

Department of Botany

B.Sc.,

M.Sc.,

M.Phil

B.Sc., Bio-Technology

B.Sc., Botany

THIAGARAJAR COLLEGE, MADURAI – 9.
(Re-Accredited with ‘A’ Grade by NAAC)
DEPARTMENT OF BOTANY
BACHELOR OF SCIENCE IN BOTANY
SEMESTER –I

Course	Code No.	Subject	Contact Hrs/ Week	Credits	Total No. of Hrs Allotted	Max. Marks. CA	Max. Marks. SE	Total
Part I	P111	Ikkala Ilakkiyam	6	3	90	25	75	100
Part II	P211	English Through Prose	6	3	90	25	75	100
Core 1	MB11	Plant Diversity I	5	4	75	25	75	100
Core 1 Lab	MBL11	Plant Diversity I Practical	2	-	30	-	-	-
Core 2	MB12	Microbiology and Plant Pathology	5	4	75	25	75	100
Core 2 lab	MBL 12	Microbiol. And Pl. Pathol. Practical	2	-	30	-	-	-
Practical Examination for MB11 & MB12			-	2	-	40	60	100
Value Education I	VE 1	Value Education I	2	2	30	15	35	50
Environmental Studies	ES 1	Environmental Studies	2	2	30	15	35	50
Total			30	20				

SEMESTER –II

Course	Code No.	Subject	Contact Hrs/ Week	Credits	Total No. of Hrs Allotted	Max. Marks. CA	Max. Marks. SE	Total
Part I	P121	Bhakthi Illakkiyamum Sitrillakkiyam	6	3	90	25	75	100
Part II	P221	English Through Drama	6	3	90	25	75	100
Core 3	MB21	Plant Diversity II	5	4	75	25	75	100
Core 3 Lab	MBL21	Pl. Diver Practical	2	-	30	-	-	-
Core4	MB22	Cell Biology and Plant Anatomy	4	4	60	25	75	100
Core4 Lab	MBL22	Cell Biol. and Plant Anatomy Practical	2	-	30	-	-	-
Practical Examination for MB21 & MB22				2	-	40	60	100
Core Elective I	EMB21 (B)	Bioremediation	3	3	45	25	75	100
Skill Based Elective I	SBE 1	Histology and staining techniques	2	2	30	15	35	50
Total			30	21				

SEMESTER –III

Course	Code No.	Subject	Contact Hrs/ Week	Credits	Total No. of Hrs Allotted	Max. Marks. CA	Max. Marks. SE	Total
Part I	P131	Kappiyallakiyam	6	3	90	25	75	100
Part II	P231	English Through Poetry	6	3	90	25	75	100
Core5	MB31	Plant Embryology and Tissue Culture	3	4	45	25	75	100
Core 5 lab	MBL31	Plant Embryology and Tissue Culture Practical	2	2	30	40	60	100
Core Elective II	EMB31 (H)	Herbs and Drugs	3	3	45	25	75	100
Allied	AC31 (B)	Chemistry	4	4	60	25	75	100
Allied Lab	ACL31 (B)	Chemistry Lab	2	-	30	-	-	-
Value Education II	VE2	Value Education II	2	2	30	15	35	50
Non Major Elective I	NME1		2	2	30	15	35	50
Total			30	23				

SEMESTER –IV

Course	Code No.	Subject	Contact Hrs/ Week	Credits	Total No. of Hrs Allotted	Max. Marks. CA	Max. Marks . SE	Total
Part I	P141	Pandai Illakiyam	6	3	90	25	75	100
Part II	P241	English Through Fiction	6	3	90	25	75	100
Core 6	MB 41	Genetics, Evolution and Biostatistics	3	4	45	25	75	100
Core 6 lab	MBL 41	Gen., Evol. and Biostat. Practical	2	2	30	40	60	100
Core Elective III	EMB 41 (B)	Basics of Computer Applications	3	3	45	25	75	100
Skill based Elective II	SBE2	Mushroom technology	2	2	30	15	35	50
Allied1	AC41 (B)	Chemistry	4	4	60	25	75	100
Allied1 Lab	ACL41(B)	Chemistry Lab	2		30	-	-	-
Practical Examination for AC31(B) & AC41(B)				2		40	60	100
Non Major Elective II	NME 2		2	2	30	15	35	50
Total			30	25				

