

New Curriculum of UG Programme

FOR

B.Sc. (Agril. Biotechnology)

(Layout and Syllabus)

for

I to VI Semester



Chairman

Director of Instructions Co-ordination Committee

&

Director of Instructions

Mahatma Phule Krishi Vidyapeeth

Rahuri-413 722, Dist. Ahmednagar

Maharashtra

Lay Out for Modification of the syllabus of
B. Sc. (Agril. Biotechnology)

- Degree programme : B. Sc. (Agril. Biotechnology)

- Duration : 4 years-8 Semesters

- Tentative layout of the syllabus :
 - ∅ I to VI semester - Course work 119 credits

 - ∅ VII semester – Seminar : 1 credits
 - Cafeteria courses : 20 credits
 - (10 credits from major department
 - 10 credits from 2 minor department)

 - ∅ VII semester – Hands on training 20 credits

 - ∅ Total Credits : 160 credits

 - ∅ Non credit courses : NCC/ NSS : 0+1 credits
 - : English : 1+1 credits
 - : Physical Education :0+1credit

 - ∅ Deficiency course : Math : 1+1 credits

 - ∅ Grand total : 166 credits

Tentative layout of Department –wise courses

A. Dept. of Biochemistry and Molecular Biology

Sr. No.	Title	Credits
Bio-111	Basic Bio-chemistry	2+1=3
Bio-122	Enzymology	2+1=3
Bio-123	Microbial Genetics	2+1=3
Bio-234	Molecular Biology	2+1=3
Bio-235	Plant Metabolic Pathways	2+1=3
Bio-236	Elements of Immunology	1+1=2
Bio-247	Techniques in Biochemistry and Molecular Biology	2+2=4
Bio-358	Recombinant DNA Technology	2+1=3
Bio-369	Molecular Plant Virology	2+1=3
		Total 17+10=27

B. Department of Plant Biotechnology

Sr. No.	Title	Credits
PB-111	Fundamentals of Genetics	2+1=3
PB-122	Cell Biology	2+1=3
PB-123	Introduction to Plant Biotechnology	2+1=3
PB-234	Plant Breeding Techniques	2+1=3
PB-235	Molecular Markers in Plant Breeding	1+1=2
PB-246	Plant Cell and Tissue Culture	2+1=3
PB-357	Biotechnology of Biotic and Abiotic Stress Tolerance	2+1=3
PB-358	Biodiversity Conservation	2+1=3
PB-369	Introduction to Bioinformatics	1+2=3
PB-3610	Bio-safety Issues	2+0=2
		Total 18+10=28

C. Department of Crop Science

CS 111	Principles of Plant Physiology	2+1=3
CS 112	Field Crop Production	2+1=3
CS 113	Introductory Entomology	1+1=2
CS 124	Fundamentals of Plant Pathology	1+1=2

CS 125	Agricultural Microbiology	1+1=2
CS 126	Horticultural Crop Production	2+1=3
CS 237	Greenhouse Technology and Protected cultivation	1+1=2
CS 248	Bio-Statistics	1+1=2
CS 249	Intellectual Property Rights	1+0=1
CS 3510	Computer Application in Biotechnology	1+2=3
CS 3611	Management of Major Insect Pests and Diseases of Field and Horticultural Crops	1+1=2
CS 3612	Marketing and Export of Biotechnological Products	1+1=2
CS 4713	Seminar	0+1=1
	Total	15+13=28
	Non Credit Courses	
LANG 111	Comprehension and Communication Skills in English	1+1=2
PHY EDN 111	Physical Education	0+1=1
NCC/NSS 121	National Cadet Corps / National Service Scheme	0+1=1
	Deficiency Course	
MATH 111	Mathematics	1+1=2
	Total	2+4=6
	Grand Total	17+16=33

D. Department of Post –Harvest and Food Biotechnology

FB-121	Human Nutrition	1+1=2
FB-232	Industrial Microbiology and Fermentation Technology	2+2=4
FB-243	Enzyme Biotechnology in Food Processing	2+1=3
FB-244	Post-harvest Biotechnology of Food Grains	2+1=3
FB-355	Technological Applications in Food Processing	1+1=2
FB-366	Post-harvest Biotechnology of Horticultural Crops	2+1=3
FB-367	Food and Nutrition Security of GM Food crops	1+1=2
		Total 11+8=19

E. Department of Animal Biotechnology

AB-231	Basics in Animal Biotechnology	2+1=3
AB-242	Animal Cell Culture	2+1=3
AB-243	Biotechnology of Ruminant Feed Utilization	2+1=3
AB-354	Dairy Process Biotechnology	2+1=3
AB-355	Livestock Genome	2+1=3
AB-366	Animal Genetic Engineering	2+1=3
		Total 12+6=18

Credit Courses : 120 (73+47)

Non-Credit Courses : 004 (01+03)

Deficiency Courses : 002(01+01)

Total Credits : 126(75+51)

F. Cafeteria Courses : 20 credits (10 from Major Department & 5 each from two minor department)

G. Hands on Training : 0+20 credits of Each Major Department

Grand Total : 166 (160 Credit courses + 6 Non-credit courses)

Tentative Semester-wise Layout of Courses

Semester I

Bio-111	Basic Biochemistry	2+1=3
PB-111	Fundamentals of Genetics	2+1=3
CS-111	Principles of Plant Physiology	2+1=3
CS-112	Field Crop Production	2+1=3
CS-113	Introductory Entomology	1+1=2
	Total	9+5=14
	Non Credit Courses	
LANG-111	Comprehension and Communication Skills in English	1+1=2
PHY EDN-111	Physical Education	0+1=1
	Deficiency Course	
MATH-111	Mathematics	1 + 1 = 2
	Total	2+3=5
	Grand Total	11+8 = 19

Semester II

Bio-122	Enzymology	2+1=3
Bio-123	Microbial Genetics	2+1=3
PB-122	Cell Biology	2+1=3
PB-123	Introduction to Plant Biotechnology	2+1=3
FB-121	Human Nutrition	1+1=2
CS-124	Fundamentals of Plant Pathology	1+1=2
CS-125	Agricultural Microbiology	1+1=2
CS-126	Horticultural Crop Production	2+1=3
	Total	13+8=21
	Non Credit Courses	
NCC/NSS 121	National Cadet Corps / National Service Scheme (NCC/NSS)	0+1=1
	Grand Total	13+9=22

Semester III

Bio-234	Molecular Biology	2+1=3
Bio-235	Plant Metabolic Pathways	2+1=3
Bio-236	Elements of Immunology	1+1=2
PB-234	Plant Breeding Techniques	2+1=3
PB-235	Molecular Markers in Plant Breeding	1+1=2
FB-232	Industrial Microbiology and Fermentation Technology	2+2=4
AB-231	Basics in Animal Biotechnology	2+1=3
CS 237	Greenhouse Technology and Protected Cultivation	1+1=2
	Total	13+9=22

Semester IV

Bio-247	Techniques in Biochemistry and Molecular Biology	2+2=4
PB-246	Plants Cell and Tissue Culture	2+1=3
FB-243	Enzyme Biotechnology in Food Processing	2+1=3
FB-244	Post-harvest Biotechnology of Food Grains	2+1=3
AB-242	Animal Cell Culture	2+1=3
AB-243	Biotechnology of Ruminant Feed Utilization	2+1=3
CS 248	Bio-Statistics	1+1=2
CS-249	Intellectual Property Right	1+0=1
	Total	14+8=22

Semester V

Bio-358	Recombinant DNA Technology	2+1=3
PB-357	Biotechnology of Biotic and Abiotic Stress Tolerance	2+1=3
PB-358	Biodiversity Conservation	2+1=3
FB-355	Technological Applications in Food Processing	1+1=2
AB-354	Dairy Process Biotechnology	2+1=3
AB-355	Livestock Genome	2+1=3
CS-3510	Computer Applications in Biotechnology	1+2=3
	Total	12+8=20

Semester VI

Bio-369	Molecular Plant Virology	2+1=3
PB-369	Introduction to Bioinformatics	1+2=3
PB-3610	Biosafety Issues	2+0=2
FB-366	Post-harvest Biotechnology of Horticultural Crops	2+1=3
FB-367	Food and Nutrition Security of GM Food crops	1+1=2
AB-366	Animal Genetic Engineering	2+1=3
CS-3611	Management of Major Insect Pests and Diseases of Field and Horticultural Crops	1+1=2
CS 3612	Marketing and Export of Biotechnological Products	1+1=2
	Total	12+8=20

Semester VII

CS 4713	Seminar	0+1=1
	Cafeteria Courses of major departments	4+6=10
	Cafeteria Courses of minor department(I)	2+3=5
	Cafeteria Courses of minor department (II)	2+3=5
	Total	8+13=21

Semester VIII

HOT481	Hands on training	0+20
	Total	0+20=20

- 1) Each Department should create the facilities required for the above training and experiential learning.
- 2) Equal students should be allotted to four major departments immediately after the registration of the semester.
- 3) Each Department should prepare at least two equal batches and allot the project work to the students.

Course contents (Syllabus)

BIO111 : Basic Biochemistry 2+1

Theory :

Biochemistry: Definition, scope and importance in Agril. Biotechnology Concept of life and living processes : Introduction, nature of biological material, properties, the identifying characteristics of a living matter, molecular logic of life, The Cell - A Brief Introduction : Structure of prokaryotic and eukaryotic cells, Cell Membrane System and Cell wall: Cell membrane and its organization; elementary idea of cellular constituents: nucleus, mitochondria, golgi bodies, endoplasmic reticulum, lysosomes and microbodies; bacterial and plant cell walls. Biomolecules : Carbon and its brief chemistry, general properties of biomolecules, water: structure and unique properties, acid, base, buffers, polyprotic acids. Carbohydrates : Monosaccharides: classification, structure, configuration, properties and derivatives, common disaccharides, structure and function, occurrence of storage and structural polysaccharides, glucosaminoglycans, glycoproteins: structure and function. Lipids : Fatty acids, triacylglycerol, phospholipids, sphingolipids: sphingomyelins, cerebrosides gangliosides, cholesterol, micelles, bilayers, liposomes, lipoproteins: structure and function. Amino acids and proteins: Amino acids: structure, nomenclature and general properties. Peptide bond, primary structure of proteins, end group analysis, amino acid composition, specific peptide cleavage and sequence determination. Secondary structure: peptide group, Ramachandran diagram, helical structures: alpha-helix and other polypeptide helices, β -pleated sheets. Protein stability: electrostatic interactions, hydrogen bond and hydrophobic forces, disulphide bond. Tertiary and quaternary structures of proteins. Vitamins and enzymes : Water soluble vitamins, their coenzyme forms, sources and biochemical functions. Fat soluble vitamins: sources and functions. Enzymes: historical perspective, naming and classification, factors affecting enzyme activity, mechanism of enzyme action, enzyme units. Nucleic acids and chromosomes : Nucleic acid structure and function, physical and chemical properties, spectroscopic and thermal properties, *in vitro* denaturation and renaturation of DNA, DNA as genetic material. Bioenergetics : Principles of thermodynamics and their applications in biochemistry -introduction and thermodynamic state functions, first and second law of thermodynamics, concept of free energy, standard free energy change, biological oxidation-reduction reactions, redox potential. High energy phosphate compounds, free energy of hydrolysis of ATP and sugar phosphates.

Practicals :

1. Preparation of standard solutions
2. Methods for measurement of pH
3. Preparation of buffer solutions
4. Qualitative tests for sugars.
5. Quantitative estimation of reducing and non reducing sugars by Nelson-Somyogi method.
6. Qualitative tests of amino acids and proteins.
7. Quantitative estimation of protein by Folin Lowry's method.
8. Estimation of free amino acids by ninhydrin reagent.
9. Separation and identification of amino acids by paper chromatography/TLC.
10. Estimation of lipid/crude fat by soxhlet apparatus
11. Estimation of saponification, iodine and acid values of oil/fat.
12. Determination of ascorbic acid from the aonla
- 13 Determination of phosphorus from a given sample
14. Estimation of nitrate reductase activity from leaves of crop plants.

Reference Books :

1. Voet & Voet, 2000, Fundamentals of Biochemistry, John Wiley, New York
2. Zubay, 1995, Biochemistry, Brown Publishers.
3. Nelson & Cox 2000, Lehningers Principles of Biochemistry. W.H. Freeman.
4. L. Stryer, 2002, Biochemistry, W.H. Freeman.
5. Harper, 2003, Biochemistry, McGraw-Hill.
6. David Metzler, 2006 Biochemistry Vol.I,II, Panima N.Delhi
7. D.T. Plumer. An Introduction to Practical Biochemistry. Tata McGraw Hill Co.

PB 111: Fundamentals of Genetics

2+1

Theory :

Comb pattern in fowls, Complementary genes; Supplementary factors; Epistasis: Plumage colour in poultry, Duplicate factors, Flower colour in sweet peas, Different Interactions of genes, Variations on dominance, Multiple alleles, Multiple allelism: Blood groups in human beings. Lethal alleles, Pleiotropism; Several genes affecting the same character, Penetrance and expressivity, Chromosomes: Chemical composition structural organization of chromatids, centromeres, telomeres, and chromatin. Chromosomal Variations, A General account of structural and numerical aberrations,;. Linkage: Basic eukaryotic chromosome mapping, The

discovery of linkage, Recombination linkage symbolism, Linkage of genes on X chromosomes, Linkage maps, Theories of crossing over, Types of crossing over's, Three point testcross, Interference Structure of DNA and RNA, Hardy-Weinberg Law, Darwin's revolution, Variation and its modulation, The effect of sexual reproduction on variation, The sources of variation, Selection, quantitative genetics, Multiple factors – Skin colour in human beings Sex Determination in Plants and animals.

