analysis of temporary and total hardness of water sample by titration; Estimation of pesticide contamination in Agro-Ecosystem; Crop adaptation to environmental variables, soils conditions; Visit to a local polluted site. Observations and remedial measures. Visit to Social Service Organization / Environmental Education Centers.

Lecture schedule

1. Environmental studies: Multidisciplinary nature, definition, scope and importance-type and segments of environment.
2. Natural Resources: Renewable and non-renewable resources- Forest, water, food, mineral, energy and land resources. Forest resources: Use and over-exploitation, deforestation. Water resources: Use and over-utilization of surface and ground water
3. Mineral resources: Use and exploitation. Food resources: World food problems. Energy resources: renewableand non-renewable energy sources, use of alternate energy sources.
4. Land resources: land degradation, soil erosion and desertification. • Role of individuals in conservation ofnatural resources. • Equitable use of resources for sustainable lifestyles.
5. Ecosystems: Definition, concept, structure and functions,types,energy flow -producers, consumers anddecomposers,
6. Ecological succession, food chains, food webs and ecological pyramids. Characteristic features, structure andfunctions of forest, grassland, desert and aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).
7. Biodiversity – definition and classification. Biogeographical classification of India -Value of biodiversity:consumptive use, productive use, social, ethical, aesthetic and option values

8 Biodiversity at global, national and local levels.Hot spots of biodiversity.Threats to biodiversity: habital loss, poaching of wildlife, man -wildlife conflicts - Endangered and endemic species of India

. Conservation of biodiversity: In-situ and Ex-situ conservation.

9. Environmental Pollution: definition, cause, effects and control measures. Air pollution -. Water pollution - Soilpollution - Marine pollution - Noise pollution - Thermal pollution - Nuclear hazards. Mid Term Examination

10. Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution.

11. Social Issues and the Environment: From Unsustainable to Sustainable development, 33 Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidentsand holocaust. dies.

12. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control ofPollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmentallegislation. Public awareness.

13. Human Population and the Environment: population growth, variation among nations, population explosion,Family Welfare Programme.

14. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health.

15. Disasters -Natural Disasters- nature, types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion.

16. 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.

17. Disaster Management- Effect to mitigatete natural disaster at national and global levels. International strategyfor disaster reduction.

18. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community –based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.

Practical schedule

1. Visit to a local polluted site -Collection, processing and storage of polluted soil and water samples.
2. Determination of pH and electrical conductivity of polluted soil and water samples.
3. Extraction and estimation of toxic/ heavy metals in the soil and water samples collected from the polluted area
4. Determination of physical properties of polluted water sample-colour ,temperature, odour, turbidity etc.
5. Determination of Biochemical Oxygen Demand (BOD) in effluent / polluted samples.
6. Determination of Chemical Oxygen Demand (COD) in effluent / polluted samples.
7. Determination of dissolved oxygen in effluent / polluted samples.
8. Determination of total dissolved solids (TDS) and total suspended solids(TSS) in effluent samples.
9. Estimation of nitrate and chlorine content in ground water .
10. Determination of carbonates and bicarbonates in water sample.
11. Determination of total hardness of water samples by titrimetry.
12. Pesticide residue analysis - collection of samples for monitoring of pesticides and extraction and clean-upproedures of pesticide residues.
13. Estimation of pesticide residues by gas-liquid chromatography.
14. Identification of plant species in an ecosystem –biodiversity assessment-pollution indicators.
15. Field visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain etc.
16. Pollution case studies- Visit to a local polluted site, observations and remedial measures.
17. Visit to Social Service Organization / Environmental Education Centers, study of simple ecosystems-pond,river, hill slopes, etc.- study of common plants, insects, birds etc.

18. Practical Examination

Suggested Readings

1. Ahluwalia, V.K and Malhotra, S. Environmental Science. 2006. Ane Books Pvt. Ltd. India
2. Banjerji, S.K. 1993. Environmental Chemistry. Prentice Hall of India Pvt. Ltd, New Delhi
3. Hodges, L.1973. Environmental Pollution. 2nd Edn. Holt, Rinehart and Winston, USA
4. Gupta, A.K. 2007. Methods in Environmental Analysis Water, Soil and Air. 2nd Edn. Published by AGROBIOS (India) Jodpur
5. Katyal, K. and Satake, M. 1990. Environmental Pollution. 2nd Edn. Anmol Publishers, New Delhi
6. Larcher, W. 1980. Physiological Plant Ecology. Springer- Verlag, New York
7. Loomis, R.S and Corner, D.J. 1992. Crop Ecology, Productivity and Management in Agricultural Systems.Cambridge University Press
8. Pandey, S.N and Misra, S.P. 2011 Environment and Ecology. Ane Books Pvt. Ltd. India
9. Purohit,S.S. 2006. Environmental Pollution Causes, Effects and Control. Published by AGROBIOS (India),Jodpur