SEMESTER –V

Course	Code No.	Subject	Contact Hrs/ Week	Credits	Total No. of Hrs Allotted	Max. Marks. CA	Max. Marks. SE	Total
Core7	MB51	Morphology and Taxonomy of Angiosperms	5	4	75	25	75	100
Core7 Lab	MBL51	Morpho. and Taxo. of Angio. Practical	3	2	45	40	60	100
Core8	MB52	Plant Biochemistry and Biotechniques	5	4	75	25	75	100
Core8 Lab	MBL52	Plant Biochemistry and Biotechniques Practical	3	2	45	40	60	100
Core 9	MB53	Ecology and Biodiversity	4	4	60	25	75	100
Core 9 Lab	MBL53	Ecology and Biodiversity Practical	2	2	30	40	60	100
Allied2	AZ51	Zoology	4	4	60	25	75	100
Allied2 lab	AZL51	Zoology Lab	2	-	30	-	-	-
Value Education III	VE3	Value Education III	2	2	30	15	35	50
Self study paper		Economic Botany	-	(Extra 5)*			100	100
Total			30	24				

* Carries Extra 5 credits that do not form part mandatory credits (140) required for completion of the course.

SEMESTER –VI

Course	Code No.	Subject	Contact Hrs/ Week	Credits	Total No. of Hrs Allotted	Max. Marks. CA	Max. Marks. SE	Total
Core10	MB61	Plant Physiology	5	4	75	25	75	100
Core10 Lab	MBL61	Plant Physiology Practical	3	2	45	40	60	100
Core11	MB62	Biotechnology	5	4	75	25	75	100
Core11 Lab	MBL62	Biotechnology Practical	3	2	45	40	60	100
Core12	MB63	Horticulture and Plant breeding	4	4	60	25	75	100
Core12 Lab	MBL63	Horticulture and Plant breeding Practical	2	2	30	40	60	100
Skill Based Elective III	SBE3	Organic Farming and Biofertilizers	2	2	30	15	35	50
Allied2	AZ61	Zoology	4	4	60	25	75	100
Allied2 lab	AZL61	Zoology Lab	2		30			
Practical Examination for AZ51& AZ61			--	2	--	40	60	100
Total			30	26				

A) CONSOLIDATION OF CONTACT HOURS AND CREDITS: UG

Semester	Contact Hrs/ Week	Credits
I	30 hrs.	20
II	30 hrs.	21
III	30 hrs.	23
IV	30 hrs.	25
V	30 hrs.	24
VI	30 hrs.	26
Part – V	--	1
Total	180 hrs	140

B) Curriculum Credits: Part wise

Part I	Tamil	4x3 = 12 Credits
Part II	English	4x3 = 12 Credits
Part III	Core	= 68 Credits (10+10+6+6+18+18)
	Allied	= 20 Credits (4+4+2) +(4+4+2)
	Core Electives	3x3 = 09 Credits
Part IV	Value Education	3x2 = 06 Credits
	Environmental studies	1x2 = 02 Credits
	Skill Based Electives	3x2 = 06 Credits
	Non – Major Electives	2x2 = 04 Credits
Part V		1x1 = 01 Credits
	Total	140 Credits

Allied Botany (for B. Sc., Industrial Microbiology – Semester III and IV)

Course	Code No.	Subject	Contact Hrs/ Week	Credits	Total No. of Hrs Allotted	Max. Marks. CA	Max. Marks. SE	Total
Semester - III								
Allied	AB31 (B)	Basics of Biotechnology	4	4	60	25	75	100
Allied Lab	ABL 31	Basics of Biotechnology	2	-	30			
Semester - IV								
Allied	AB41 (B)	Economic Botany	4	4	60	25	75	100
Allied Lab	ABL 41	Economic Botany	2	-	30	-	-	-
Practical Examination for AB31 (B) & AB41(B)		Economic Botany and Basics of Biotechnology Practical	-	2		40	60	100

Non- Major Elective offered by Botany Department

Course	Code No.	Subject	Contact Hrs/ Week	Credits	Total No. of Hrs Allotted	Max. Marks. CA	Max. Marks. SE	Total
Semester – III								
Non Major Elective I	NME 1	Horticulture	2	2	30	15	35	50
Semester – IV								
Non Major Elective II	NME 2	Gardening	2	2	30	15	35	50

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Course: B.Sc., Botany	Code No	: MB11
Semester: I	No. of Hrs allotted/semester	: 5hrs/week
Paper: Core 1	No. of Credits	: 4
Title of the Paper: Plant Diversity I	Marks	: 25 +75 = 100

Course Objectives:

- To learn about the Cryptogamic plants.
- To understand the diversity, complexity and the economic value of lower plants.

Unit I: General classification of Algae based on Fritsch system – General characters of Blue-green Algae- *Nostoc* – Occurrence – Structure– Heterocyst structure and function – Reproduction – Vegetative reproduction – Asexual reproduction – Hormogones, Endospores and Akinetes- Life cycle of *Nostoc*. General characters of Green algae – *Caulerpa* – Thallus structure – Internal structure – Reproduction – Vegetative reproduction – Sexual reproduction – Diplontic Life cycle.