Concepts of allosomes and autosomes, XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types, Mutations Types: spontaneous and induced, Mutagens: Physical and chemical, Mutation at the molecular level. Mutations in plants, animals, and microbes for economic benefit of man. Plant karyotype, Inherited disorders - Allosomal (Klinefelter syndrome and Turner's syndrome), Autosomal (Down syndrome, Haemophilia and Sickle cell anaemia).

Practical:

1. Squash and Smear techniques – Cell division : Mitotic and meiotic studies in Onion root tip and flower buds
2. Study of Karyotypes and ideograms using suitable plant materials
3. Identification of DNA using Schiffs Reagent
4. Histochemical staining of DNA & RNA
5. Calculating recombinant frequencies from selfed, dihybrids, examples on linkage maps,
6. The χ^2 test
7. Genetics practical will include working problems in genetics
8. Simple genetic problems (Problems and Interaction of genes, Lethal factor interaction)
9. Isolation of chloroplasts and mitochondria
10. Vital staining of mitochondria
11. Blood smear – differential staining
12. Problems on coat colour in rabbit (Multiple alleles)
13. Problems on sex linked traits

Reference Books:

1. Genetics by Strickberger M.W 1976 . McMilian Co. New York.
2. Genetics by Goodenough U. 1990 . Saundres College Publishing, New York
3. Genes I -IX by Lewin B. Oxford University Press , Oxford.
4. Fundamentals of Genetics by B.D. Singh, Kalyani Publishers.
5. Fundamentals of Genetics by Ringo, Kalyani Publishers.
6. Genes IX, 2006, by Benjamin Lewin, Pearson Prentice Hall, Pearson Education Inc., New Jersey

CS 111 : Principles of Plant Physiology

2+1

Theory :

Definition, scope and introduction in agriculture, Osmosis, DPD, TP. Water absorption by plants; Ascent of sap. Transpiration-Mechanism, factors affecting it, Structure and function of stomata. Osmotic pressure, guttation. Plant Nutrition: Major and minor nutrients; their roles and deficiency symptom; Active and passive mineral uptake mechanisms. Photosynthesis-Structure and function of chloroplast; Light and dark reactions; Cyclic and non-cyclic electron transfer; C_3 , C_4 , Crassulacean acid metabolism and photorespiration. Respiration types; R.Q. Hormones: types and role in agriculture biotechnology. Growth phases, photoperiodism, and vernalization. Stress physiology (Drought, heat, frost and salinity); mechanism of resistance to above types. Physiological aspects and problems of cereals, pulses, oilseeds, cotton and sugarcane.

Practicals:

Plasmolytic method of cell sap determination. Effect of osmotic pressure on rate of imbibitions; Determination of water losses, effect of salinity on water absorption. Determination of dry matter content in leaves, stem and roots. Determination of transpiration by photometric---and cobalt chloride paper method. Colorimetric estimation of Chlorophyll a, b and total chlorophyll content in a leaf. Measurement of photosynthesis –Dry weight difference method. Demonstration of energy release during respiration. Determination of R.Q. by Ganong's respirometer in different seeds. Demonstration of effect of phytohormones, IAA and GA on crop growth. Demonstration of effect of ethylene on fruit ripening. Demonstration of vegetative growth by Arc-axanometer. Demonstration of effect of water stress on seed germination by using PEG. Study of deficiency symptoms of major and minor plant nutrients.

Reference Books:

1. A Text Book Plant Physiology by Verma V 1973 M.K publication house New Delhi
2. An Introduction to Plant Physiology of Field Crops by Shivraj A 1978 Oxford and I.B.H publishing Co-operative PVT Ltd , New Delhi
3. Plant Physiologists by Pande S.N and Sinha B.K 1978 Vikas publishing house New Delhi.
4. Practical Plant Physiology by Amar Singh 1982 Kalyani publisher New Delhi
5. Useful techniques for plant scientist by Dhopte A.N and Levra N 1989 Publication of forum of plant physiologist Akola
6. Plant Physiology by Salisbury F and C . Ross 1990, Prentice Hall of India New Delhi

CS 112 : Field Crop Production

2+1

Theory :

Meaning and scope of Agronomy, Field crops-classification with examples. Tillage-Definition, types of tillage, importance and implements used for tillage, manures and fertilizer application and their types, Irrigation-water managements, methods of irrigation, micro irrigation, Weeds : classification of weeds, methods of weed control, cropping systems, organic farming. Agronomy of important field crops of the region-cereals, pulses, oilseeds, commercial crops, soil and climatic requirements, Land preparation, varieties, seeds and sowing, cultural practices, manuring, irrigation, weed management practices, plant protection measures, harvesting and yield, seed production of important crops.

Practical:

Study of tillage implements and working with them, seed bed preparation. Seed treatment, sowing methods, irrigation layouts and schedules, identification of manures and fertilizers and their methods of application. Weeds : identification, classification and control measures, Study of plant protection equipments and their use. Identification of important pests and diseases. Harvesting, threshing and preparation of product for marketing. Identification of seeds and crops.

Reference Books:

1. Modern Techniques of raising field crops-Chidra Singh, Oxford and IBH Publishing Co. Lt. Bangalore.
2. Agronomy-S.C. Panda, 2006. Agribios Publication, New Delhi.
3. Crop Production and Management – Y. B. Morachan, Oxford and IBH Publishing Co. Ltd. Bangalore.
4. Principles of Agronomy- S. R. Reddy, Kalyani Publishers, Ludhiana.
5. Field crops- Rajendra Prasad.
6. Weed Management: Principles and practices- O. P. Gupta, Agribios, New Delhi.
7. Organic farming- O.P. Dahama.

CS 113 : Introductory Entomology

1 +1

Theory:

Definition, importance and scope for Entomology, place of insects in animal Kingdom. Insect in relation to man, Insect integument: structure and function, cuticular process and appendages. Structure of insect; head, thorax, abdomen, their functions and modifications, Wing venation and wing coupling apparatus. Metamorphosis, sense and sound producing

organs. Study of digestive, excretory, respiratory, circulatory, reproductive, endocrine and nervous system.

Practical :

General organization of body of cockroach, structure of head, head positions, Antennae. Types of mouth parts in cockroach, red cotton bug housefly, honey bee, butterfly. Thorax, leg, wing, wing venation and wing coupling apparatus. Abdomen, structure, segmentation and appendages, Types of larvae and pupae, Dissection of cockroach for digestive, male, female reproductive and nervous system.

Text books:

1. Imms General Text Book of Entomology Vol. I & II – Richards and Davies.
2. Destructive & useful insects – R.L. Metcalf and W.D. Flint.
3. Anatomy and Physiology of Insects by N.C. Pant and S. Ghai.

LANG-111: Comprehension and Communication Skills in English

Theory:

Reading Comprehension: To locate specific information for meaning of words, phrases and sentences for understanding logical relationship between statements. Taking and making notes.

Technical Reports: Structure, Language, Press notes/ articles Précis, summary, abstracts. Paragraph writing, Job application & CV writing, Notice, agenda and minutes Personal and professional correspondence. Stress and Intonation, Group discussion, Interview (Interviewee & interviewer), Listening comprehension, Power point presentation.

Practical:

Reading Comprehension: Location of specific information, meaning of words, phrases. Sample analysis, writing analysis, Taking and making notes, case studies/Sample analysis, technical reports, press notes, news articles: Sample analysis and case studies, job application and CV writing, sample analysis, notice, agenda minutes writing: sample analysis and case studies, personal and professional correspondence., Sample analysis and case studies.

Stress and Intonation: Practice and Drill, Group discussion, mock interviews.

Listening Skills : Practice of listening to talks, speeches & lectures.

Power point presentation : Practice and sample analysis.

Following syllabus will not be included in the examination. But, it is decided in the meeting to cover following topics in the classroom

Word order, Subject- Verb Agreement, Preposition, Tenses, Voices, Phrasal verbs etc. Technical reports, Handling media, Business presentation, Referencing, E-mail, FAX etc.

MATH 111 : Mathematics

1+1

Theory

Quadratic equation : Definition of quadratic equation, Roots of quadratic equation, Nature of roots, Sum and product of roots, Formation of quadratic equation, Examples based on above topics. Logarithm : Definition, Laws of logarithm and Change of base theorem (without proofs) Examples based on laws. Determinants : Definition of determinant (Statements) Minors of the determinant, Expansion of determinant, Properties of determinant (Statement only) Examples based on expansion of determinant. Point, Distance between two points, section formulae : Co-ordinate axes, origin, Quadrants, Distance between two points, section formulae for internal division (without proof). Examples based on distance and section formulae. Locus of a point, different forms of straight lines : Definition of locus, equation to a curve, equation to axes and straight lines parallel to axes, statements of equations of straight line in slope intercept form, double intercept form and two points form. General equation of straight line, Formula for angle between two straight lines (without proof), Conditions for two straight lines to be parallel and to be perpendicular. Circle : Definition of circle, Statements of standard form, centre-radius form, General form and the most general form of equation of circle (without proof) Examples based on these forms. Trigonometry : Fundamentals of Trigonometry, Definition of angle of elevation and angle of depression with examples. Mensuration : Illustration of ordinates of curve and common distance between ordinates, Statement of Simpson's rule and its application for measuring areas of irregular field. Examples based on Simpson's rule. Function, Limit : Definition of function, Domain and range of function, independent and dependent variables Illustration of different types of functions with examples only such as Algebraic (rational, polynomial and constant), Non algebraic function (Logarithmic, Trigonometric, Inverse trigonometric and exponential). Definition of limits, theorems and standard limits (only statements) Examples on evaluation of finite limits of polynomial, rational, trigonometric functions. Differential calculus, Theorems of differentiation : Definition of differentiation, Differential coefficient, Theorems of differentiations, Composite function and Chain Rule (without proofs, List of standard formulae for power, trigonometric, logarithmic and exponential functions. Examples based on rules. Integral calculus, Concept of indefinite Integral : Definition of Integral of a function, Integrand and process of Integration, study of integral calculus, constant of Integration, table of elementary integrals, Theorems on integration (without proof), Examples on integration by decomposition method only, definition of definite integral and simple examples on definite integral.

PRACTICAL:

1. The credit "+1" of (1+1) credit be used for tutorial periods.
2. In the tutorial periods practice of solving examples using suitable theory portion, covered in theory periods.

3 To cover fundamental topics on trigonometry, differential and integral calculus any suitable book for XI and XII standard may be referred.

Reference Books:

- | | |
|--------------------------------|-------------------|
| 1. Higher Algebra | - Hall and Knight |
| 2. plane Trigonometry Part I | - S. L. Loney |
| 3. Co-ordinate Geometry Part I | - S. L. Loney |
| 4. Mensuration – I | - Pierpoint |
| 5. Differential Calculus | - Shanti Narayan |
| 6. Integral Calculus | - Shanti Narayan |

BIO 122 : Enzymology

2+1

Theory:

Introduction : Review of brief history, enzymes as biological catalysts, classification, nomenclature, proximity and orientation, covalent catalysis, acid-base catalysis. Isolation and purification of enzymes : Objectives, strategy, choice of source, methods of homogenization and separation. Enzyme assays, specific activity, enzyme activity units. Factors affecting the rate of enzymatic reactions : substrate concentration, enzyme concentration, pH, temperature, coenzymes and cofactors. Specificity of enzymes : absolute specificity, broad specificity, intermediate specificity, stereospecificity. Active site of enzymes : common features, enzyme-substrate complex formation, evidences. Enzyme kinetics: Monosubstrate reactions, Michaelis-Menten equation and its linear transformations, K_m and V_{max} : definition, determination and significance. Enzyme inhibition: Reversible inhibition, competitive, non-competitive and uncompetitive inhibitions. irreversible inhibition, specific examples. Identification of functional groups essential for catalysis, ribonuclease and chymotrypsin as specific examples. Bisubstrate enzyme reactions : Single and double displacement reactions, random and ordered mechanisms. Enzyme regulation : allosteric enzymes, cooperativity, special characteristics, Monod and Koshland models, covalent modification of enzymes, specific examples to be studied: ATCase, phosphorylase, lactate dehydrogenase. Mechanism of enzyme action : specific examples; chymotrypsin, lysozyme, ribonuclease A, carboxypeptidases. Isoenzymes : Characteristics and importance. Enzyme as tools in biotechnology : Methods of enzyme immobilization and its industrial applications.

Practical:

1. Extraction of crude enzyme, purification of enzymes: General principles.
2. Assay of the α - and β - amylases

3. Effect of substrate concentration, pH, enzyme concentration, assay media, and temperature on enzyme activity
4. Determination of K_m value
5. Effect of different inhibitors on the enzyme activity
6. Effect of coenzyme and metal ions on enzyme activity.
7. Extraction and assay of peroxidase, polyphenol oxidase, catalase and invertase.
8. *In vivo* and *in vitro* nitrate reductase activity from tissue samples
9. Isolation and sequential purification of enzymes by different analytical techniques.
 - a. Purification of enzyme by dialysis membrane
 - b. Purification of enzyme by ammonium sulfate precipitation
 - c. Purification of enzyme by gel filtration
 - d. Purification of enzyme by ion exchange chromatography.