BSAC 3104 Enzymology and enzyme technology (2+1)Theory

UNIT I

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

UNIT II

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

Practical

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

Lecture Schedule

1-3. Enzymology Historical Aspects - Discovery of enzymes, Chemistry of enzymes. Enzymes definition, source,classification, general characteristics, role of different enzymes in biological and geological cycles

4-5. Terminologies in enzymology – Cofactors, coenzyme, prosthetic groups, metallo enzymes, monomeric and oligomeric enzymes, Activation energy and transition state theory, enzyme activity, specific activity, common features of active sites, enzyme specificity

6-7.Mechanism of enzyme action- lock & key model , induced fit model , transition state model , quantum tunnelling model, differences , factors affecting the mechanism of enzyme action

8-9. International union of Biochemists- (IUB) nomenclature of enzymes, classification based on the functions – specific role in biochemical cycles -Oxidoreductase-dehydrogenase ,Transferase , Hydrolase , Lyase ,Isomerase ,Ligase

10. Specificity- Types- classification - absolute specificity, group specificity and linkage specificity

11-12. Mechanism of enzyme catalysis-Reaction Mechanisms and Catalysis-Active Site Investigations-Specific enzymes

13. Structure of enzymes- Structural Features- Primary and secondary structure – Methods of determination- Biophysical and molecular

14- 15. Methods of enzyme assay- different substrates and products – Agriculturally significant

enzymes- Dehydrogenase, Urease, phosphatase, cellulose, laccase, Glucosidase, protease

16. Instrumentation for enzyme activity assay- UV- Vis Spectrophotometer-Principle- Beer Lamberts law- Parts- selection of wavelengths and measurement Reflectrometric Interference Spectroscopy.

17. Isolation, purification, characterization and assays of enzyme and international units; Criteria for purity

18-19. Enzyme kinetics; Michaelis – Menten s constants -K_m and V_{max}, factors affecting the V_{max} and K_m

,Michaelis – Menten s constants for different substrates

20. Kinetic models for enzymes-Transient state kinetics, Steady state kinetics and equilibrium kinetics

21. Factors affecting enzyme activity-pH, temperature, heavy metals, agrochemicals, Xenobiotics- impact on theactivity of enzymes

22-23 Inhibitors- Types - Competitive and non-competitive inhibition, reversal of inhibition methods

24-25 Isoenzymes, schizomers and isoschizomers. Ribozymes; types and specific role in biochemistry -Zymogens and their activation (proteases and prothrombin)

26 enzyme catalysis- types- Electrostatic base for enzyme catalysis- significance

27—28 Qualitative description of concerted and sequential models, Negative cooperativity-Half site reactivity,

29 Enzyme regulation: Product inhibition, feedback control, covalent modification

30-31 Enzyme immobilization-Methods of immobilization of enzymes –Adsorption- entrapment-encapsulationtechniques- Mechanism of action of immobilized enzymes-, immobilized enzyme reactors.

32. Industrial application of enzymes – Medicine, agriculture, biotechnology, food industry, pharmaceuticals33-34. Biosensors. enzyme Electrodes.-Immunoelectrodes.-Other Biosensors.-Bioaffinity Sensors

35-36. Commercial enzyme cocktails- isolation and purification, preparation, Commercial forms

Practical Schedule

1-3. Methods of isolation and purification of major enzymes4.-5. Assay of enzymes in soil, compost and media

7-8. Determination of Michaelis Mentens constants –Line weaver Burk Plot

9. Effect of pH on enzyme activities

10. Thermal stability analysis- Effect of temperature on enzyme activities-

11. Effect of heavy metals on enzyme activities12-13. Assay of isozymes and Ribozymes

14-15. Analysis of Immobilized Enzymes.

16. Bio physical methods for structural characterization of enzymes

17. Techniques for the study of catalysis of enzymes

18. Practical examination

Suggested Readings

1. Bisswanger H. 2011. Practical Enzymology.2nd Ed. Wiley-Blackwell.
2. Cook PF & Cleland WW. 2007. Enzyme Kinetics and Mechanism. Garland Publishing Inc.
3. Cornish-Bowden A. 2012. Fundamentals of Enzyme Kinetics.4th Ed. Wiley-Blackwell.
4. Price NC & Stevens L. 1999. Fundamentals of Enzymology: Cell and Molecular Biology of CatalyticProteins. 3rd Ed. Oxford University Press

BSTA 1101 Basic mathematics (2+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 a 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., sum of n terms and infinite number of terms of a G.P., geometric mean; Harmonic series, harmonic mean; Arithmetic- geometric series and special series $\sum n$, $\sum n^2$, $\sum n^3$. Partial fractions; Logarithms; Binomial theorem for any index: Expansion, middle term, general term, terms independentof 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.