Unit II: General characters of Brown algae – *Padina* – Occurrence – Thallus structure – Internal structure- Reproduction – Vegetative, asexual and sexual reproduction – Isomorphic Diplohaplontic Life cycle of *Padina*. General characters of Red algae- *Gracillaria* – Occurrence – Thallus structure – Cell structure- Reproduction – Vegetative, asexual and sexual reproduction –Life cycle of *Gracillaria*. Economic importance of Algae.

Unit III: General characters of Fungi based on Alexopoulos system – General characters of Zygomycetes – *Rhizopus* – occurrence - somatic structure – Asexual reproduction – sexual reproduction – Life cycle. General characters of Ascomycetes – *Aspergillus* – Occurrence – somatic structure – Asexual reproduction – sexual reproduction – Life cycle. General characters of Basidiomycetes – *Agaricus* – Occurrence – mycelium - Asexual reproduction – sexual reproduction- Mature fruiting body (sporophore) –Life cycle.

Unit IV: General characters of Deuteromycetes – *Fusarium* – Occurrence – vegetative structure – Asexual reproduction. Economic importance of Fungi. Lichens: Morphology of the thallus – crustose, foliose, and fruticose – Fungal components – Algal components – symbiosis – vegetative reproduction: Fragmentation, Isidia and Soredia – sexual reproduction – Apothecium – Lichen as pollution indicators. Economic importance of Lichens.

Unit V: General classification of Bryophytes based on Rothmaler – *Marchantia*, *Polytrichum*– Occurrence – external features of adult gametophyte – Internal structure – Reproduction – Asexual reproduction – Sexual reproduction – Sporophyte structure – Life cycle. (Development of sex organs excluded).

Text Books:

1. Stephenson, S.L. 2010. The Kingdom fungi: The Biology of Mushroom, Molds and Lichens, Timber Press Inc., UK.
2. Lynda Ed. West. 2010. Algae, Cambridge University Press, UK.
3. Vashishta, B.R. 1988. Bryophyta, 6th Edition, S. Chand and company, (Pvt.) Ltd., New Delhi.
4. Kumar, H.D. 1990. Introductory Phycology, Affiliated East West Press (P) Ltd., New Delhi.
5. Rashid, A. 1998. An introduction to Bryophyta, Vikas Publishing House (P) Ltd., New Delhi.

Reference Books:

1. West, G.S. 2010. Algae vol. I. Myxophyceae, Peridinieae, Bacillariaceae, Chlorophyceae, Cambridge Botanical hand book series, UK.
2. Tuba, Z., N.G., Sleck and L.R. Stark. 2011. Bryophyte, Cambridge University Press, UK.
3. Dube, H.C. 2009. Introduction to Fungi, Vikas publishing pvt. Ltd., New Delhi.
4. Paracer, S and V.Ahmadjian. 2002. Symbiosis, Oxford University Press, Chennai.

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Course: B.Sc., Botany	Code No	: MBL11
Semester: I	No. of Hrs allotted	: 2 hrs / week
Paper: Core Lab for MB11	No. of Credits	:
	Marks	:

Title of the Paper: **Plant Diversity -I**

Study of the following algal samples of:

1. Chlorophyceae – *Chlorella*-Morphological and anatomical variations of *Caulerpa*
2. Phaeophyceae- *Padina*: a) Morphology of macroscopic thallus and gametangium, b) Anatomical study of sporophyte.
3. Rhodophyceae - *Gracilaria*: gametophyte, sporophyte and Cystocarp
4. Micropreparation of *Rhizopus*, *Aspergillus*, *Agaricus* and *Fusarium*.
5. Study of *Parmelia* and *Usnea*, L.S. of Lichen Apothecium.
6. Study of external and internal structure of *Marchantia* thallus.

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Course: B.Sc. Botany	Code No	: MB12
Semester: I	No. of Hrs allotted	: 5hrs/ week
Paper: Core 2	No. of Credits	: 4
Title of the Paper: Microbiology and Plant pathology	Marks	: 25 +75 = 100

Course Objectives:

- To understand the classification, nutrition and growth of microbes.
- To know the basic practices in microbial culture production
- To acquire information about plant diseases

Unit I: Important events in microbiology –invention of microscope- discovery of microbes, fermentation, Germ theory of disease, Koch's postulates, vaccination, - types of microorganisms: general structure of Algae, Fungi, Protozoa, Bacteria, Virus, Mycoplasma & Prions. Major groups of bacteria (Bergey's manual 8th ed.).