Reference Books:

1. Nelson & Cox 2000, Lehninger's Principles of Biochemistry. W.H. Freeman.
2. Voet & Voet, 1991. Biochemistry.
3. Dixon, M., Webb, E.C. Thorne, C.J.R. and Tipton, K.F. 1979. Enzymes, 3rd edn.
4. Price, Fundamentals of Enzymology.
5. Palmer, T. 2001. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, England.
6. Price, N.C. and Stevens, L. 1999. Fundamentals of Enzymology, 3rd edn.
7. Marwaha, 2000 Food Processing Biotechnological Applications. Asiatech publishers, N.Delhi

BIO 123 : Microbial Genetics

2+1

Theory:

Introduction to microbial genetics. Prokaryotes: bacteria, cyanobacteria, mycoplasma etc. The evolution of prokaryotic genetics; early concept of bacterial variation; adaptation, mutation and selection. Prokaryotic chromosome structure: bacterial chromosome, supercoiling of the genome, circular and super helical DNA, Plasmids: Types, properties and roles, Conjugal transfer of plasmid DNA – stage in transfer process, effective contact and pilli, mobilization and transfer *tra* genes of F plasmids, host restriction in transfer; plasmid replication. Transposable elements, insertion sequences, types of bacterial transposons, transposition, transposase, excision of transposons, transposons and evolution. Mutations: Biochemical basis of mutations, spontaneous mutation, isolation of mutants, mutagenesis, reversion, suppression, genetic analysis of mutants. Genetic recombination, transformation, conjugation and transduction. Transformation: Discovery of transformation, competence and DNA uptake.

Conjugation. Insertion of F plasmid into the *E. coli* chromosome, *Hfr* transfer, Transduction : generalized and specialized, sexduction, Viruses: different genomes; bacteriophages with lytic (T4 phage) and lysogenic (lambda phage) in detail.

Practicals:

1. Culture techniques for isolation of single colonies of bacteria *Escherichia coli*– streaking, serial dilutions etc.
2. Induction of mutation in bacteria through physical, chemical and biological agents; studying the mutation rate.
3. Replica plating technique
4. Bacterial Genomic DNA isolation
5. Plasmid DNA isolation techniques: Alkali lysis; Heat lysis etc.
6. Bacterial competent cell preparation and transformation
7. Triparental mating experiments for studying conjugation (Donar x Recipient x Helper), conjugation frequency calculation
8. Bacteriophage Lambda infection and plaque study.

Reference books:

1. Microbial Genetics, 2006, Second Edition, by S. R. Maloy, J. E. Cronan, Jr. and David Freifelder; Narosa Publishing House, New Delhi.
2. Molecular Biology, 2005, Second Edition, by David Freifelder; Narosa Publishing House, New Delhi.
3. Genetics, 2005, Third Edition, by M. W. Srtickberger, Prentice Hall of India Private Ltd. New Delhi.
4. Genetics, 2006, First Edition, by B. D. Singh, Kalyani Publishers, New Delhi.
5. Genes IX, 2006, by Benjamin Lewin, Pearson Prentice Hall, Pearson Education Inc., New Jersey

PB122 : Cell Biology

2+1

Theory :

Cellular basis of life, Application of Microscope, Evolution of cell theory, Cell structure, organelles and their function ,types of cells, Eukaryotes/Prokaryotes cells and its organization plant and animal cells, Plasma membrane , endoplasmic reticulum ,mitochondria ,cytoskeleton, nucleus, Golgi apparatus, cytosomes and chromatin . Cell

division, differentiation –mitosis meiosis Inter and intracellular communication . Cell growth and proliferation, molecular constituents of cells. Regulation of cellular function by growth factors and hormones. Cell pigments, cell viability, Active and passive transport ,movement of molecules into and out of cells.

Practicals:

Study of microscope, Light, fluorescents, phase contrast. Fixing of tissues for mitosis, meiosis, Microscopic preparations, staining of cells /chromosomes, preparation of slides, cell lines and development.

Reference Books:

1. Molecular cell biology by Darnell J, H.Lodish & D. Baltimore,1986
Scientific American books Inc, New York.
2. Cell and molecular biology by Sheeler P. & D.E. Branchi, 1987. John Wiley & sons Inc,New York.
3. Cytology by Verma P.S. & V.K. Agarwal 1994 S.Chand & co., New Delhi.
4. Molecular aspects of cell biology, Part V by Garret R.H. & C.M. Grisham.1995. Saunders college publishing, New York.
5. Plant Cell biology by Gunning B.E.S. & M.W. Steer.1996. Jones & Bartlett Publishers, London.
6. Molecular Biology by Freifelder,2007 Narosa Publishing.
7. Molecular Cloning Lab Manual by Sambrook & Russel, Vol.1-3,2007, CBS Publishing.
8. Cell Biology by Cellis Vol. I-III.
9. Cell & Molecular Biology by De Robertis.
10. Plant Cell Biology by Hawes.

PB 123 : Introduction to Plant Biotechnology

2+ 1

Theory:

Introduction Definition, Classical vs modern biotechnology. Basic concepts and history of biotechnology, Different branches of biotechnology, Tools of Genetic Engineering: Cloning vehicles, Restriction enzymes, Modifying enzymes, DNA ligase, Polymerase etc. Cloning Vectors: Plasmids, Lambda phage, Phagemids, Cosmids, Artificial chromosomes (BACs, YACs), Shuttle vectors, virus based vectors, Methods of gene transfer: Transformation, transduction, Particle gun, Electroporation, liposome mediated, microinjection, *Agro-bacterium* mediated gene transfer, Preparation and application of molecular probes: DNA probes, RNA probes, Radioactive labeling, Non radioactive labeling, use of molecular probes, DNA fingerprinting,

Analysis and expression of cloned gene in host cells: Expression vectors, Restriction enzyme analysis, Southern blotting, Northern blotting, Western blotting, In-situ hybridization. Colony and plaque hybridization, Factors affecting expression of cloned genes, Reporter genes, Fusion proteins, Gene libraries - cDNA synthesis, Genomic DNA libraries, Amplification of gene libraries, Identifying the products of cDNA clones, Isolation, Sequencing and synthesis of gene: Different methods of gene isolation, Techniques of DNA sequencing, Artificial DNA synthesis, Polymerase Chain reaction (PCR): Basic principles, modifications, applications, Modifying Genes: Site-directed mutagenesis, Insertion & Deletion Mutagenesis.

Practical:

Isolation of DNA from Plant sample and bacteria.

Isolation of RNA from plant sample.

Restriction analysis of the plant DNA and bacterial DNA.

Separation of DNA by Gel Electrophoresis methods

Application of Polymerase Chain reaction.

Genetic transformation through *Agro-bacterium*.

Reference books:

1. Biotechnology Vol I and VII by Rehm HJ and Reed G 1997. Verlag Chemic Weinheim, USA.
2. Elements of Biotechnology by Gupta PK 1999. Rastogi Publication, Meerut, India.
3. Biotechnology by Singh BD. Kalyani publishers, New Delhi.
4. Introduction to Plant Biotechnology by H.S. Chawala, 2002, Oxford IBH.

FB 121: Human Nutrition

1 + 1 = 2

Theory :

Nutritional science – historical perspective, Importance and functions of food, Food constituents : carbohydrates, proteins, lipids, minerals and vitamins-their role and functions, dietary requirements of food for infants, pre-school children, adults, Pregnant and nursing mothers. Under nutrition and malnutrition. Nutrition and aging, Nutrition and human genetics – genetic determinants of nutrient needs, genetic abnormalities, racial differences in nutrient needs or nutritional processing, the frequency of genetic abnormalities, gene stability, genetic change and carcinogenesis, genetic basis of obesity, nutrition and immune system, nutritional disorders, Food in relation to health and diseases. Inborn errors of metabolism. Losses of vitamins and minerals due to food processing. Food pattern. Food policies – applied nutrition programme.

Practical :

1. Analysis of food for proximate composition
 - a. Determination of dry matter and moisture
 - b. Determination of ash
 - c. Determination of acid soluble and insoluble ash
 - d. Determination of crude fiber
 - e. Determination of crude fat
 - f. Determination of crude protein by micro-Kjeldhal method
 - g. Determination of nitrogen free extract
2. Estimation of calorific value of the food by bomb calorimeter
3. Estimation of the phosphorus by molybdo-vanadate method
4. Estimation of calcium
5. Estimation of water soluble vitamin ascorbic acid
6. Estimation of water soluble vitamin thiamin
7. Estimation of fat soluble vitamin A/D/E
8. *In vitro* protein digestibility of grain protein and starch.
9. Nutritional disorders.

Reference Books :

1. Human Nutrition and Dietetics by Garrow, J.S., James, W.P. T. and Ralph, A. 2000. Churchill Livingstone, Edinburgh.
2. Human Nutrition by Barasai.
3. Food Science and Human Nutrition by Swaminathan Vol.1-2.
4. Text Book of Human Nutrition by Bamji M.S., Oxford IBH.

CS 124 Fundamentals of Plant Pathology

1 + 1

Theory

Introduction to the science of phytopathology, its objectives, scope and historical background. Terms and concepts in Plant Pathology. Classification of plant diseases, symptoms, signs, and related terminology. Parasitic causes of plant diseases (fungi, bacteria, viruses, phytoplasma, protozoa, algae and flowering parasitic plants), their characteristics and classification, Non-parasitic causes of plant diseases. Infection process. Survival and dispersal of plant pathogens. Plant disease epidemiology, forecasting and disease assessment. Principles and methods of plant disease management. Integrated plant disease management.

Practical:

Acquaintance with equipments used in plant pathology laboratory. Study of disease symptoms and signs and host parasite relationship. Identification and isolation of plant pathogens. Koch's postulates. Study of different group of fungicides and antibiotics, Preparation of fungicidal solutions, slurries, pastes, applications (seed, soil and foliar) and bioassay of fungicides (poisoned food technique and slide germination technique). Bio-control techniques: Dual culture technique.

Reference Books :

1. Introduction to principles of plant pathology by R. S. Singh, Oxford and IBH Publ. Co., New Delhi (1996)
2. Essentials of plant pathology by V. N. Pathak, Prakash Publ., Jaipur (1972)
3. Plant pathology by G. N. Agrios 4th edition, Academ. Press, New york (2004)
4. Introductory Plant Pathology by M. N. Kamat, Prakash Publ, Jaipur (1967)
5. Plant diseases by R. S. Singh 1983 Oxford and IBH Publishing Co. New Delhi.
6. Introductory Plant Pathology by H.C. Dube
7. Practical Plant Pathology by Kamat M.N 1971. Prakash Publ. House Pune
8. Introductory Mycology by Alexopoulos, Mims and Blackwel (2004), Wiley Eastern Ltd. New Delhi.
9. Disease of Crop Plants in India by Rangaswami, G and Mahadevan 2006.

CS 125 Agricultural Microbiology 1+1

Theory :

History of Microbiology: Spontaneous generation theory, Role of microbes in fermentation, Germ theory of disease, Protection against infections, Applied areas of Microbiology
Metabolism in bacteria: ATP generation, chemoautotrophy, photo autotrophy, respiration, fermentation. Bacteriophages: structure and properties of Bacterial viruses – Lytic and Lysogenic cycles: viroids, prions. Microbial groups in soil, microbial transformations of carbon, nitrogen, phosphorus and sulphur, Biological nitrogen fixation. Microflora of Rhizosphere and Phyllosphere microflora, microbes in composting. Microbiology of food: microbial spoilage and principles of food preservation. Beneficial microorganisms in Agriculture: Biofertilizer (Bacterial Cyanobacterial and Fungal), microbial insecticides, Microbial agents for control of Plant diseases, Biodegradation, Biogas production, Biodegradable plastics, Plant – Microbe interactions.

Practical:

General instructions, Familiarization with instruments, materials, glassware etc. in a microbiology laboratory: Practice of Aseptic methods: I - Evaluation of aseptic technique with Nutrient broth tubes. II- Evaluation of aseptic technique with a Nutrient agar plate. Methods of Sterilization and Preparation of media I- Preparation of nutrient broth, nutrient agar plates, nutrient agar slant and nutrient agar stab; II- Sterilization of glassware by Dry heating; III - Sterilization of nutrient broth by Filtration. Plating methods for Isolation and Purification of bacteria I - Streak plate method. II - aerobic spore forming bacteria by Streak plate method. III - Checking of purity of a bacterial culture by Streak plating method. Identification of bacteria by staining methods and Biochemical tests: I- Morphological examination of bacteria by Simple and Differential staining. II – Different biochemical tests for identification of bacterial culture; Enumeration of bacteria: I - Stain slide method. II- Most probable number method. III - Pour plate method and Spread plate method.