Theory

1	Real Numbers and their properties
2-3	Complex numbers and properties of complex numbers, their addition, multiplication and division.
4-5	Square root of complex numbers and examples, cube roots of unity and their properties
6-7	De-Moivre's theorem; Theory of equations: Solution of a quadratic equation, equation reducible to quadratic equation with examples
8-9	Relation between roots and coefficients, nature of roots and formation of quadratic equation withgiven roots and examples
10-11	Geometric series: nth term of G.P, sum of n terms and infinite number of terms of a G.P, geometric mean
11-12	Arithmetic progression: - common ratio and nth term of an A. P, Harmonic progression, nth term of H. P and harmonic mean, and Arithmetic- geometric series
12-13	Special series like $\sum n$, $\sum n^2$, $\sum n^3$ etc
14-16	Partial fractions: proper and improper fractions, types of partial fractions depend upon nature of factors of denominator
17-18	Logarithms and its properties, examples
	Midterm Examination
19-20	Binomial theorem for positive integers and its expansion, middle term terms independent of x, Binomial Theorem for any index with example
21	Trigonometry: Trigonometric ratios, properties of trigonometric ratios
22-23	Trigonometric ratios of allied angles, graphs of trigonometric functions
24-27	Trigonometric functions of sum and difference of two angles – sum difference formulae,Product and sum formulae
28-31	Multiple and sub-multiple angles, sine, cosine and projection formulae
32-36	Coordinate Geometry: Area of a triangle.

Suggested Readings

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

BSTA 1202 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-testfor means of 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 regressionequations; Analysis of CRD, RBD and LSD.

Lecture Schedule

1	Definition of statistics, its use and limitations; Frequency distribution and frequency curve and cumulative frequency curve.
2	Measures of central tendency: - Definition, Characteristics of a good measure of averages, arithmetic mean, median and mode, quartiles
3	Measures of dispersion: -definition and characteristics of a good measure ofdispersion, measures of dispersion-range, standard deviation, quartile deviation and coefficient of variation
4	Probability: Definition, mutually exclusive events, independent events, additive and multiplicative law for two events
5	Normal distribution and its properties
6	Introduction to sampling and different methods of sampling
7	Tests of significance: Null hypothesis, alternate hypothesis, Type I & II error, one and two tail tests, level of significance and confidence interval etc
8	SND test for means: one sample and two samples Z-test and test for correlation coefficients
9	Student's t-test for means of single sample and two samples, paired t-test; F-test
	Midterm Examination
10-11	Chi-square test in 2x2 contingency table; Yate's correction for continuity
12-13	Correlation: Scatter diagram and Karl Pearson's coefficient of correlation for ungrouped data and its testing
14	Linear regression and its properties.
15-16	Analysis of variance and its assumptions-one wayand two-way anova
7	Analysis of CRD and RBD
18	Analysis of Latin Square Design.

Practical Schedule

1	Construction of frequency distribution tables and frequency curves
2	Computation of Arithmetic: Mean, median, mode
3	Computation of measures of dispersion for ungrouped and grouped data

4-5 Test of significance -test based on SND – Z test for means and correlation coefficients
6-9 Computation of Student's t-test for one sample and two sample means; F-test for two variances
10 Chi-square test
11 Computation of Correlation coefficient 'r' and its test of significance
12 Fitting of regression equations and test of regression coefficients
13-15 Analysis of variance- one-way and two-way anova
16-17 Analysis of CRD, RBD and LSD.
18. Practical Examination

Suggested Readings

1. Freud JE & Perles BM. 2006. Modern Elementary Statistics. 12th Ed. Pearson India.
2. Kapoor VK. 2003. Problems and Solutions in Statistics. 7th Edition. Sultan Chand andSons.
3. Snedecor GW. & Cochran WG. 1989. Statistical Methods. Iowa State University Press.

BSTA 2103 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; Handlingof audio-visual equipment; Planning, preparation, presentation of posters, charts, overhead transparencies and slides; Organization of an audio-visual programme.

Lecture schedule

1 IT and its importance - IT tools, IT-enabled services and their impact on society.
2 Computer fundamentals. Hardware: Central Processing Unit, Memory - Primary andSecondary Memory - RAM and ROM, Input and Output Devices.
3 Software Categories - System Software and Application Software - Word and

Characterrepresentation.

4 Features of machine language, assembly language, high-level language and their advantages and disadvantages.

5 Principles of programming - algorithms and flowcharts.

6 Operating systems (OS) - definition, basic concepts. Introduction to WINDOWS and LINUX Operating Systems.

7 Local area network (LAN), Wide area network (WAN), Internet and World Wide Web, HTML and IP.

8 Word processing - Word processing packages - features - Document - units of document - Menus.

9 Word processing - Creating, Editing, Formatting and Saving documents. Midterm Examination

10 Word processing - Copy, Cut and Paste functions - Creating Tables - Merging of Cells - Column and Row width.

11 Electronic Spreadsheets - Concept - Spreadsheet packages - Worksheet and Workbook - Creating, Editing and Saving a workbook.