Unit II: Morphology and fine structure of Bacteria. Reproduction: Binary fission. Methods of recombination: Conjugation, Transduction & Transformation. Bacterial virus; Structure and reproduction of T4 phage - Plant virus: TMV.

Unit III: Nutritional types in bacteria- bacteriological media-types- Growth: Sigmoid growth-diauxy growth. Factors affecting growth. -Sterilization methods-Pure culture techniques: Pour plate method, Spread plate method, streak plate method-Staining: Simple-Gram's staining- Flagellar, Capsular staining -Preservation of microbial cultures.

Unit IV: Classification of plant diseases: Based on host, pathogen and symptoms. Entry of pathogen into a host- Role of Enzymes and toxins in the establishment of the pathogen. Pre- infectious and post- infectious defense mechanism.

Unit V: Study of the following diseases; Causal organism-Symptoms-Disease cycle-Disease management.

- a) Fungal disease: Early and Late leaf spot disease of Ground nut.
- b) Bacterial disease: Blight of cotton
- c) Viral disease: Bendi yellow vein mosaic disease
- d) Phytoplasma disease: Brinjal little leaf disease
- e) Algal disease: Red rust of Tea
- f) Nematode disease: Root Knot disease of Tomato.

Text Books:

- 1) Ananthanarayanan, R. and C.K. Jayaram Paniker. 1996. Text book of Microbiology. Orient Longman, Hyderabad.
- 2) Aneja, K.R. 1996. Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom Cultivation. Vishwa Prakashan (New Age International (p) Ltd.) New Delhi.
- 3) Pandey, B.P 1997. Plant pathology. S.Chand and Co. Ltd., New Delhi.
- 4) Mehrotra, R.S. 1980. Plant pathology, Tata McGraw Hill Publishing Company Ltd., New Delhi.

Reference Books:

- 1) Pelczar, M.J., E.C.S. Chan and N.R Krieg. 2010. Microbiology-Concepts and applications, Tata McGraw-Hill Publishing Company, New Delhi.
- 2) Prescott, L.M., J.P. Harley, and D.A .Klein. 2002. Microbiology, McGraw -Hill Publishing Company, New Delhi.
- 3) Bhatia, A.L. 2005. Handbook of Microbiology, Pointer Publishers, Jaipur.
- 4) Ingram, J.L. and C.A. Ingram. 2004. Introduction to Microbiology, Thomson Books, UK
- 5) Agrios, G.N.2006. Plant pathology, Fifth edition, Academic Press, New York.
- 6) Singh, R.S. 2009. Plant Diseases, Oxford & IBH Publishing Co.Pvt. Ltd., New Delhi.

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Course: B.Sc., Botany	Code No	: MBL12
Semester: I	No. of Hrs allotted	: 2 hrs / week
Paper: Core Lab for MB12	No. of Credits	:
	Marks	:

Title of the Paper: **Microbiology and Plant Pathology**

1. Glassware handling and laboratory practices
2. Preparation of culture media-sterilization technique. Inoculation and purification of microorganism-Streak plate method.
3. Quantification of soil microbes by plating technique.
4. Motility of bacteria by hanging drop method.
5. Staining: Simple staining and gram staining, Fungal staining: lacto phenol cotton blue.
6. Demonstration of acid and gas production by bacteria.
7. Study of the following diseased plant materials: a) Mildew and brown rust b) Red rot and leaf spot of Ground nut c) Canker, Red rust and white rust.
8. Demonstration of the isolation of pathogen from diseased material.
9. Submission of 5 herbarium sheets of infected plant materials –Valued externally.

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Course: B.Sc., Botany	Code No	: MB21
Semester: II	No. of Hrs allotted:	5hrs/week
Paper: Core 3	No. of Credits	: 4
Title of the Paper: Plant Diversity -II	Marks	: 25 + 75 = 100

Course Objectives:

- To understand the classification of Pteridophytes and Gymnosperms
- To identify the various forms of Pteridophytes
- To differentiate various members of Gymnosperms

Unit I: Pteridophytes: The first vascular plants, General features, Stele system, Heterospory and seed habit, affinities, Classification and important characteristics of Psilopsida, Lycopsidea, Sphenopsida and Pteropsida.

Unit II: General features, Habitat and distribution, Structure, Reproduction and alternation of generation with special reference to Psilotum, Lycopodium, Selaginella and Marsilea.

Unit III: Gymnosperms: General features, Classification, Habitat and distribution, External Features, Anatomy of vegetative and reproductive structures and reproduction with special reference to Pinus and Gnetum.