Reference Books:

1. Agricultural Microbiology. 1998. G. Rangaswani and D.J. Bagyraj. Prentice Hall of India., New Delhi.
2. An Introduction to Microbiology. 1996. P. Tauro, K.K. Kapoor and K.S. Yadav. Wiley Eastern Ltd., New Delhi.
3. Microbiology, 1986. M.J.Pelczar, E.C.S. Chan and N.L. Krieg. Mc Graw Hill 5th Edition, New York, USA.
4. Soil microorganisms and plant growth. 1977. N.S.. Subbarao Oxford & IBH Publ. Co. , New Delhi.

CS 126 : Horticultural Crop Production

2+1

Theory :

Horticulture- Definition, scope, importance, and branches of horticulture. Classification of horticultural crops. Climatic zones of Maharashtra and India in relation to horticultural crops. Area, production and export. Propagation methods. Growth habit, training and pruning objectives, methods and season. Special horticultural practices for horticultural crop production, plant growth regulators and their uses in horticulture. Package of practices for cultivation of major horticultural crops Fruits: mango, banana, guava, pomegranate, grape, sapota, citrus, ber, fig, aonla, cashewnut, coconut, arecanut, jackfruit. Vegetables : chilli, brinjal, tomato, okra, peas, beans, cucurbitaceous crops (cucumber, watermelon, muskmelon, bottle gourd, bitter gourd, ridge gourd); bulb (onion and garlic) and tuber crops(sweet potato, radish, carrot), cole crops (cabbage, cauliflower). Flowers: rose, chrysanthemum, marigold, gladiolus, carnation, tuberose. Major pest and diseases of horticultural crops and their control.

Practicals:

Identification of important horticultural crops with their significant important varieties. Different garden tools and implements. Preparation of nursery beds for raising rootstocks and seedlings, Special horticultural practices, Propagation methods – cutting, layering, budding and grafting. Application of growth regulators in propagation. Layout of planting of fruit crops; methods of irrigation, methods of fertilizer application and fertigation. Training and pruning of horticultural crops. Methods of harvesting. Visit to micro-propagation laboratory.

Reference Books:

1. Hartman and Kestar. Plant Propagation, Principles and Practices. Prentice Hall of India Ltd., New Delhi.
2. Parthasara. Biotechnology of Horticultural Plants, Vol. 3.
3. Edmond, J.B., A. M. Musses and F. S. Andrews. 1957. Fundamentals of Horticulture. McGraw Hill Book Co., New York.
4. Arteca, 1996. Plant Growth substances- Principles and Application. Chapman & Hall.
5. S. K. Mitra, 2005. Post Harvest Physiology and Storage of ropical and Subtropical Fruits. RBC, N. Deli.
6. Gardner, Bradford and Hooker. Fundamentals of Horticulture.
7. Kumar, P.2008. Management of Hort. Crops Horscience series Vol. 11, New India Publishing Agency, NIPA.
8. Singh, A.K. 2006. Flower crops: Cultivation and Management. New India Publishing Agency, NIPA.
9. Shanmugavelu, K. G. Production Technology of Fruit Crops.
10. Kunte, Y.N., Kawthalkar, M. P. And Yawalkar, K .S. 1997. Principles of Horticulture and Fruit Growing. 3rd Edn.
11. Singh, S. P. 1997. Principles of Vegetable Production. Agrotech Publishing Academcy, Udaipur.
12. Hazra, P. and M. G. Som. 1999. Technology for Vegetable Production and Improvement, Naya Prokash, Calcutta.
13. Bose, T. K. *et al.* (Eds.). 2002. Fruit : Tropical and Subtropical. Vol. II
14. Bose, T. K. *et al.* (Eds.). 1993. Vegetable Crops : Naya Prokash, Calcutta.
15. Bose, T. K. and Yadav, L. P. (Eds.). 1998. Commercial Flowers. Naya Prokash, Calcutta.

BIO 234: Molecular Biology

2+1

Theory:

Chromosome structure: basic chemical aspects – DNA, histones and non-histones; basic structural aspects – the nucleosomes, euchromatin and heterochromatin. Organization of the genome in eukaryotes: Gene and gene number; C-value paradox; organization of replication; gene amplification, chromosomal redundancy, repetitive DNA and its relevance to plants and animals, inverted and tandem repeats. DNA replication: DNA replication and its overview: semiconservative mechanism of DNA replication, replicons, origins and termini, semi-discontinuous replication, RNA priming, replication in prokaryotes and eukaryotes. DNA damage and repair: Biological indications of damage to DNA, evidence for repair systems, repair of thymine dimers. Regulation of gene expression: Basic principles of transcription, transcription in prokaryotes. Transcription in eukaryotes, its regulation, RNA processing and RNPs.– multiple RNA polymerases, sigma like factors in eukaryotes; heterogeneous nuclear RNA; messenger RNA - structure and complexity; interrupted genes and RNA splicing; expression of specific genes; genes for ribosomal RNA; histone genes; globin genes; heat-shock genes; The dynamic genome: Mobile genetic elements in eukaryotes (jumping genes) – relevance to plants; studies in maize. Brief introduction to the complexity of eukaryotic genome. Molecular biology of organelles: Genomes of mitochondria and plastids - interaction with nucleus;

Practicals:

1. Preparation of buffer solutions for isolation and purification of DNA and RNA.
2. Isolation and purification of genomic DNA from plants, fungi, bacteria and animal tissues.
3. Quantification of DNA by different methods.
4. Fractionation and isolation plant organelles.
5. Isolation and purification of organelle DNA.
6. Isolation of total RNA and mRNA from plant sample
7. Isolation of ribosomes, rRNA and PR proteins

Reference Books:

1. Lewin B, Genes IX, Oxford University Press, Sixth Edition
2. Darnell, J., Lodish, H. and Baltimore, D. 1986. Molecular Cell Biology., W.H. Freeman and

Company, New York.

3. Alberts, B. Bray, D. Lewis, J., 1989. Molecular Biology of the Cell. Garland Publishing, Inc. New York.
4. Wolfe, S.L., Molecular and Cellular Biology, Wordsworth, Belmont, CA.
5. Fundamentals of Molecular Biology by Allison, 2007, Panima, N.Delhi.
6. Plant Molecular Biology by Shaw, Panima, N.Delhi.
7. Biochemistry and Molecular Biology of Plants by Buchanan *et al.*
8. Molecular Biology by Friefedler.

BIO 235: Plant Metabolic Pathways

2+1

Theory:

Introduction to metabolism: anabolism and catabolism, metabolic compartments, thermodynamics, transport systems, translocators, Carbohydrate metabolism: Photosynthesis : photosynthetic pigments in relation to their functions, photosynthetic electron transport and generation of NADPH and ATP, cyclic, non-cyclic and pseudocyclic photophosphorylation. Carbon reduction in C₃ plants – reactions of Calvin cycle (reductive pentose phosphate pathway), oxidative pentose phosphate pathway, regulation of reductive and oxidative pentose phosphate pathway, photorespiration. Carbon reduction in C₄ plants - leaf anatomy of C₄ plants, biochemical pathway of CO₂ assimilation and CAM plants, Sucrose metabolism : Transport of sugar from source to sink, phloem loading and unloading of sucrose, sucrose metabolizing enzymes, sucrose synthesis, sucrose storage and utilization, sucrose-starch inter-conversion, Starch metabolism : Starch biosynthesis, regulation and degradation Metabolism of nitrogen-amino acids and nucleotides : Pathway of nitrate assimilation, incorporation of NH₃ into amino acids and proteins, biosynthesis of amino acids, sulfate assimilation, biosynthesis of nucleotides – *de novo* and salvage pathway, biological nitrogen fixation – a scheme for nitrogenase action, protection of nitrogenase against damage by oxygen in non-symbionts, role of leghemoglobin, regulation of nitrogenase activity, hydrogen evolution and uptake, energetics of N₂ fixation vis-à-vis nitrate assimilation, molecular biology of nitrogen fixation – genes involved in *Rhizobium*-legume symbioses; Protein synthesis : Major components of protein synthesizing machinery, steps in polypeptide synthesis; Lipid metabolism : Saturated and unsaturated fatty acid biosynthesis, biosynthesis of triacylglycerols and phospholipids, catabolism of lipids – lipid degrading enzymes, fatty acid oxidation (α, β, ω); Catabolism : Glycolysis, gluconeogenesis, citric acid cycle, electron

transport chain and oxidative phosphorylation, interrelationships of metabolic pathways; Biochemistry of seed germination and development; biochemistry of fruit ripening.

Practicals:

1. Isolation of cell organelles-mitochondria and chloroplasts.
2. Estimation of chlorophyll
3. Measurement of Hill reaction
4. Assay of mitochondrial enzyme, succinate dehydrogenase
5. Determination of activities of enzymes of nitrate assimilatory pathway: nitrate reductase, nitrite reductase
6. Assay of ammonia incorporating enzymes GS and GOGAT.
7. Assay of lipooxygenase / phospholipase C activity.
8. Assay of sucrose synthase/ invertase activity.
9. Assays of α -amylase and polygalacturonase.

Reference books:

1. Buchanan, B.B., Gruissem, W. and Jones, R.L. (Eds.). 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Rockville, Maryland, USA.
2. Metzler, D.E. 2001. Biochemistry, Vol. II : The Chemical Reactions of Living Cells, 2nd edn. Harcourt Academic Press, London and New York.
3. Stryer, L. 1995. Biochemistry, 4th edn. W.H. Freeman and Company, New York.
4. Stumpf, P.K. and Conn, E.E. (Eds.). The Biochemistry of Plants : A Comprehensive Treatise, Vol. I, II, III, IV & V. Academic Press, London.
5. Voet, D., Voet, J.G. and Pratt, C.W. 1999. Fundamentals of Biochemistry, John Wiley and Sons Inc., New York and Toronto.
6. Mehta, S.L., Lodha, M.L. and Sane, P.V. (Eds.) 1993. Recent Advances in Plant Biochemistry, Publication and Information Division, ICAR, Krishi Anusandhan Bhavan, Pusa, New Delhi.

BIO 236: Elements of Immunology

1+1

Theory:

Introduction to immunology. Immune systems-overview, immunity with historical perspective. Molecular and cellular basis of immune system, self versus non-self recognition; antigen – antibody and their structure, and function. Concepts of Ag-Ab reactions. Immunoglobulins - structure, biological characters and functions, isotypes, structure and

function. Theories of antibody synthesis, complement system and their reactions. Organisms and cells involved in immunity. The humoral immune response; antibodies-structure, diversity of function and mechanism of action. The cell mediated immune response; recognition of antigen by T cells; antigen precipitation; the major histocompatibility proteins; the role of cytokinins and the regulation of immune responses, hypersensitivity reactions. Lymphocytes. Differentiation of stem cells and generation of lymphocytes, mechanisms. Lymphocyte traffic, effector mechanisms in immune response, immunity to infectious diseases, vaccines. generation of monospecific antibodies : hybridoma technology.

Practicals :

1. Detection of albumins by double immunodifusion (DID) method
2. Detection and quantification of antigen using indirect ELISA
3. Detection of antigens by dot immunoblot binding assay (DIBA)
4. Immuno detection of antigens by immunofluorescent assay
5. Protein blotting (Western blotting) or immunoblots

Reference Books :

1. Text Book of Biochemistry and Human Biology by Talwar, G.P.1980. Prentice Hall of India, New Delhi.
2. Elements of Biotechnology by Gupta, P.K. 2000. Rastogi Publications, Meerut, India.
3. Cell Biology : Fundamentals and Applications by Gupta, M.L. and M.L. Jangir, 2002 Agribios ,Jodhapur, India..
4. Pelczer & Krieg, 1986, Microbiolgy, McGraw Hill.
5. Stanier, 1986, General Microbiology, McMillan Publishing Co.
6. William, E. Paul (1989) Fundamental Immunology, 2nd Edition Raven Press, New York.
7. Molecular cloning by Sambrook
8. Kubuy- Fundamentals of Immunology
9. Roit- Elements of Immunology

PB 234: Plant Breeding Techniques

2+1

Theory:

Historical milestones in plant breeding. Aims and objectives of plant breeding Significance of plant breeding in crop development. Various methods of plant breeding in self and cross

pollinated crops, acclimatization ,selection ,pure line theory, Reproductive systems of plants, Floral biology, flower parts, Self and cross pollinated crops. Genetic consequences and differences between self and cross pollinated crops. Clonal selection, population improvement programme. Heterosis, Genetical and physiological basis. Male sterility Types of male sterility. combining ability-general and specific, its exploitation. Interspecific/ Intergeneric hybridization, Heterosis inbreeding depression. Polyplidy its types. Mutation breeding Gene actions, heritability, genotype and environmental interactions. Its importance in plant breeding. Introduction to seed production (Nucleus, breeder, foundation ,certified) Maintenance of genetic purity during seed production.

Practicals:

Floral morphology of important crops. Anthesis and dehiscence Emasculation-pollination techniques in self and cross pollinated crops. Pollen viability, chemical : mutagenesis on seedling and buds. Hybridization study of male sterility and incompatibility in field.

Reference books:

1. Principles of Plant Breeding by Allard R W 1960 .Kalyani Publishers, New Delhi
2. Principles of Plant Breeding by Singh B.D 1983 .Kalyani Publishers, New Delhi.
3. Principles of Genetics by Gardner E.J, M.J Simons and D.P Sanstad 1991. John Wiley and Sons Inc New York.
4. Plant Breeding by Lamkey and Lee 2006, Panima, N.Delhi.
5. Breeding Field Crops by Sleper and Poehlman 2007, Panima N. Delhi.