12 Electronic Spreadsheets - alignment of rows, columns and cells using Format toolbar - Entering formula in a cell.

13 Electronic Spreadsheets - Statistical functions - SUM, AVERAGE, VARIANCE, MAX, MIN, IF. Data Analysis - regression, correlation, frequency distribution, t-test. Creating graphs and charts.

14 Presentation Software - Preparation of slide shows.

15 Audio visual aids - definition, advantages, classification and choice of AV aids. Criteria for selection and evaluation of AV aids.

16-18 Video conferencing, Communication process, Berlo's model, feedback and barriers to communication.

Practical Schedule

1-2 Exercises on binary number system.

3 Algorithm and Flow chart.

4-7 Word processing packages - Creating and Saving a document - Editing and Formatting a document - Use of options from Tool bars - Format, Insert, Tools - Copy, Cut and Paste functions - Spelling and Grammar checking - Creating Tables - Merging of Cells - Columnand Row and width.

8-11 1 Electronic Spreadsheets - Creating, Editing and Saving a workbook - Alignment of rows,columns and cells - using Format Toolbar - Entering a formula in a cell - Use of inbuilt functions - Statistical Functions - SUM, AVERAGE, VARIANCE, MAX, MIN, IF - Data Analysis - Regression, Correlation, Frequency distribution, t-test - Creating Graphs and Charts

12-14 13 Presentation software - preparation of slide shows. Internet applications: Web browsing, Creation and operation of email account, Handling of audio-visual equipment.

15 Planning, preparation, presentation of posters, charts, overhead transparencies and slides.

16-17 Organization of an audio-visual programme.

18. Practical Examination

Suggested Readings

1. Gurvinder Singh, Rachhpal Singh & Saluja KK. 2003. Fundamentals of Computer Programming and Information Technology. Kalyani Publishers.
2. Harshawardhan P. Bal. 2003. Perl Programming for Bioinformatics. Tata McGraw-Hill Education.
3. Kumar A 2015. Computer Basics with Office Automation. IK International Publishing House Pvt Ltd.
4. Rajaraman V & Adabala N. 2015. Fundamentals of Computers. PHI

BSTA 2104 Biomathematics (1+1)Theory

UNITI

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

and its applications.

UNITII

Solution of ordinary differential equation of first degree and first order and their application for determination ofvolume 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; differentiation and Partial differentiation; Euler's theorem; Change of variable, total derivative, implicit function, maxima and minima of single variable functions, functions with two more than two variables, eigen values and eigen vectors of matrix, reduction formulae, definite integrals and their properties; Epidemic models, predator models; Determination of volume of blood and drug distribution;Ordinary differential equation of first order, linear differential equation of higher older and their applications to biological problems, numerical methods.

Lecture schedule

1	Rolle's theorem; Lagrange's theorem; Taylor's and Maclaurin's series
2	Differentiation: definition of a differential coefficient, properties of differentiation
3	Partial differentiation- differentiation with more than one variable, total differentiation etc.
4	Euler's theorem on homogeneous function, change of variable.
5-6	Jacobian, maxima and minima of one variable, two or more than two variables.
7	Eigen values and eigen vectors of a matrix; Reduction formulae
8-9	Definite integrals and its applications
	Midterm Examination
10	Differential equations and solution of ordinary differential equation of first degree and first order
11-12	Application of differential equations for the determination of volume of blood and drug distribution, Epidemic models
13	Simultaneous differential equation of first order and their applications to predator models.
14-16	Linear differential equations of higher order and their applications to simple biological problem.
16-18	Numerical methods for solving algebraic and transcendental equations.

Practical Schedule

1	Tutorials on Taylor's and Maclaurin's expansions
2-4	Differentiation and Partial differentiation, Euler's theorem
5-7	Change of variable, total derivative, implicit function
8	Maxima and minima of single variable functions, functions with two more than two variables
9	Computation of reduction formulae
10	Definite integrals and their properties
11-12	Epidemic models, predator models, Determination of volume of blood and drug distribution
13	Ordinary differential equation of first order
14-15	Linear differential equation of higher older and their applications to biologicalproblems
16-17	Numerical methods
	18. Practical Examination

Suggested Readings

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

BSTA 3105 Biostatistics (1+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; 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; Testing of heritability.