Unit IV: Economic importance of Gymnosperms: Food, Fodder, Timber, Ornamentals, Medicine and Fuel for energy, fossil fuels

Unit V: Palaeobotany-Geological time scale, brief account on process of fossilization. Structure and reproduction of the following fossil types. Rhynia and Lepidodendron.

Text Books:

1. Parihar, N.S. 1965. An Introduction to Embryophyta, Vol. I., Central Book Depot, Allahabad.
2. Sporne, K.R. 1974. Morphology of Gymnosperms, B.I. Publications, Chennai.
3. Sporne, K.R. 1976. Morphology of Pteridophytes, B.I. Publications, Chennai.
4. Vashishta, P.C. 1976. Gymnosperms, S.Chand and Co., New Delhi.
5. Vashishta, P.C. 1976. Pteridophytes, S.Chand and Co., New Delhi.
6. Pandey, B.P. 2001. College Botany, Vol.II, S.Chand and Co., New Delhi.

Reference Books:

1. Alan Reid Smith. 1981. Pteridophytes, California Academy of Sciences. California.
2. Reddy, S.M. and S.J. Chary. 2003. Gymnosperms, New age international (p) Ltd. Publisher. New Delhi.
3. R. A. Spiler and B.A. Thomas, 1986. Systematics & Taxonomic approaches in Paleobotany, Clarendon Press, UK.

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Course: B.Sc., Botany	Code No	: MBL21
Semester: II	No. of Hrs allotted	: 2 hrs / week
Paper: Core Lab for MB21	No. of Credits	:
	Marks	:

Title of the Paper: **Plant Diversity -II**

Plant Diversity II

1. Study of morphology and reproductive structures of the following types:

Pteridophytes: *Lycopodium*, *Selaginella*, *Equisetum*, *Marsilea*

Gymnosperm: *Pinus*, *Gnetum*,

Fossils: *Rhynia*, *Lepidodendran*

2. Field studies, submission of field reports and herbarium

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Course: B.Sc., Botany	Code No	: MB22
Semester: II	No. of Hrs allotted	: 4hrs/ week
Paper: Core 4	No. of Credits	: 4
Title of the Paper: Cell Biology and Plant Anatomy	Marks	: 25 +75 = 100

Course Objectives:

- To know the components and structure of plant cell
- To understand the internal structure and organization of the various parts of the plant

Unit I: Plant and animal cell- ultra structure of plant cell – structure of cell wall, Plasma membrane – Fluid mosaic model. Structure and function of cytoplasmic organelles: Cytosol – cytoskeleton organization — endoplasmic reticulum – peroxisomes –lysosomes – vacuoles – ribosome – golgi apparatus- ergastic substances.

Unit II: Mitochondria –Plastids- structure and function. Nucleus – structure and function. Structure of chromosome – Euchromatin – heterochromatin – abnormal structure in chromosome – lampbrush and polytene structures. Cell cycle – mitosis – meiosis.

Unit III: Meristematic tissues – Characters and types – structure and function of apical meristems – root apex and shoot apex – theories of meristems. Structure and function of simple– parenchyma, collenchyma, sclerenchyma. Secretary tissues. Structure of surface appendages- trichomes, glands.

Unit IV: Complex tissues- xylem, phloem. Types, structure and function of cambium. Primary structures of dicot root (*Vigna*), monocot root (*Maize*), dicot stem (*Tridax*), monocot stem (*Maize*), dicot leaf (*Tridax*) and monocot leaf (*Polyanthus*).

Unit V: Secondary growth: normal secondary growth in dicot stem and root. Anomalous secondary growth in *Nyctanthes*, *Boerhaavia* and *Dracaena*. Nodal anatomy: unilacunar node (*Polyalthia*), trilacunar node (*Azadirachta*) and multilacunar node (*Aralium*).

Text books:

1. Becker, W.M., L.J. Kleinsmith and J. Hardin, 2011. The World of the Cell, Dorling Kindersley (India) Pvt. Ltd., New Delhi.
2. Verma P.S. and V. K. Agarwal, 2006. Cytology, S. Chand and Co. Ltd., New Delhi.
3. Pandey, B.P. 2010. Plant Anatomy, S. Chand and Co. Ltd., New Delhi.
4. Vashista P.C., 1986. Plant Anatomy, Pradeep Publications, Jalandhar, India.

Reference Books:

1. Fahn, A. 1990. Plant Anatomy, Pergman press, Oxford, London.
2. Prakash, E.J.J. 1987. A text book of Plant Anatomy, Emkay Publications, New Delhi.
3. Pandey, S. N. and A. Chandha. 2009. Plant Anatomy and Embryology, Vol III, Vikas Pub. House Ltd., New Delhi.