PB235 : Molecular Markers in Plant Breeding 1+1

Theory :

Distinction between various morphological, biochemical and molecular markers with their strength and weaknesses. Types of molecular markers. PCR technology and its implications on molecular biology. Isozymes; RFLP; RAPD; ISSR; STMS; AFLP; SNP; SCAR; CAPS; RAMP; and SSCP markers (techniques, methodology and its application in plant breeding). Functional expression markers. Application of molecular markers in plant breeding especially in varietal identification; germplasm divergence analysis; phylogenetic relationship in crops; markers assisted selection; QTL, mapping and map based cloning, mapping strategies- NIL, RIL, BSA. Mapping genes on specific chromosomes: somatic cell hybrids, in situ hybridization, transposon tagging, genetic linkage mapping, expressed sequence tags (EST).

Practicals:

Rapid DNA isolation technique, DNA purification. Gel electrophoresis vs. Capillary electrophoresis. PCR amplification reaction with detail role of each component. Principles of primer designing. Modifications in PCR components for RAPD, ISSR, AFLP and SSR analysis. Southern blotting and its application in RFLP analysis. Visit to a laboratory with automated Genotyping/sequencing facility. Software programmes for phylogenetic relationship and linkage analysis.

Reference books:

1. Biotechnological Renovations in Crop Improvement by Biotol Series, Elsevier.
2. Techniques for Engineering Genes by Biotol Series, Elsevier
3. Genetic Engineering By Nicholl, 2006, Cambridge Univ. Press.
4. Molecular Biotechnology: Principles and Applications, by Glick, 2006, Panima.
5. GE of Plants for Crop Improvement by Lal, CRC press.

FB 232: Industrial Microbiology and Fermentation Technology 2+2=4

Theory:

Histological land marks. Screening of microorganisms for new products. Improvements of strain, mutant selection. Fermentation process development. Shake flask, Scale up of process and bioreactors. Metabolite antibiotics enzymes, biopesticides, growth regulators, steroids organic acids, bio ethanol and enzymes production. Genetically engineered microbes (GEMs). Metabolic engineering. Process and types of bioreactors, production of yeast and antibiotics, ethanol, lactic acids. Various methods of fermentation.

Practicals:

Isolation and screening of microorganisms. Maintenance of isolates/strains. Development of inoculums. Improvement of strain. Preparation of wine from fruits. Visit to beverages industries. GMOs and their industrial application. Production of biopesticides, growth regulators, ethanol from grains, Study of fermentation technology of alcoholic beverages, downstream processing of secondary metabolites. Technology of indigenous and oriental fermented food. Probiotics.

References books:

1. Industrial microbiology by Casida, Jr L.E 1966 Wiley Eastern Ltd, New Delhi
2. Industrial microbiology and Biotechnology By Demain A.L and N.A Soloman 1986. American Society for microbiology, Washington.
3. Biotechnology. Singh B.D 2000. Kalyani Publishers, Ludhiana.

4. Fermentation a Practical Approach by McNeil & Harvey,2007, Panima N.Delhi.
5. Industrial Microbiology A Lab Manual, by MMathur & Singh,2007, Avishkar, Jaipur.

AB-231 Basics in Animal Biotechnology 2+1=3

Theory

Importance and classification of livestock and birds of economic importance; Important breeds of Cattle,Buffalo,Sheep,Goats and their physical and economic characteristics; Anatomy of reproductive system of male and female bovine and ovian; Role of hormones in male and female reproductive mechanism, gametogenesis, oogenesis, estrous cycle, ovulation, fertilization, implantation and pregnancy diagnosis; Fertility and infertility and sterility; Systems of breeding: inbreeding, outbreeding
Anatomy and structure of mammary gland, hormonal regulation of reproduction and lactation; Biosynthesis of milk and its constituents, factors affecting milk yield and composition of milk.

Practicals :

1. Routine and periodic livestock farm operations.
2. Anatomy of male reproductive system.
3. Anatomy of female reproductive system.
4. Anatomy of reproductive system of poultry.
5. Determination of inbreeding coefficient of animal.
6. Anatomy and structure of mammary gland of different livestock species.
7. Harmonal regulation of reproduction and lactation.
8. Study of milking systems in relation to scientific and hygienic milk production.
9. Factors affecting milk yield and composition of milk.

References :

1. Textbook of Animal husbandry by GC Banerjee
2. Livestock Production and Management by NSR Sastry and CK Thomas
3. Textbook of Animal genetics and breeding by Kanakraj
4. Animal Reproduction by ESE Hafez
5. Animal reproduction by Roberts
6. Poultry – GC Banerjee

CS 237 Greenhouse Technology and Protected Cultivation 1+1

Theory :

Types of green house, importance, functions and features of green house. Scope and development of green house technology. Location, Planning of various components of green house. Design criteria and calculation. Construction material, covering material and its characteristics, growing media, green house irrigation system. nutrient management. Green house heating, cooling and shedding and ventilation system, Computer controlled environment. Phytotrons, fertigation, roof system, containers and benches. Growing of ornamentals and vegetables under protected environment, physiology of plants in green house, pest and disease control.

Practicals :

Visit to functional green house. Measurement of temperature, humidity, air velocity, CO₂, inside the green house. Calculation of environment indices inside green house. Study of various containers used for protected cultivation of vegetable and flower, special horticultural practices i.e. training, dis-budding, de-shooting, supporting and bending. Study of harvesting, grading, packaging of vegetable and flowers. Economics of analysis of green house. Visit to commercial green house.

Reference books :

1. Greenhouse Management of Horticultural Crops by S. Prasad and U. Kumar, Kalyani Publishers.
2. Greenhouse Technology and Management by Manohar. 2006. International Book Distribution Co., Lucknow.
3. Greenhouse Environment by Mastalez, J. W. 1977. John-Wiley and Sons, New York.
4. Greenhouse Management : Forcing of Flowers, Vegetables and Fruits by Taft, L. R. 2001. Daya Publication House, New Delhi.
5. Green House Operation & Management by Nelson, 2007.
6. Green House and Shelter structure for tropical regions/FAO by Zbeltitis.
7. Protected Cultivation by A. S. Jadhav, P. V. Patil and M. T. Patil.
8. Commercial Protected Floriculture by M. T. Patil and P. V. Patil

BIO247: Techniques in Biochemistry and Molecular Biology 2+2

Theory :

General principles of biochemical investigations. Units in biochemistry and molecular biology. Principle methods of separation of biomolecules. Centrifugation techniques – Basic principles, analytical and preparative centrifugation, their applications. Spectrophotometry : UV-visible spectrophotometer, fluorimetry. Chromatographic techniques – Basic principles, types-adsorption, partition, ion exchange, molecular sieve, affinity, GLC and HPLC and mass spectrometry, flow cytometry and its application in DNA estimation. Electrophoresis : theory and different types – PAGE, SDS-PAGE, capillary electrophoresis, and IEF. Radioisotope techniques : Nature, detection and measurement of radioactivity. Molecular biology techniques – Southern hybridization, northern hybridization, western blotting, microarray technology, complementation techniques; Polymerase chain reaction (PCR); radioactive/ non radioactive labeling, RFLP, AFLP, RAPD; RT-PCR and DNA sequencing.

Practicals :

1. Extraction of proteins from seeds of cereal, legume, oilseed plant material and calli.
2. Concentration of the proteins using ammonium sulfate precipitation, dry sephadex, dialysis, ultra filtration, and organic polymers.
3. Separation of the proteins by native – and SDS - PAGE
4. Separation and identification of amino acids by paper chromatography.
5. Isolation of messenger RNA by affinity chromatography.
6. Restriction digestion of DNA.
7. Agarose gel electrophoresis of DNA.
8. Non-radioactive random labeling of probe with DIG-dUTP system
9. Detection of restricted DNA fragment by Southern hybridization.
10. Amplification of plant/bacterial DNA by polymerase chain reaction.
11. Separation of sugars by TLC.

Reference Books:

1. Techniques in Molecular Biology by Walker J.M. and W. Gastra. 1983. Croom Helm, London.
2. A biologist's Guide to Principles and Techniques of Practical Biochemistry by Wilson K. and K.H. Goulding. 1992. 3rd edition, Cambridge University Press, Cambridge.
3. Standard methods of biochemical analysis. 1999. By Thimmaiah, S. R. Kalyani Publishers, Ludhiana

4. Methods in plant biochemistry and molecular biology. 1997. By Dashek, W. V. CRC Press, Boca Raton, New York
5. Practical biochemistry – Principles and Techniques 2005. By Wilson, K. and Walker, J. Cambridge University Press, UK.
6. Rob Reed, David Holmes, Jonathan., Practical Skills in Bimolecular Sciences., Weyers and Allan Jones. Addison Wesley Longman Ltd. 1998.
7. Williams and Fleming, 1980. Spectroscopic Methods in Organic Chemistry.
8. Walker, 1987. Techniques in Molecular Biology.
9. Hamilton and Sewell, 1982. Introduction to HPLC.
10. Ausubel, 1995. Short protocols in molecular biology.
11. Shlein, B. (ed.) (1987). Radiation safety manual for users of radioisotope in Research and Academic Institutions. Nucleon Lactern Associates. Olney, Md.
12. Palumbi, S.R., The Polymerase Chain Reaction Nuclear Acids II : In Molecular Systematics (Iind Edn.) 1996. Edtd by D. Hillis, C. Moritz and B. Mable. Sinauer Assoc., Inc., USA.

PB246 : Plant Cell and Tissue Culture 2+1

Theory

Historical perspective of Plant cell/tissue culture, Scope and importance in crop improvement , totipotency and morphogeneis, Organogenesis, Rhizogeneis, Embryogenesis, Nutritional requirement of in vitro cultures, Different techniques of in-vitro culture- Micro-prpoagation , Anther culture, Pollen culture, ovule culture, Embryo culture, *in-vitro* pollination, *in-vitro* fertilization ,Endosperm culture., Factors affecting in vitro culture. Achievements, Somaclonal variation, types, causes, Somatic embryogenesis and synthetic seed production. Protoplast isolation , culture Manipulation and fusion. Cybrids, Products of somatic hybridization, Cryopreservation of germplasm. Secondary metabolites production, extaction of secondary metaboliltes .Hardening techniques of micro-propagated seedlings.

Practicals:

Laboratory organization of plant tissue culture lab, equipments required. Media components and preparation, Sterilization techniques, Growth conditions, Maintenance of aseptic condition, Causes of infection and its elimination, Callus culture, shoot tip/meristem culture in fruit, forestry crop. Regeneration studies in cereals/pulses. Virus free production of plants, Virus indexing- ELISA and PCR, Demonstration of protoplast isolation. Hardening /Acclimatization of regenerated plants, Minor technical problems in plant tissue culture.

References books:

1. Plant cell tissue and organ culture: fundamental methods by C. L. G. C. Phillips and L.R.Wetter 1995. National Research council, Canada, PRL, Saskatoon.
2. In vitro embryogenesis in plants by Trevor Thorpe A.1995. Kluwer Academic press London.
3. Plant Tissue Culture Theory and Practices by Bhojwani & Razdan,2008, Elsevier, India.
4. Introduction to Plant Tissue Culture by Razdan, 2007, Oxford IBH.
5. Plant Cell Culture By Dixon,2004, Panima N.Delhi.
6. An introduction to plant tissue Culture by Kalyan Kumar De.
7. Clonal tissue culture of important fruit crops by Atul Kumar and vandana A. Kumar, International book Distribution comp. Lucknow.

FB 243: Enzyme Biotechnology in Food Processing 2+1=3

Theory :

General Introduction – Introduction, historical developments, applications and business of enzymes, enzyme safety, enzyme therapy, enzyme specificity, measurement and expression of enzyme activity, enzyme stability and denaturation; Regeneration of cofactors for biocatalysis- common cofactors required for biotransformation and their representative *in situ* regeneration methods : regeneration of NAD(P)(H), NAD(P)⁺, ATP/NTP, Sugar nucleotide, PAPS, Acetyl coenzyme A; Potential, selection and application of some of the important enzymes in food. Carbohydrases: amylases(s) glucoamylase(s), hemicellulase(s) and cellulase(s). Proteolytic enzymes: proteases; cathepsin(s), trypsin, papain, bromelain and ficin, , rennin, pepsin, lipase(s): lipoxygenase(s), lipoxidase, etc. Oxidoreductase(s) : glucose oxidase, catalase, peroxidase, polyphenol oxidase and ascorbic acid oxidase. Importance of enzymes in various food and agro process industry.

Practical :

High and efficient recovery of proteins from enzyme treated defatted oilseed flours. Estimation of PPO activity, preparation of glucose syrup/ high fructose syrup, Immobilized cell for production of alcohol and high fructose syrup. Degradation of cellulose by cellulases. Use of pectinase in classification; use of papain in meat tenderization. Reduction of heavy flavor by inactivation of lipoxyge.

Reference books

1. Advances in Enzymology, Vol. 1-10. Nord, F.F. (ed.). 1941-50. Interscience Publisher, New York.
2. Enzyme Technology by Pandey, A., Colin W., Carlos, R. S., Christian, L. 2005. Asiatech Publishers Inc., New Delhi.
3. Principles of Enzymology for the Food Sciences by Whitaker, J. R. 1972. Marcel Dekker, New York.
4. Enzymes in Food Processing by G. Reed 1975. Academic Press, London.
5. Industrial Enzymology by Godfry, T. and J. R. Relchelt, (2nd Edn.). 1997. Macmillan Publishing Co., London.