Lecture schedule

1	Random variables: expected value and its variance, probability distribution of random variables
2	Conditional probability, Bayes' theorem and its applications
3-4	Introduction to Uniform, Binomial, Poisson probability distributions and their properties

5-6 Normal, Exponential and Gamma probability distributions
7 Random mating populations, Hardy-Weinberg Law
8-9 Introduction to Poisson process and Markov chains
Midterm Examination
10 Transition probability matrix, n-step transition probabilities, steady state.
11 Random walk models; Sensitivity and specificity.
12 Chi-square test: testing heterogeneity and its use in genetic experiment
13 Detection of linkage and testing for linkage using chi-square, linkage ratios and its estimation.
14-16 Analysis of variance: One-way and two-way classification with interaction
16-18 Analysis of covariance; Estimation and significance of genotypic and phenotypic variation

Practical schedule

1-2 Calculation of expected value and variance of Uniform, Binomial and Poisson Distributions
3-4 Normal, Exponential and Gamma Probability distributions
5 Hardy-Weinberg Law
6-9 Construction of one step two step and n-step transition probability matrix in Markov Chains
10 Calculation of sensitivity and specificity
11-12 Detection and linkage using Chi-square test, linkage ratio and its estimation
13 One-way and two-way analysis of variance
14-15 Analysis of covariance
16-17 Estimation of phenotypic and genotypic variation
Practical Examination
18

Suggested Readings

1. Biswal PC. 2009. Probability and Statistics. PHI Learning Pvt. Ltd.
2. Kaps M. &Lamberson W.2007. Biostatistics for Animal Science. CABIPublishing.
3. Narayan P, Bhatia VK & Malhotra PK.1989.Handbook of Statistical Genetics. Indian Agricultural Statistics Research Institute, New Delhi, India.
4. Pal N. & Sahadeb Sarkar. 2009. Statistics – Concepts and Applications. 2nd Ed. PHI Learning Pvt. Ltd.

BSTA 3106 Agricultural informatics (1+2)Theory

UNIT1: Computer Fundamentals – generations, classifications, components, accessories.
UNIT 2: Number systems – Number representations & Conversions
UNIT 3: Computer Programming- General Concepts, Documentation and Program Maintenance, Debugging programs, Errors. Introduction to Visual Basic, Java, Fortran, C/ C++ concepts and standard input/output operations, Variables and Constants, Operators and Expressions, Flow of control, Inbuilt and User-defined functions
UNIT 4: e-Agriculture, concepts, design, and development. Application of innovative ways to use information and communication technologies (IT) in agriculture/forestry. ICT for Data Collection, formation of developmentprograms, monitoring, and evaluation of programs.
UNIT 5: Computer models in agriculture/forestry: statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages, and application of models for understanding plantprocesses, sensitivity, verification, calibration, and validation. IT application for the computation of water and nutrient requirements of crops, computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in Agriculture for farm advice, market price, postharvest management
UNIT 6: Geospatial technology, concepts, techniques, components, and uses for generating valuable

agri- information. Decision support systems, taxonomy, components, framework, classification, and applications in agriculture/forestry, DSS, Agriculture Information/ Expert System, and Soil Information Systems for supportingFarm 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 & folders, file management. Introduction of various programming languages such as Visual Basic, Java, Fortran, C, C++, and their components Hands on practice on writing small programs. Use of MS-Word and MS PowerPoint for creating, editing, and presenting ascientific document, handling of tabular data, animation, video tools, art tools, graphics, templates & designs. MS-EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data, handling macros. MS-ACCESS: Creating Database, preparing queries and reports, demonstration of Agri- information system. Introduction to World Wide Web (WWW) and its components, creation of scientific website, presentation and management agricultural information through web. Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/CropSyst/ Wofost. Preparation of Inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools. Use of smart phones and other devices in agro-advisory and dissemination of market information. Introduction of Geospatial Technology, demonstration of generating information important for Agriculture. Hands on practice on preparationof Decision Support System

Lecture Schedule-Theory

1. Computer characteristics, evolution, generations, classifications and major components
2. Computer hardware – input devices with examples and output devices with examples
3. Computer hardware - Central Processing Unit (ALU, CU, Memory), cache, registers, Secondary storage devices
4. Computer software – System software (OS, device drivers, translators, utilities, firmware). Programming languages
5. Number systems – character representation; ASCII, EBCDIC. Number representations & Conversions from decimal to binary, and vice-versa, in both integers and floating-point numbers, Conversion from decimal to octal and vice-versa; decimal to hexadecimal and vice-versa, in both integers and floating-point numbers
6. Computer Programming- algorithms, flowcharts, introduction to C/ C++, concepts, and standard input/outputoperations, Small programs in C/C++ to show the use of constants, operators, expressions and in-built functions
7. Computer Programming- Programming in C/C++ to display flow of control using IF… THEN conditions, FOR loop, WHILE loop. Program debugging
8. Programming in C/C++ to display Arrays, string processing. Sub-programs/user -defined functions
9. World Wide Web (WWW): Concepts and components. Communication tools in IT (email, smartphones,social media, text messaging, audio/video calls and conferencing, internet)

Mid-term examination

10. Internet and applications - e-Agriculture, e-learning, e-Journals – their concepts, design, and development.
11. Geospatial technology, concepts, techniques, components and uses for generating valuable agri-information.
12. Smart phone applications in agriculture for farm advice, market price, post-harvest management. IT application for the computation of water and nutrient requirements of crops,

computer-controlled devices (automated systems) for agri-input management,

13. Decision Support Systems – their characteristics, components, types, merits/demerits framework, classification and applications in agriculture/forestry. Expert System, Soil Information Systems - Components and Applications in Agriculture. for supporting Farm decisions.