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Course: B.Sc., Botany	Code No	: MBL22
Semester: II	No. of Hrs allotted	: 2 hrs / week
Paper: Core Lab for MB22	No. of Credits	:
	Marks	:

Title of the Paper: **Cell Biology and Plant Anatomy Practical**

Cell Biology and Plant Anatomy

1. Cell division: Mitosis – Onion root tip squash
2. Study of cell inclusions – Starch grain from banana, rice and potato
3. Study of cell inclusions - Cystolith (Ficus leaf), Raphides (Pothos leaf)
4. Study of the internal structure of Dicot root – *Vigna*
5. Monocot root- *Maize*
6. Dicot stem – *Tridax*
7. Monocot stem – *Maize*
8. Dicot leaf – *Tridax*
9. Monocot leaf- *Grass*
10. Normal secondary growth : *Tecoma* stem
11. Anomalous secondary growth : *Boerhaavia* stem, *Dracaena* stem
12. Nodal Anatomy – *Polyalthia*, *Azardirachta*, *Albizzia*

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Course: B.Sc., Botany	Code No	: EMB21(B)
Semester: II	No of Hrs allotted:	3hrs/week
Paper: Major Elective I	No of Credits	: 3
Title of the Paper: Bioremediation	Marks	: 25+75=100

Course Objectives:

- To know about the causes and factors influencing xenobiotics in the environment
- To learn the principles of bioremediation

Unit I: Introduction to pollution - Pollutants-types –effects on environment- recalcitrant compounds and xenobiotics-radioactive wastes.

Unit II: Bioremediation – types – factors affecting – mechanism of bioremediation – limitation – microbes involved in bioremediation – essential characters of microbes - Phytoremediation.

Unit III: Bioremediation techniques: *In situ* and *Ex situ* remediation. Bioleaching – copper and gold.

Unit IV: Bioremediation of xenobiotics – reductive degradation, oxidative degradation, hydrolysis. Bioremediation of hydrocarbons – bioremediation of heavy metals.

Unit V: Degradation of organic wastes: lignin and cellulose – degradation of oil – biological treatment of sewage and industrial effluents.

Text books:

1. Rajendran, P. and P.Gunasekaran, 2006. Microbial bioremediation, MJP publishers, Chennai.
2. Dubey, R .C. 2002. A textbook of Biotechnology. S.Chand and Co. Ltd ., New Delhi.
3. Singh, B.D., 1998. Biotechnology. Kalyani publishers, New Delhi.

Reference books:

1. Gupta, P.K.1994. Elements of Biotechnology, Rastogi and Co., Meerut, India.
2. Dubey, R .C. 2000. A text book of Biotechnology, S.Chand and Co. Ltd., New Delhi.

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Course: B.Sc., Botany

Code No: SBE1

Semester: II

No of Hrs Allotted: 2Hrs/Week

Paper: Skill Based Elective I

No of Credits: 2

Title of the Paper: **Histology and Staining Techniques**

Marks: 15+35=50

Course objectives:

- To study the nature of cell and types.
- To acquire knowledge about microscopes and cell observation.
- To understand the staining techniques and its types.

Unit-I: Histology-Introduction- types of plant tissues-Simple and compound tissues- histological classification of cells. Microscopic examination of cells- Microscopy: Principles and maintenance of compound microscope, magnification, resolving power. Different applications of microscopes.

Unit-II: Microtome techniques: Microtomy, Killing and Fixation, Dehydration, stains and staining. Sections: free hand sections, and serial sections- Selected methods for preparation of permanent slides.

Text books:

1. Prasad, M.K. and Prasad M.Krishna. 1975. Outlines of Microtechniques, Emkay publications. Delhi.
2. Periyasamy, K. 1980. Histochemistry, developmental and structural anatomy of angiosperms: a symposium, P & B publications, Tiruchirapalli.

Reference Books:

1. Penney, D.P., J.M.Powers, M.Frank and C. Churukian. 2002. Analysis and testing of biological stains--the Biological Stain Commission Procedures, Biotech Histochem. 77 (5–6): 237–275. PMID 12564600.
2. Clark, G.1981. Staining Procedures, Fourth edition, Baltimore: Williams & Wilkins, ISBN 0683017071.
3. Histological techniques: Microtomy; <http://www.histologicaltechniques.com>

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DEPARTMENT OF BOTANY
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Course: B.Sc., Botany	Code No	: MB 31
Paper: Core 5	No. of Hrs allotted/semester:	3hrs/week
Semester: III	No. of credits	: 4
	Marks	: 25+75=100

Title of the Paper: Plant Embryology and Plant Tissue Culture

Course Objectives:

- To provide students with a fundamental understanding of study about plant embryology
- To familiarize the students with the basic principles and techniques in tissue culture
- To know about the various techniques employed in plant tissue culture

Unit I: Androecium of flowers: Anther and pollen grains-Structure and development of Microsporangium-Development of male gametophyte. Gynoecium of flowers: Structure and development of Megasporangium-female gametophyte, Structure and types of Ovule.