FB 244 : Post Harvest Biotechnology of Food grains

2+1

Theory:

Classification, chemical composition and nutritional values of food grains (cereals including millets, legumes and pulses). Anti-nutritional factors- chemistry and methods of their removal. Importance and scope of food preservation and storage. Food spoilages- causes and effects. Principles and methods of food preservation and processing of food crops. Starch- Role in cookery. Mechanism of starch isolation and applications. Molecular biology of starch, gluteins with their role in dough quality. Bakery and confectionary- types, ingredients used with their role. Other processing techniques- Fermentation, malting, brewing, puffing, flaking, pearling, sprouting, roasting. Enrichments- Methods, need and fortification. Genetic engineering for value addition from economic point of view as well as nutritional composition- Transgenes for altered composition of oil/ starch/ amino acid/vitamins/anti-nutrients with their sources. Golden rice, high quality protein maize, hypoallergenic rice, wheat gluten modification. Biosol concept. Spheroplast fusion technology. Biocatalysts and worldwide food industry market

Practical:

Morphological, physical and chemical properties of various cereals, pulses and oilseeds. Estimation of protein, oil and starch contents in grain crops. Food preservation techniques- osmotic (sugar/salt); physical (drying, freezing, radiation) and chemicals. Food processing techniques- baking, fermentation (curd/ sauerkraut) and malting. Determination of gluten content. Preparation of Idli and Dhokla. Reduction of antinutritional factor. Production of starch from grains.

Reference books:

1. Food processing: Biotechnological Applications by Marwaha & Arora,2000, Asiatech Publishers N.D.
2. Postharvest physiology and storage of tropical and subtropical Fruits,2005, CABI Publishing.
3. Postharvest by Wills, Mcglasson,2007, CABI.
4. Essentials of Food Science by Vaclavik,2003,Plenum,NY.
5. Fruit & Vegetable Biotechnology by Valpuestav.

AB-242 Animal Cell Culture

2+1=3

Theory:

History, types of tissue culture, advantages and limitations; Culture environment, adhesion, proliferation, differentiation; Development of media- physicochemical properties, complete media, serum and supplements; Serum free media; Primary culture – mouse, embryo, chick culture; Cell lines; Cloning and selection; Cell separation; Cell characterization, differentiation, transformation; Cyto-toxicity; Specialized cells; Molecular techniques in cell culture.

Practicals:

1. Design and layout of cell culture laboratory
2. General laboratory rules.
3. Aseptic techniques – sterilization methods.
4. Preparation and sterilization of media.
5. Selection of animal cell line.
6. Quantitation techniques.
7. Cryo preservation techniques.

Reference :

1. Animal Cell Culture: Methods by Wesley GD and W.May.1980 Blackwell Scientific Publishers ,Edinburgh,UK
2. Animal Cell Culture: A practical approach by Freshney R 1986.ES Livingstone Ltd.Edinburgh,UK
3. Elements of Biotechnology by Gupta PK,200.Rastogi Publication, Meerut
4. Biotechnology by Singh BD 2000 Kalyani Publishers New Delhi
5. Cell Biology; Fundamental and applications by Gupta ML and ML Jangir ,Agribios, Jodhpur
6. Biotechnology by Animal Tissue by PR Yadav DPH Publications

AB-243 Biotechnology of Ruminant Feed Utilization 2+1=3

Theory:

Anatomy of ruminant and non-ruminant digestive system; Mechanism of digestion and the role of rumen micro flora; Source of feeding stuff, nutritive value of common feedstuff; Nutrients and animal body – water, carbohydrates, lipids, proteins, minerals and vitamins; Digestion, absorption and metabolism of carbohydrates by ruminants and non ruminants; Digestion, absorption and Metabolism of proteins and NPN by ruminants and non ruminants; Digestion, absorption and Metabolism of Fats; Rumen manipulation ,defaunation and its effect on rumen digestion and feed utilization; Characteristics of good ration, nutritive ratio and starch equivalent; Computation of balanced ration for livestock; Feeding standards and thumb rule for feeding of Cattle and Buffaloes- Calf, heifer, lactating cows, dry and pregnant animal; Single cell proteins in ruminant nutrition; Conventional and non- conventional industrial byproducts as cattle feed.

Practicals:

1. Identification of feed stuffs of their chemical composition and nutritive value.
2. Proximate analysis of feed.
3. Dry matter
4. Crude protein
5. Crude fibre
6. Ether extract
7. Nitrogen Free extract
8. Calcium and Phosphorus
9. Determination of digestibility coefficient,, calculation of TDN,SE,DE and NE
10. Preparation of Bypass protein and fat feed
11. Toxic factors in feed—saponins, gossypol, mimosine, aflatoxin, HCN, Nitrates and nitrites.
12. Visit of Cattlefeed plant.

Reference:

1. Rumen and its microbes by Hungate RE 1966. Academic Press,New York
2. Straw and other fibre by-products as feed by Sundastol F. and E.Owen. 1984 Elsevier Publishers,Amsterdam
3. Matching livestock system to available feed resources in the Tropics and Sub tropics by Preston TR and RA Leng. 1987 Penambal Books, NSW,Australia
4. Advanced Animal Nutrition for developing countries by Singh UB. 1987.Indo Vision Pvt.Ltd.,Ghaziabad

5. Biological and physical treatment of fibrous crop residue as animal feed by Singh K, TW Fligel and GB Schiere. 1987 Proc. Indo Dutch Bioconversion Workshop , New Delhi
6. Food Biotechnology by King RD and PSJ Chetan 1989 Elsevier Applied Sciences, London
6. Textbook of Animal Husbandry by GC Banerjee
7. Applied Animal Nutrition research techniques by Raman Mullick and SK Sirohi, NDRI, Karnal
8. Animal Nutrition by SK Ranjan (CBS)
9. Application of biotechnology to nutrition of animals in developing countries FAO, 1995
10. Feeding of ruminants on fibrous crop residues. ICAR, New Delhi

CS 248: BIOSTATISTICS

1 + 1

Theory :

Importance and application, Tabulation and classification of data, Frequency distribution and Graphical distribution of data, Measures of central tendencies, Mean, Median, Mode and their properties, Measures of Dispersion, Mean deviation, Variance, Standard deviation and coefficient of Variation, Correlation, linear and nonlinear regression. Hypothesis testing F. T and Chi-square test Probability and Distribution Concepts and problems on probability, Binomial, Poisson, Normal Distribution and their applications. Basic principles of design CRD and RBD design. Different models of data presentation with special reference to biological samples.

Practical:

Determination of mean, mode and median, SD and CV.

Fitting of linear and non linear regression and multiple regression equation with example.

Computation of simple correlation, partial and multiple correlation coefficients.

Analysis of variance of CRD and RBD.

Interpretation of 't' test, 'F' test, and χ^2 test.

Reference books:

1. Statistical Methods for Agricultural Workers by Panse, V. G. & P.V. Sukhatme 1967. ICAR, New Delhi.
2. Statistical Methods by Snedecor, G.W. Cochran 1968. Oxford & IBH Publ. Co., Calcutta.
3. Biometrical Genetics by Mathur, K. & J.L. Jinks. 1974. Chapman & Hall Ltd. London.
4. Statistics (Theory, Methods & Application) by Sancheti, D.C. & V.K. Kapoor. 1985. Sultan Chand & sons, New Delhi.
5. A Textbook of Agricultural Statistics by Rangaswamy, R. 1995. New International publishers Ltd., New Delhi.

CS 249: Intellectual Property Rights 1+0

Theory:

IPR: Meaning, Nature and Scope of IPR, Recent developments in Registration of inventions and protections of IPR, WIPO and its role, World Trade Organization regimes, GATT agreement and its impact on agriculture and biotechnology. WTO and Agreement on Agriculture (AoA). Trade Related Aspects of Intellectual Property Rights (TRIPS). History of IPRs. Categories of IPRs- Copyrights, Patents, Trademark, Geographical Indications. Industrial Designs, Layouts. Design of integrated circuits. Recent amendments in Indian acts and regulations related to IPR. Product patent and Process Patent. Current status of Plant variety protection in India as well as in other countries (USA; Australia & Japan) with historical perspectives. UPOV revisions. Sui generis system for protection of plant varieties, Registration of new varieties, Farmers Rights on indigenous knowledge, Benefit sharing. Biological Diversity Act. IPRs in WTO regime. Current status of patenting of gene and genetically engineered organisms in India and world. Patent filing-opposition-retrieval. Recent developments, advances in IPR.

Reference books and Journals :

1. Ram Kumar, 2008. Intellectual Property Rights-Demystified, New India Publishing House, New Delhi.
2. Chawala, 2002. Introduction to Plant Biotechnology, Oxford IBH, New Delhi.
- 3 IPR BULLETIN. Technology Information, Forecasting & Assessment Council, Department of Science & Technology, New Delhi.
4. Indian Journal of Agricultural Economics
5. Economic and Political Weekly
6. Indian Farming
7. Indian Journal of Agricultural Marketing
8. Agricultural Economics and Research Review

BIO358 : Recombinant DNA Technology 2+1

Theory:

Recombinant DNA : Definition, recombinant DNA and evolution, Host controlled restriction-modification system; The range of manipulative enzymes – nucleases, ligases, polymerases, modifying enzymes, topoisomerases, restriction endonucleases - Types of restriction enzymes, characteristics of RE II, nomenclature, restriction sites, unit of restriction enzymes, cleavage pattern, restriction mapping, linkers, adaptors, homopolymer tailing, Vectors :

Definition, properties of the good vectors, plasmid – pBR322 and pUC vector properties and physical maps. Bacteriophage vectors – lambda phage vector, M13 vectors, insertion vectors, replacement vectors, cosmids, phasmid, YAC, BAC, and MAC; Introduction of the vector into suitable host: Properties of good host, preparation of competent cells, transformation, transfection and *in vitro* packaging; Selection of recombinant clones: Selection of clones containing recombinant vectors. Reporter genes, elimination of non-transformed cells, identification of clones having recombinant vectors; selection of clones having specific DNA insert – colony hybridization, hybrid arrested translation, nucleic acid hybridization, complementation, unique gene products, immunochemical methods – antibodies specific to the protein product, colony/plaque screening with antibodies; Gene library: Construction cDNA library and genomic library, screening of gene libraries – screening by DNA hybridization, immunological assay and protein activity, methods of labeling nucleic acids and probes- nick translation, primer extension method, methods based on RNA polymerases; Important genome sequencing projects of plants. Applications of recombinant DNA technology in crop improvement.

Practicals:

1. Isolation, propagation and storage of bacterial (*E. coli*) strain.
2. Methods for long and short term storage (conservation) of microorganisms.
3. Isolation of plasmid DNA from *Escherichia coli*
4. Digestion of plasmid DNA with restriction endonucleases and separation of products in agarose gel.
5. Preparation of restriction maps.
6. Ligation of plasmid DNA with DNA restriction fragments
7. Electrophoresis of the ligated samples
8. Preparation of competent cells of *Escherichia coli* by CaCl_2 method
9. Transformation of plasmid and recombinant DNA into *Escherichia coli*
10. Selection of recombinants and calculation of transformation rate.

Reference books:

1. Recombinant DNA by Watson, J. D., Gilman, M., Witkowski, J. and Zoller, M. 1992, Second Edition, W. H. Freeman and Company, New York.
2. Biotechnology by Singh, B. D. Kalyani Publishing Co., New Delhi.
3. Gene cloning and DNA analysis: an introduction by Brown, T. A. 2001, 4th edition, Blackwell Sci. Ltd., Blackwell Pub. Co., USA

4. Methods in biotechnology by Schmauder, H. P., Schweizer, M. and Schweizer, L. M. 2005. Replica Press Pvt. Ltd. Kundl
5. Principles of gene manipulation : An introduction to genetic engineering by Old, R. W. and Primose, S. B. 1989. Blackwell Scientific Publication, London
6. Molecular Biotechnology. Glick, B.R. and Pasternak, J.J. 2003. ASM Press, USA.
7. DNA cloning 1 and 2. Glover, D.M. and Hames, B.D. 1995. IRL Press (Oxford University Press, USA).
8. Molecular Cloning, A laboratory Manual. Sambrook, J., Fritsch, E.F., Mariatis. 3rd edition. 2001. Cold Spring Harbor Laboratory, USA.
9. Molecular Biology of the Cell (4th edition). Alberts, Johnson, Lewis, Raff, Roberts and Walter.
10. Molecular Cell Biology (5th edition). Lodish, Berk, Matsudaira, Kaiser, Krieger, Scott, Zipersky and Darnell.
11. Lehninger Principles of Biochemistry (4th edition). Nelson and Cox.