14. Application of innovative ways to use information and communication technologies (IT) in agriculture/forestry. - Application of MS-Office Suite (MS Word, MS Excel, MS PowerPoint, MS Access),Features of Word Processing, Electronic Spreadsheets, Databases and Presentation Packages

15. Concept of Database and Information management - Units of Database, Creating Database. Extractingresults from database.

16. Presentation packages, Features of presentation.

17. e-Agriculture, concepts, design and development. Application of innovative ways to use information and communication technologies (IT) in agriculture/forestry. ICT for Data Collection, formation of development programs, monitoring and evaluation of programs

18. Computer Models in agriculture/forestry- statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation.

Practical schedule

1. Computer Components - Booting and Shut Down. Fundamental DOS Commands, basic commands inLinux, creating- renaming-deleting- moving folders, CUT, COPY and PASTE functions.
2. Installation of C program. Small programs in C/C++ to show the use of Constants, Operators, Expressions,to display
3. Small programs in C/C++ to show the use of in-built functions
4. Programming in C/C++ to display Flow of control Sequencing, alteration and iteration- using IF… THENconditions, FOR loop, WHILE loop.
5. Program debugging
6. Programming in C/C++ to display Arrays, string processing.
7. Sub-programs/user -defined functions
8. MS Word: Creating a document – Text editing, paragraph editing, File SAVE and SAVE AS,
9. MS Word -Document Layout, View and Review, Headers and Footers, Columns
10. Tables- creation and formatting. Image insert and formatting, Shape insert and formatting
11. MS Word- Mail Merge
12. MS Excel- Basic operations, mathematical calculations, basic functions creating Spreadsheets
13. MS Excel - alignment of rows, columns and cells using format tool bar. entering expressions through theFormula Tool Bar
14. MS Excel – Inbuilt Functions, Statistical functions - Data Analysis using Inbuilt Tool Packs, Correlationand Regression.
15. MS Excel- Creating Graphs
16. MS Excel – Writing Macros, Linking sheets.
17. MS Access - Creating Database, creating tables
18. MS Access- structuring with different types of fields and data entry
19. MS Access - Developing queries and related files with single tables
20. MS Access –Developing queries and related files from multiple tables after setting relationships
21. MS Access – forms, combo box and reports
22. MS PowerPoint - Preparation of slides for presentation
23. MS Powerpoint– including text, tables, bullets, headers, footers, images, shapes
24. MS PowerPoint – animations, transitions, recording voice, setting audio
25. MS PowerPoint- hyperlinks, automating the presentation

26. Email- setting up an email, composing, editing, sending mail. CC, BCC. Mail attachments
27. Internet – tabs, browsing, Incognito/InPrivate browsing, history
28. Smartphone Apps – crop management, soil management
29. Smartphone Apps – soil management
30. Smartphone Apps- pest and disease management apps
31. Soil Information Systems – using free software Soil Info,
32. Soil Information Systems – using free software CarbonToSoil, SoilCares
33. Crop Simulation Models (CSM) using standard software.
34. Introduction of geospatial technology for generating valuable information for agriculture.
35. Applications of Decision Support System in agriculture
36. Applications of Expert System in Agriculture.

Suggested Readings

1. Balaguruswamy, E. 1998. Programming with ANSI - C. Tata Mc Graw Hill, New Delhi.
2. Capron, H.L. 1996. Computers tool for an information age: Benjamin/ Cummings Publishing Company, Inc.New York
3. Date, C.J. 2000. Introduction to Database System. Addison Wesley
4. Gottfried, B. 1999. Programming with C, Schaum Outline Series. Tata McGraw Hill.
5. Malvino, A.P. and Brown, J.A. 1999. Digital Computer Electronics. Tata McGraw Hill.
6. Nortons, P. 2001. Introduction to computers, 4th Ed,Tata Mc Graw Hill, New Delhi
7. Parekh R. 2006. Principles of Multimedia. Tata McGraw-Hill.
8. Rob, P. and Coronel, C. 2006. Database Systems: Design, Implementation and Management. 7 th Ed. ThomsonLearning.
9. Silberschartz, A., Korth, H.F. and Sudarshan, S. 1997. Database Systems Concepts. Tata McGraw Hill
10. Vaughan, T. 2003. Multimedia-Making it Work. McGraw-Hill

Student READY - In-house Skill Development Modules (0+20)BSRP 4101 Plant biotechnology (0+20)

Exposure to plant tissue culture laboratory and equipment. Plant tissue culture methods, large scale production ofplanting materials, virus indexing, traceability protocol, standard operating protocols, fidelity testing using molecular markers, hardening of tissue culture plants. Molecular markers, Genetic transformation techniques andscreening of transformants.