Unit II: Fertilization: types of fertilization (Porogamy, Chalazogamy and Mesogamy), Process and significance of double fertilization, Post fertilization changes, Endosperm: Types-Nuclear, Cellular and Helobial, Embryo: Structure and development - Monocot embryo-*Luzula*, Dicot embryo-*Capsella*-Polyembryony.

Unit III: History of plant cell and tissue culture, Nutrient media: Composition of commonly used culture media. The concept of totipotency of cells, Role of plant growth hormones in tissue culture, various types of cultures: callus, cell suspension, root, meristem, anther culture, pollen culture.

Unit IV: Micropropagation, Organogenesis - formation of shoots and roots, Somatic embryogenesis - Process of somatic embryogenesis, Synthetic seeds-applications.

Unit V: Haploid production – Androgenesis, Anther and pollen culture, Gynogenesis-ovule and ovary culture, plantlets from haploids, Protoplast culture and regeneration, transgenic plants and their uses, Applications of tissue culture in forestry, horticulture, agriculture and pharmaceutical industry.

Text books:

1. Rahavan, V. 1976. Experimental Embryogenesis in Vascular plants, Academic Press, London.
2. Maheswari, P. 1963 An Introduction to Embryology of Angiosperms, International Society of Plant Morphologies, University of Delhi.
3. Smith, R. H. 1992. Plant Tissue Culture: Techniques and Experiments, Academic Press, San Diego
4. Gupta, P. K. (2000). Elements of Biotechnology, Rastogi Publications, Meerut.
5. Dubey, R. C. 2001. A text book of biotechnology, S Chand & Co., New Delhi.
6. Ignacimuthu, S. J. 2003. Plant Biotechnology, Oxford & IBH Publishing, New Delhi.
7. John Jothi Prakash, E. 2005. Outlines of Plant Biotechnology, Emkay Publishers, New Delhi.
8. Kalyankumar De. 2008. Plant tissue culture, New Central Book Agency, Calcutta.

Reference books:

1. Bhojwani, S. S. and Razdan, M. K. 2004. Tissue Culture: Theory and Practice, Elsevier, New Delhi.
2. Purohit, S. S. 2010. Plant tissue culture, Student edition, S.S. Publication, Jodhpur.
3. Smith, R. 2012. Plant Tissue Culture, Techniques and Experiments, Third Edition, Academic Press, Sandiego.
4. [Bhojwani](#), S. S. and P.K. [Dantu](#). 2013. Plant Tissue Culture: An Introductory Text, Springer, India.

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Course: B.Sc., Botany	Code No	: MBL31
Semester: III	No. of Hrs allotted	: 2hrs / week
Paper: Core Lab for MB31	No. of Credits	: 2
	Marks	: 40+60=100

Title of the Paper: **Plant Embryology and Plant Tissue Culture Practical**

1. Preparation of Murashige and Skoog medium
2. Explant preparation
3. Callus induction in tobacco leaf disc, regeneration of shoots, root induction, role of hormones in morphogenesis
4. Cell suspension culture initiation from tobacco callus cultures
5. Isolation of protoplast from leaves
6. Demonstration of protoplast isolation from fungi
7. Demonstration of protoplast fusion by using PEG
8. Slides showing developmental stages of anther, embryo sac, endosperm and embryo
9. Study of different types of pollen grains
10. Dissection of endosperm haustoria – *Cucumis*
11. Dissection of embryo – *Tridax*

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Course: B.Sc., Botany	Code No	: EMB31 (H)
Semester: III	No. of Hrs allotted	: 3Hrs/Week
Paper: Major Elective II	No. of Credits	: 3
Title of the Paper: Herbs and Drugs	Marks: 25 +75 = 100	

Course Objectives:

- To realize the significance of medicinal plants.
- To understand the medicinal importance of plants.

Unit I: Classification of drugs based on morphology, pharmacological and chemical nature. – Herbs used in Siddha, Ayurveda, Unani and Homoeopathy - A general account on collection, harvesting, drying, garbling and packing. Methods to detect drug adulteration.

Unit II: Chemical nature of natural medicines: Brief study on general properties, Classification, uses and chemical test of the following: Alkaloids, Terpenoids, Glycosides, Lipids, Volatile oils and tannins.