PB357 : Biotechnology for Biotic and Abiotic Stress Tolerance 2+1

Theory:

Prospects & Perspective of Biotic & abiotic stress resistant plants, Genetics of host-pathogen interactions, Mechanism of plant resistance. Role of jasmonates and salicylic acid in systematic resistance induction on wounding. Insect pest resistance – Structural/ morphological changes ; Protease and amylase inhibitors; polyphenol oxidases; peroxidases; lectins; chitinase; seed proteins; their limitations and significance in multi-gene pyramiding. Vertical and Horizontal resistance to pathogens. Hypersensitive host response (HRGP) and apoptosis in relation to plant defense. Virulence- Avirulence in host–pathogens interaction. Race specific Resistance Gene Analogues (RGAs). Pathogenesis related proteins – groups with examples (Glucanases; chitinases; osmotin, chitin binding proteins; thaumatin like proteins; micropeptidal defensins; phytoalexins) and their role. Role of Phenylalanine ammonia lyase, callose synthases, detoxification for pathogen resistance. RIP. Field testing of transgenic for fungal, bacterial, viral and pest resistance. Prospects and perspectives. Biopesticides- Developing antagonistic strains suitable for varying stress conditions. Biochemical basis of abiotic stresses namely osmotic (drought, salinity), temperature, heavy metals, air and water pollutants, synthesis and functions of proline and glycine betaine in stress tolerance interaction between biotic and abiotic stresses; stress adaptation. Reactive oxygen species and biotic and abiotic stress, antioxidants, enzymes defense system. Role of

calcium, nitric oxide and salicylic acid in plant development. Molecular strategies for imparting tolerance against biotic and abiotic stress.

Practicals:

Meristem culture for virus elimination. Screening toxins and culture filtrate of fungi and bacteria for *in vitro* screening of host resistance, toxin bioassay, selection of toxin resistant calli/ cell suspension culture and its regeneration. *Agro-bacterium*-mediated transformation protocol and selection of transformed regenerated plants. Biocontrol: Testing antagonism of *Trichoderma* and *Pseudomonas fluorescens*- mass production agents.

Measurement of water status of plants, determination of osmotic potential by vapour pressure and freezing point depression, Stress imposition and quantification, Stress –stomatal conductance. Root- shoot signals-ABA and cytokinin effect on stomatal behavior, Heat tolerance and membrane integrity. chilling tolerance Galactolipase and free fatty acid levels as biochemical markers for chilling damage,

Reference Books :

1. Basra AS. 1997. Stress Induced Gene Expression in Plants. Harwood Academic Publ.
2. Chessin M, DeBorde D & Zipf A. 1995. Antiviral Proteins in Higher Plants. CRC Press.
3. Crute IR, Burdon JJ & Holub EB. (Eds.). 1997. Gene-for-Gene Relationship in Host-Parasite Interactions. CABI.
4. Hopkins WG & Huner NPA. 2004. Introduction to Plant Physiology. John Wiley & Sons.
5. Salisbury FB & Ross C. 1992. Plant Physiology. 4th Ed. Wadsworth Publ. Taiz L & Zeiger E. 2006. Plant Physiology. 4th Ed. Sinauer Associates.
6. Kosuge T & Nester EW. 1989. Plant-Microbe Interactions: Molecular and Genetic Perspectives. Vols I-IV. McGraw Hill.
7. Verma DPS & Kohn TH. 1984. Genes Involved in Microbe-Plant Interactions. Springer Verlag.
8. Molecular Plant-Microbe Interactions. Journal Published by APS.

PB358: Biodiversity Conservation

2+1

Theory:

Definition, Historical and geographical causes of diversity. Types of diversity- Genetic, Species and population diversity. Distribution of diversity in life forms. Ecological diversity and stability. Biodiversity and centers of origins of plant. Hot spots in India. Principles of conservation biology. Biosphere concept, Genetical and evolutionary principles of conservation. Collection Maintenance and conservation of biodiversity. Assessing and

documenting of vulnerability and extinction of biodiversity; red list categories as per IUCN (International Union for the Conservation of Nature and Natural resources): Extinct, Extinct in the wild, Critically Endangered, Endangered, Vulnerable, Lower risk, Data deficient and Non Evaluated. Bio-village concept: *in situ* and *ex situ* conservation. Community level Gene banks, Utilization of biodiversity. Global biodiversity system. Intellectual Property Rights and legal concerns of Bio-resources. Biodiversity and human welfare

Practicals:

Collection of ITK (Flora) Study of species composition in surrounding areas. Morphological description of plant parts. Collection of seeds of rare species of forest and medicinal plants. Study the microclimate and forest soils. List of important medicinal plants used in healthcare.

Reference Books:

1. Biodiversity Utilization and conservation by Arunachalam,2008,Avishkar,Jaipur
2. Biodiversity conservation and legal aspects by Kandya,2007, Avishkar, Jaipur
3. Biodiversity conservation by Kumar M.S.2008
4. Biodiversity conservation and systematics by P. Singh, 2007

FB 355 :Technological Applications in Food Processing 1+1=2

Theory

Recent trends in food processing. Techniques and applications of immobilized enzymes in food industry. Applications of glucose oxidase, catalase and pectinase in food processing. Single cell proteins for human food consumption. Biotechnology for natural and artificial flavor and fragrance production. Microbial biotechnology for food flavour production, oils and fats, Molecular High Intensity Low Calorie sweeteners. Essential oils. Sources and production of vitamins under controlled conditions. Safety issues related processed foods, parealization, nanotechnology, hardle technology, bio-preservation/ Natural preservation. High electric light pulse technology. Aseptic packaging/ vaccum packaging, biodegradable plastics, extrusion cooking.

Practicals:

Preparation of extruded products, preparation of pickles, preservation of food using organic acids, production of β -carotene/citric acid, SCP production, bioflavours/ biocolor.

Reference Books :

1. Food Biotechnology, by Roges, A. 1989. Elsevier Applied Sci. Pub., London, U.K.
2. Functional Foods by Goldberg, I.. 1994. Chapman and Hall, New York.

3. Fundamentals of Food Biotechnology by Byong, H. L. 1996. VCH Publishers, New York.
4. Food Biotechnology by Shetty, 2006, CRC, NY
5. Comprehensive Biotechnology by Campbell, R.W. and J. A. Howell. 1995. Pergamon Press, Oxford.
6. Biotechnology by Singh, B. D. 2000. Kalyani Publishers, Ludhiana.

AB-354 Dairy Process Biotechnology

2+1 =3

Theory:

Present status of dairy industry in India; Physico-chemical properties of milk, factors affecting of abroad milk and milk constituents; Microorganisms associated with milk and milk products; Hygienic milk production- sources of contamination; Role of microorganisms in spoilage of milk and milk products; Milk borne diseases; Role of lactic and non-lactic acid bacteria in the preparation of various fermented milk products, classification of fermented milks; Propagation of starter cultures – factors affecting propagation, bacterial interaction, characteristics of good starter culture; Health benefits of fermented milk and milk products and benefits derived through genetic improvement of starter culture; Industrial production/processing of fermented milks; Application of membrane processes and hurdle technology in the dairy industry; Impact of biotechnology on dairy industry; Developments in probiotic foods; Use of Probiotics/Prebiotics/Synbiotics in fermented milk products; Application of bio additives in dairy processing; Application of biotechnology in dairy waste management; Role of enzymes in dairy processing

Practicals:

1. Quality assessment of raw milk.
2. Detection of preservatives in milk
3. Detection of adulterants in milk
4. Separation of cream.
5. Heat processing and homogenization of milk.
6. Type, preparation and propagation of starter culture and preparation of fermented milks
7. Preparation of Paneer, Channa, cheese
8. Preparation of indigenous milk products
9. Preparation of partially hydrolysed milk
10. Application of manurane processing and handle technology
11. Dehydration

Reference:

1. Principles of Biotechnology by Wiseman A.1980.Survey Univesrity Press,New York
2. Food Biotechnology by Rogers A.1989.Elsevier Applied Sciences,London
3. Functional food by Goldberg I .1994.Chapman & Hall , New York
4. Biotechnology : Theory and Techniques by Chirikjian,JG1995.Jones and Bartlet Publishers,London
5. Fundamentals of food biotechnology by Byong HL,1996.VCH Publishers,New York
6. Dairy Biotechnology by Sukumar De
6. Dairy technologists textbook by Ramaswamy and Shibu
- 7 Laboratory manual of dairy analysis. Third edition,Richmond HDrop
- 8.Handbook of Milk Microbiology by Shrivastava and ManishL
9. Laboratory manual of market milk by DKThompkinson and Latha Sabikhi,NDRI,Karnal
10. Laboratory manual of cheese and fermented milk by DKThompkinson and Latha Sabikhi,NDRI,Karnal
11. Dairy Microbiology by Parihar and Parihar.Agrobios India,Jodhpur.
12. Analysis of milk and milk products : A Lab manual.Milk Industry Foundation
13. Laboratory manual of dairy analysis by Richmond

AB-355 Livestock Genome

2+1 =3

Theory:

History , common terms in genetics and breeding; Chromosome, numbers in livestock and poultry; Mitosis, meiosis –linkage, crossing over, Mendel's laws and modifications; Gene and genotype frequency and their estimation, Hardy-Weinberg's law of equilibrium; Gene actions; Concepts of probability and its application in genetics; Important economic traits of livestock and poultry; Environment and genotype; Preliminary concepts of heritability, repeatability, genetic and phenotypic correlation of different economic traits, breeding efficiency; Selection-basis, response, measures. Marker assisted selection; Gene mapping. Karyotyping; Transgenic animals- production, merits and demerit, Study of important genome sequencing projects of animals, Application possibilities for gene transfer, Growth, Disease resistant, Quality of animal products, Gene farming.

Practicals:

1. Laws of probability.
2. Problems on Mendel's laws and the modification.
3. X² test and detection of linkage.

4. Estimation of gene and genotype frequencies
5. Mapping of chromosomes.
6. Problems on multiple alleles.
7. Estimation of heritability, repeatability, genetic and phenotypic correlation.
8. Breeding records of livestock farms
9. Breeding value of cows and sire evaluation
10. Karyotyping

Reference Books:

1. General Cytogenetics by Sybenga J, North Holland Publishing Corp.,Amsterdam
2. Eukaryotic chromosomes by Bostock CJ and AT Summer.1980.North Holland Publishing Corporation, Amsterdam
- 3.Chromosome techniques by AKSharma 1980 Butterworths, London
- 4.Eukaryotic Genes by MacLean,N.,SP Gregory and RA Hanell.1983.Buttreworths , London
- 5.Genetic Engineering in Higher Organisms by Warr, J.Rober . 1985.Edward Arnold Pvt.Ltd., Victoria ,Australia
- 6.Textbook of Animal Husbandry by GCBanerjee
- 7.Textbook of animal genetics 2nd revised edition Kanakraj
- 8.Basic Genetics by Miglani .Narosa
- 9.Genetics;Principles,concepts and implications by HKJain Oxford and IBH
10. Gene Biotechnology by SNJogdand. Himalayan Publishing
- 11.Cell Biology ,Genetics,Molecular Biology,Evolution and Ecology by PSVerma and VKAgarwal. S.Chand
- 12.Biotechnology:Expanding horizons by BDSingh.Kalyani Publishers
- 13.Genetics by Strickberger .Prentice Books,India

CS-3510: Computer Application in Biotechnology

1+2

Theory:

Introduction to computers and window O.S. introduction to MS word, MS *power* point, MS Excel. Network & its type Internet , www. Multimedia and its types . Data base management sys. Introduction to programming with C – language. Introduction to web sites, E-mail, programming in Perl.

Practicals:

Internet, E-Mail, Internet surfing. Database management sys. Programming in C. Programming in Perl.

Reference books:

1. The concept guide to Microsoft office. Mansfield Ron 1994 BPB publications, New Delhi.
2. Mastering the internet- Glee Harrah Cady and Pat Mc Gregor 1995 BPB publications, New Delhi.
3. Rapidex computer course 4th Edn. 1996. Gupta V., Pustak Mahal, Delhi.
4. Windows 95 A to Z. Galgotia S. 1996. Galgotia Publications (P) Ltd., New Delhi.

BIO 369: Molecular Plant Virology 2+1

Theory :

Historical developments of virology. General classification, purification, structure and replication of plant viruses. Transmission of virus, virus-vector relationship and virus assaying. Translocation of viruses in plants, physiology of virus-infected plants, chemical composition and nature of viruses, methods of virus detection and identification. methods of virus disease management. Virus resistance:- coat protein genes , movement protein genes, replicase, RNA polymerase genes. Antisense and hairpin loop based on small interfering RNA.

Practicals:

Symptom studies, virus transmission – mechanical, grafting and insect transmission. Microscopy. Purification of plant viruses, serology, ELISA and molecular detection. Viral DNA isolation and detection by electrophoresis.

Reference books:

1. The Molecular Biology of Viruses by Coher, J.S. and W. Paranchych. 1967. Academic press, New York.
2. The Biology of Large RNA Viruses by Barry, R. D. and B.W.J Mahy. 1970. Academic Press, London.
3. Virology: Principles and Applications by Carter & Saunders, 2007, J. Willey.