BSRP 4102 Animal biotechnology (0+20)

Basic techniques in animal cell culture: Principles of sterile techniques and cell propagation, chemically defined and serum-free media for cell culture; scaling up of animal cell cultures; preservation and characterization of animal cells, cytotoxicity and viability assays; maintenance of cancer cells, testing of anticancer drugs, cell cultureas a source of valuable products.

BSRP 4103 Bioinformatics (0+20)

Use of key databases of genes and proteins, sequence analysis tools, phylogenetic analysis, primer designing, Protein structure prediction and analysis, docking, protein- protein interaction databases Gene ontology database

and pathways, SNP databases. Software and web resources for microarray, ESTs, NGS & mass spec. Downstreamanalysis of mass-scale data, Molecular network analysis and visualization of molecular

interactions: ncRNA databases, transcription factor databases and cytoscape.

BSRP 4104 Microbial and environmental biotechnology (0+20)

Mass production of biofertilizers and biocontrol agents. Quality control and ISI Standards for marketing of biofertilizers and biocontrol agents. Preparation of biofertilizer consortium, Mass multiplication of *Metarrhizium, Beauvaria, Lecanicillum.* Waste management using composting inoculum, Estimation of cost and returns, capitalrequirement, operational cost, preparation of balance sheet, income and cash flow statement, Identification of market channels

BSRP 4205 Project Formulation, execution and Presentation (0+ 4) - 4 weeks on campus

Students to identify relevant problem faced by farmers. Create an idea to resolve the problem through biotechnological approach and formulate the project. Project proposal include introduction, objectives, review ofliterature, methodology, time frame, budget and outcome of the project.

BSRP 4206 Entrepreneurial development in biotechnology (0+16)

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

The students will be attached for an Internship within KAU or other public or private institutes/ industries involvedin biotechnology activities. They will take part in the ongoing activities of the institute. After completion of the internship, they shall prepare a report and make a presentation about the activities they performed during the internship.

Student READY - In-house Skill Development Modules Four Modules (0+20)Evaluation Criteria:

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

Student READY - Project Formulation, Execution and Presentation (0+4)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+16)Evaluation Criteria:

Parameter	Marks Distribution (%)

Project Planning and Writing	10
Presentation	10
Regularity	10
Monthly Assessment	10
Output Delivery	15
Technical Skill Development	15
Entrepreneurial and Business Networking Skills	10
Report Writing	10
Final Presentation	10

Non-Credit Courses

BEGL 1101 Comprehension and communication skills in English (0+1)

Practical

Listening Comprehension: Listening to short talks lectures, and speeches (scientific, commercial and general in nature). Oral Communication: Phonetics, stress and intonation, Conversation practice. Conversation: rate of speech, clarity of voice, speaking and listening, politeness &Reading skills: reading dialogues, rapid reading, intensive reading, improving reading skills. Mock Interviews: testing initiative, team spirit, leadership, intellectualability. Group Discussions.

Practical schedule

1 - 2 Listening comprehension – Short talks – Lectures – Speeches
3 -6 Oral communication – Phonetics, stress, intonation – Conversation practice
7-10 Conversation - Rate of speech – Clarity of voice – Speaking and listening – Polite conversation
11- 12 Reading skills – Reading dialogues – Rapid reading – Intensive reading – Improving reading skills 13-15 Mock interviews – Testing initiative – Team spirit – Leadership – Intellectual ability 16-17 Group discussion
18. Practical Examination

Suggested Readings

1. Lewis, N. 2009. Word Power Made Easy. Goyal Publishers, New Delhi.
2. Mohanraj, J. 2015. Let Us Hear Then Speak. Saje Publishers, New Delhi.
3. Pinker, S. 2014. The Sense of Style: The Thinking Persons' Guide to Writing in the 21st Century. PenguinPublishers, New York.
4. Strunk, W. and White, E.B. 1959. The Elements of Style. Macmillan.

BNSS 1101 NSS/NSO/ (NC)NCC (0+1)

Practical

Course aims at evoking social consciousness among students through various activities viz., working together, constructive and creative social work, to be skillful in executing democratic leadership, developing skill in programme development to be able for self-employment, reducing the gap betweeneducated and uneducated, increasing awareness and desire to help sections of society.

Practical schedule

1. Introduction and basic components of NSS: Orientation
2. NSS programmes and activities
3. Understanding youth
4. Community mobilization, social harmony and national integration
5. Volunteerism and shramdan
6. Citizenship, constitution and human rights

7. Family and society
8. Importance and role of youth leadership
9. Life competencies, youth development programmes
10. Health, hygiene and sanitation, youth health, lifestyle, HIV AIDS and first aid
11. Youth and yoga
12. Vocational skill development, issues related environment
13. Disaster management
14. Entrepreneurship development
15. Formulation of production-oriented project, documentation and data reporting
16. Resource mobilization
17. Additional life skills, activities directed by the Central and State Government
18. Practical Examination

BPED 1201 Physical education and yoga practices (0+1)

Practical

Definition and Meaning of Physical Fitness, First Aid, Track & Field, Games Basketball, Volleyball, Football, Shuttle Badminton, Cricket, Health Related Physical Fitness Test, Concept of Yogic Practices, Asana, Pranayama,Meaning and Concepts of Meditation

Practical schedule

1. Definition and Meaning of Physical Fitness - Values of Physical Fitness - Components of health related Physical Fitness and Athletic related Physical Fitness – Health benefits of Physical Activity- Hypo kinetic/ lifestyle diseases and their management.
2. First Aid - Treatment - Laceration – Blisters – Contusion - Strain – Sprain – Fracture – Dislocation andCramps – Bandages – Types of Bandages – trapping and supports.

3-11. Optional: Any two is to be offered according to the infrastructure facilities available

Track & Field

i. Conditioning (warming up- jogging – free hand exercises- short sprints- cooling down)
ii. Starting and finishing techniques
iii. Jumps (long jump, triple jump and high jump)
iv. Throws (Shot put, discus throw, javelin throw, hammer throw)
v. Technique of Relay Race- Various methods of baton exchange
vi. General competition Rules of track and field events

Games Basketball

i. Hold, passing – chest pass, bounce pass, baseball pass, overhead pass, shuffle pass
ii. Dribbling- high dribble , low dribble, zigzag dribble, figure of eight
iii. Shooting- layups, free throw and jump shot
iv. Moves- two man, three men weave
v. Tactics- Offence, defense, pivot and screening

Volleyball

i. Passing- over head and under arm
ii. Service- simple service, tennis service
iii. Lift- vertical lift, arch lift and short lift
iv. Smash and block

Football

i. Kicks - kicking with the inside of the foot, kicking with the Instep of the foot, kicking withthe outer instep of the foot.
ii. Heading- from standing, from running, from jumping
iii. Throw-in

iv. Feinting: - with the lower limb, with the upper part of the body.
v. Tackling - simple block tackling, slide tackling
vi. Goalkeeping- Collection of balls, Diving
vii. Ball clearance- Kicking, throwing and deflectingShuttle Badminton
i. Grip – forehand and back hand
ii. Service – long service and short service
iii. Lob- Underhand and over head
iv. Overhead strokes – drop shot and smash
v. Tactics: singles and doubles

Cricket

i. Vertical bat strokes- Front foot strokes (Front foot defense, Front foot drive), Back foot strokes (Back foot defense, Back foot drive)
ii. Bowling: Types of Bowling- Basics (Grip, run up, delivery stride and follow through)
iii. Fielding: defensive fielding, attacking fielding
iv. Catching: different types of catches
v. Throwing: different types of throws
vi. Wicket keeping-basic stance, collection and stumping

Health-Related Physical Fitness Test (Compulsory)

	Test Items	Health Related Component tested
i	One mile rum / 20m multi stage fitness test	Cardio respiratory endurance
ii	Abdominal sit-ups (60 sec)	Musculoskeletal fitness (Core)
iii	Standing broad jump	Musculoskeletal fitness (Lower body)
iv	Seated medicine ball throws (2kg)	Musculoskeletal fitness (Upper body)
v	Height and weight Body Mass Index (BMI)	Body Composition

12. Yoga Practices: Concept of Yogic Practices – Kinds of Yogic Practices: Asana, Pranayama, Kriya, Bandha,Mudra, Dhyana.
13-14. Asana: Definition, Scope and Limitation of Asanas – Classification of Asanas – Meditative Asanas –Relaxative Asanas-Cultural Asanas – Step by Step Performance of Asanas - Safety Measures and Precautions.
15-16. Pranayama: Meaning – different Phases in Pranayama Practice: Puraka (Inhalation), Kumbhaka (Retention) and Rechaka (Exhalation) – Breathing Ratio in Pranayama Practice – Application of Bandhas inPranayama – Safety Measures and Precautions.
17. Meaning and Concepts of Meditation.
18. Practical Examination

BSTR 3201 Educational tour I (All India)

To familarise the student with crops and other research activities of different SAUs, Research Institutes, Agro Industries, Govt. and private organizations in different parts of India. To expose the students to variousnational/heritage monuments as part of national integration activity (15 days duration).

BSTR 4102 Educational tour II (All Kerala)

Study tour of one-week duration in the different districts of Kerala to familarise the students with the activities ofdifferent research stations of Kerala Agricultural University, other research institutes, government and private organisations in the state (One week duration)