PB-369: Introduction to Bioinformatics 1+2

Theory :

1. Introduction, Scope and application of Bioinformatics
2. Biological database, NCBI, ENSEMBL, EBI, EXPASY, Genbank ,AgriCola

3. Computer tutorial, introductory programming,
4. Computers and biology, online resources for bioinformatics,
5. Simple pair wise alignment, Induction to Blast , FASTA, BLAST searching, BLAST and PHI/PSI-BLAST,
6. Introduction to Gene expression and microarrays,
7. Introduction Micro array data analysis,
8. Introduction to protein structure and structural databases,
9. Molecular visualization, Basics of Proteomics, Bioinformatics methods for studying proteins,
10. sequence alignment, Pairwise alignment Multiple sequence alignment tools for alignments (CLUSTALX, CLUSTAL W),
11. Concepts in Protein structure prediction,
12. Phylogeny, cladistics, and evolution, Phylogenetic trees

Practicals:

1. Find Agribiotechnology related research paper from AgriCola
2. Find Research paper from NCBI-pubmed
3. Study of NCBI database with different parameters
4. Primary work on Entrez Home Search engine
5. Find out 5 Plant genome related Genes from different Plant Genome database with specific characters (3)
6. Study on Plant genome database
7. Data analysis of Rice genome with Nutritional valuable genes
8. Find out the present stress tolerance gene
9. Study on Introduction of BLAST
10. Analysis of Basic sequence analysis with BLAST
11. A biochemist suspects that P450 protein sequences are characterized by the following motif: FMFEGHDTTA
 - a. Use the ScanProsite -- select the Search Swiss-Prot with a PROSITE entry part of the form! -- or FPAT (*server down?*) programs to search for matches to this motif in SwissProt.
 - b. Take these hits and use PRATT to construct *regular expressions* characterising these sequences. *A brief explanation of what PRATT does can be found here.*
 - c. Search back into SwissProt with FPAT or ScanProsite using (some of) these patterns and see what hits are obtained.
 - i. Do these searches return all of the original sequences?

- ii. What other sequences (if any) are identified by these patterns? Are these also P450 sequences?
 - d. You can also try IBM's TEIRESIAS program to generate patterns.
- 12. Take the set of P450 sequences that you have identified with the FMFEGHDTTA motif
 - a. Randomly divide it into a training set and a test set. (Set the ratio of training to test sequences as somewhere between 1:1 and 1:3.)
 - b. Use PRATT to learn a significant pattern for the training set.
 - c. Search into the test set (or the entire database if you can't do this) with that pattern.
 - d. Use your results to compute the sensitivity and specificity for your pattern.
- 13. Nucleotide Analysis check for vector contamination, BLAST similarity search, FASTA similarity search, whole genome search, pairwise alignment, ClustalW2 multiple sequence alignment and translation of DNA/RNA into protein.
- 14. Protein Structure
 Topics include; introduction to nucleotide structures, introduction to protein structures and bioinformatics for protein structure prediction.
- 15. Genome Browsing Topics include; information on the two main genome browsers available Ensembl in the UK and UCSC Genome Bioinformatics in the USA.
- 16. Database Browsing Topics include; summary of the interfaces available for searching multiple databases and also a detailed explanation of the Sequence Retrieval System (SRS) provided by the EBI.
- 17. EBI Web Services Topics include: What are SOAP Web Services, where to get these from; how to use them and how to develop applications with these.

Reference books:

1. Elementry Bioinformatics by I.Khan,2007 Pharma Book Syndicate,HYD.
2. Bioinformatics by A. Baxevanis, 2007, Panima ND.
3. Practical Bioinformatics by Bujnicki,2008 Springer.
4. Bioinformatics By Polanski, 2008 Springer.
5. Structural Bioinformatics by Philips Bourne, Panima ND.
6. Bioinformatics by Dear P., 2008, Panima, ND.

PB3610: Bio Safety Issues 2+0

Theory

Definition, Biosafety concerns. Biosafety regulations in various countries. International agreements related to biosafety. Regulatory frame work of biosafety in India . Guidelines for recombinant DNA technology . Status, prospectus and concerns of GM crops, Biosafety of environment and human health. Guidelines for research in transgenic plants and drugs. Social and ethical issues; Biosafety issues related to genetically modified organisms (GMOs) by Biotechnology Consortium India Ltd. and Department of Biotechnology Govt. Of India. Gene contamination, Super weed and super pest.

Reference books:

1. Food Biotechnology by K.Shetty,2006, CRC publication.
2. Biotechnology expanding Horizon, B.D.Singh,2004, Kalyani Publishing,ND
3. Plant Biotechnology by Chawla,2002, Oxford IBH, ND.
4. WEB sites
 - 1) www.agbios.com,
 - 2) www.dbt.nic.in,
 - 3) www.bcil.nic.in,
 - 4) www.moef.nic.in,
 - 5) www.lgmoris.nic.in.

FB 366: Post Harvest Biotechnology of Horticultural Crops 2+1=3

Theory:

Importance of post harvest loss management. Pre- and Post-harvest factors affecting shelf life of Horticultural crops. Post harvest molecular biology- ripening (role of ethylene, climacteric vs. non-climacteric fruits), fruit softening (Pectinase and polygalacturonases), flavor fragrance and senescence. Genetic engineering plants for delayed ripening and better shelf life. Packing techniques- grading, containers, cushioning, vacuum packing, canning, bottling, freezing, dehydration, drying, UV and Ionizing radiations. Principles of preservation by heat, low temperature, chemicals and fermentation. Preservatives and colours permitted and prohibited in India. Storage techniques- Zero Energy Cold Storage Chambers and On Farm Storage facilities. Microbial contaminants and post-harvest pathology. Export Quality Standards. Biotechnology for recycling Horticultural waste as manures and livestock feed. Phytosanitation, HACCP, GM fruits and vegetables.

Practical:

Maturity standards of some selected fruits and vegetables. Ethylene assay. Determination of Physiological loss of weight, TSS, total sugars, acidity, pigments and ascorbic acid contents in selected horticultural crops. Packing and storage techniques. Quality standards for exports. Visit to pre-cooling and packing unit. Grading for international market and national quality code standards. Role of UV in preservation of food.

Reference books:

1. Food Biotechnology, by Roges, A. 1989. Elsevier Applied Sci. Pub., London, U.K.
2. Functional Foods by Goldberg, I.. 1994. Chapman and Hall, New York.
3. Fundamentals of Food Biotechnology by Byong, H. L. 1996. VCH Publishers, New York.
4. Food Biotechnology by Shetty, 2006, CRC, NY
5. Comprehensive Biotechnology by Campbell, R.W. and J. A. Howell. 1995. Pergamon Press, Oxford.
6. Biotechnology by Singh, B. D. 2000. Kalyani Publishers, Ludhiana.
7. Hand book of horticulture – by ICAR, New Delhi

FB367 : Food and Nutrition Security of GM Food crops 1+1

Theory:

International aspects of the quality and safety of Foods derived from modern Biotechnology, Application of ELISA for detection of Toxins in food, Biosensors for food quality Assessment, Malnutrition, consequences, causes, prevention and control. Applied community nutrition. Food safety and food faddism. safety testing for toxicity, allergenicity , anti nutritional effects Native toxins and toxins produce during storage, health hazards.

Practicals:

Quantitation of toxins by various methods, Biofilm production, Antimicrobial activity and ELISA for toxins and viruses,

Reference books :

1. Food Biotechnology, by Roges, A. 1989. Elsevier Applied Sci. Pub., London, U.K.
2. Functional Foods by Goldberg, I.. 1994. Chapman and Hall, New York.
3. Fundamentals of Food Biotechnology by Byong, H. L. 1996. VCH Publishers, New York.
4. Food Biotechnology by Shetty, 2006, CRC, NY
5. Comprehensive Biotechnology by Campbell, R.W. and J. A. Howell. 1995. Pergamon Press, Oxford.

AB-366 Animal Genetic Engineering

2+1=3

Theory :

Introduction to recombinant DNA techniques using restricted enzymes; Cloning vectors, plasmid, phages, cosmids, and transposons. DNA and RNA separation and characterization; Oligo nucleotide synthesis, DNA and RNA sequencing. *In vitro* site directed mutagenesis, radioactive probes, Southern, Northern, Western and Dot blot; *In vitro* transfer and expression for foreign DNA in host cell; Genetic markers in farm animal classes of genetic markers. Microsatellite markers and their role in assistance in animal genetic resources. Single nucleotide polymorphism (SNPs) identification and genotyping; QTLs for candidate gene in animal production; Physical gene mapping and current status of gene maps of farm animals. Bio hazards and safety aspects in genetic engineering; Physical and biological containment, Status and prospectus of transgenic animals and animal products.

Practicals

1. Isolation of DNA
2. Preparation of plasmid DNA and large scale preparation of phage DNA and *in vitro* packaging in E-coli
3. Amplification of plasmid copy number by Chloramphenicol treatment
4. Use of restricted enzymes and mapping of purified DNA samples (Plasmid DNA, *lambda* phage)
5. Visit to leading Biotechnological laboratory
6. Computer applications in DNA and RNA sequencing

Reference Books:

1. Principles of Gene Manipulation –An Introduction to Genetic Engineering by Old, F. W. and S. B. Primrose. 1981. Blackwell Sci. Pub. London.
2. Molecular Cloning –A Laboratory Manual by Maniatis, T., E.F. Fritsch and J. Sambrook 1984. Cold Spring Harbor, New York.
3. Gene Cloning – The Mechanics of DNA Manipulation by Glover D.M. 1984. Univ. Press, Cambridge.
4. Experiments with Gene Fusions by Silhavy T.J., M.L. Berman and L.W. Enguist. 1984. Cold Spring Harbor, New York.
5. Genetic Engineering in Higher Organisms by Warr J. R. 1985. Edward Arnold Pvt. Ltd. Victoria, Australia.
6. Recombinant DNA Methodology by Dillon J.R.A. Nasim and E.R. Nestmann. 1985. John Wiley and Sons Inc., New York.

7. Recombinant DNA-A Short Course by Watson, J.D., J. Tooze, and T.T. Kurtz 1987. Scientific American Books, New York.

CS 3611 : Management of major insect pests and diseases of field and Horticultural crops 1+1

Theory :

Scientific names taxonomic position, host range, nature of damage life history, bionomics and management of important pests infesting cereals, fibres, oilseeds, pulses, sugarcane, forage crops, vegetables and fruit crops. Different pest control methods, IPM concept, Insecticide resistance management; Economic importance, symptoms, etiology, and integrated management of major diseases of rice, sorghum, bajra, wheat, sugarcane, turmeric, ginger, groundnut, sunflower, safflower, cotton, red gram, Bengal gram, soybean, citrus, mango, banana, grapevine, pomegranate, papaya, guava, betelvine, chilli, brinjal, lady finger, potato, crucifers, cucurbits, tomato, onion, beans, rose, chrysanthemum, gladiolus, carnation, tuberose, and gerbera.

Practical:

Collection, identification and preservation of insect pests and natural enemies of above crops. Pesticide application technique; Study of symptoms, epidemiology and disease cycle, and specific control measures of major diseases of rice, sorghum, bajra, wheat, sugarcane, turmeric, ginger, groundnut, sunflower, safflower, cotton, red gram, Bengal gram, soybean, citrus, mango, banana, grapevine, pomegranate, papaya, guava, betelvine, chilli, brinjal, lady finger, potato, crucifers, cucurbits, tomato, onion, beans, rose, chrysanthemum, gladiolus, carnation, tuberose, and gerbera. Field visits at appropriate time during the semester. Survey and collection of disease samples of above crops and their preservation. Isolation, methods of preserving cultures, production of different commercial formulations, and quality control of bioagents.

Text Books:

1. Elements of economic entomology – B.V. David & T. Kumarswami.
2. Insects and Fruits: D.K. Batani.
3. Insects in Vegetables : D.K. Batani and M.G. Jotwani
4. Handbook of economic entomology for South India – T.V.R. Ayer.
5. Agril. Pests of India and South East Asia – A.S. Atwal.
6. Diseases of tropical and subtropical field, fibre and oil plants by Cook, A. A. 1981, Mac Millan Pub NewYork

7. Diseases of crop plants in India by Rangaswamy G. and Mahadevan. 2006.
8. Plant Diseases by Singh, R. S. 1996, Oxford & IBM Ltd New Delhi.
9. Plant Pathology by G. N. Agreose 5th Edition.
10. Diseases of fruit crops by Pathak, V. N. 1980 Oxford & I BH Pub.
11. Diseases of ornamental plants in India by Sohi, H. S. 1992 ICAR, New Delhi.
12. Diseases of vegetable crops. Singh, R. S. 1994, Oxford & IBM, New Delhi.

CS 3612: Marketing and Export of Biotechnological Products 1+1

Theory:

External trade in Agricultural products, Present status, policy and prospects under WTO regime, Export import policy, Regulation of Agricultural marketing system, Infrastructural facilities for exporting efficiency, Biotechnological Products in India, Quality parameters and quarantine procedures of export. Market integration :Types and effects Marketing costs margins and price spread.

Biotech industries & institutes in India & world, Concepts of Biotech park/ Biotech Hub

Practicals :

Visit to different small scale and large scale Agro-based products. Study the production techniques of biotech products. Collecting the information on export import data on biotech products, quality standards for export and their potential. Analyze data in relation to demand supply .

Comparison between non biotechnological products and biotechnological products. Safety and licensing for import and export of biotechnological products.

Reference books:

1. Agriculture Marketing in India by Acharya and Agrawal 1999, Oxford IBH, N. Delhi.
2. Principles of Marketing by Kotlar and Armstrong 1997, Prentice-Hall, N. Delhi.

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