Unit III: Various methods for the preparation of drugs - Preparation of commercial drugs – Juice, Paste, Extract, Infusion, Decoction, Mixture, Powder, Syrup, Fomentation and Medicated oil. Drugs from non – flowering plants: Sources and uses of the following:

1. Bryophyte – *sphagnum*
2. Fern – *Adiantum*
3. Gymnosperm – *Pinus*

Unit IV: Cultivation, phytochemical constituents and uses of following:

1. Root – *Withania somnifera*
2. Rhizome – *Zingiber officinale*
3. Leaves – *Adhatoda vasica*
4. Bark – *Alstonia scholaris*

Unit V: Cultivation, phytochemical constituents and uses of following:

1. Flower – *Syzigium aromaticum*
2. Fruits – *Piper nigrum*
3. Seeds – *Ricinus communis*
4. Whole plant – *Phyllanthus amarus*

Text Books:

1. Kumar, N.C. 1993. An introduction to medical Botany and pharmacognosy. Emkay publication, New Delhi,
2. Kokate, C.K, Purohit, A.P. Gokhale, C.B.2003. Pharmacognosy Nirali prakashan, Pune.
3. Pal, D.C. and Jain, S.K. 1998. Tribal medicine, Naya prokash, Calcutta.

Reference Books:

1. Wallis, T.E.1985. Text Book of Pharmacognosy. CBS publishers and Distributors, Delhi.
2. Mohammed Ali, 1998 Text Book of Pharmacognosy CBS publishers and Distributors, New Delhi.

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Course: B.Sc., Botany	Code No	: NME 1
Semester: III	No. of Hrs allotted	: 2 Hrs/Week
Paper: Non Major Elective I	No. of Credits	: 2
Title of the Paper: Horticulture	Marks	: 15+35=50

Course Objectives:

- To know the basic aspects of horticulture
- To learn the methods of propagation

Unit I: Importance of horticulture- Classification of horticultural crops-Garden implements- Preparation of potting medium- Transplanting- Pruning and Training- Irrigation methods- Manure: types and application –Methods of weeding.

Unit II: Propagation techniques: Separation or division- Cutting: Root –Stem-Leaf cutting- Layering: Ground and Air layering. Grafting: Detached scion grafting: Splice-Wedge-Cleft grafting- Approach grafting: Spliced approach – tongued approach- Repair grafting: Bridge – Inarching- Budding; 'T' – Patch- 'H' - Chip budding

Text Books:

- 1) Rao.K.M.1991. Text book of Horticulture, Mac Millan India Ltd. New Delhi.
- 2) Vishnu Swarup, 1999. Ornamental horticulture. Mac Millan India Ltd, New Delhi.
- 3) Chandha,K.L 2001. Hand book of Horticulture, New Delhi.
- 4) Kumar N., 1994. Introduction to Horticulture. Rajalakshmi Publications, Nagarcoil.
- 5) Randhawa G.S. and A. Mukhopadhyay. 1986. *Floriculture in India*. Allied Publishers Pvt. Ltd. Ahamedabad.
- 6) Sadhu M.K. 1996. Plant propagation. New age international publishers, New. Delhi.

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Course: B.Sc., Botany	Code No	: MB41
Semester: IV	No. of Hrs allotted	: 3hrs/ week
Paper: Core 6	No. of Credits	: 4
Title of the Paper: Genetics, Evolution and Biostatistics	Marks	: 25 +75 = 100

Course Objectives:

- To learn the various aspects of plant genetics
- To learn the basic concept and theories on Evolution
- To learn the basics of data collection and analysis by statistical methods

Unit I: Mendel's laws on heredity – Terminologies - Monohybrid cross – Law of dominance and law of segregation – Incomplete Dominance in *Mirabilis jalapa* – Reciprocal cross, Back cross and Test cross – Method and significance; Dihybrid cross – *Pisum sativum* plant – Law of independent Assortment; Modifications of Mendelian ratios - Duplicatory genes, Supplementary genes, Dominant Epistasis

Unit II: Linkage – Morgan's Principle – Types – Complete (*Drosophila*) and incomplete (*Zea mays*); Crossing over – Mechanism in *Drosophila* and maize – Coupling – Reciprocal crossing experiments in *Lathyrus odoratus* - Theories – Chiasma type – breakage first – differential contraction – Limiting factors of crossing over - significance; Polygenic inheritance – Kernel colour in wheat – Quantitative inheritance

Unit III: Sex determination – mechanism in *Melandrium album*; Sex-linked inheritance – Eye colour in *Drosophila*, Hemophilia; Extra chromosomal inheritance – Plastid inheritance in *Mirabilis jalapa* – Uniparental inheritance in *Chlamydomonas reinhardtii*; Chromosomal variations – Euploidy and aneuploidy; Chromosomal aberrations – Mechanism and significance of the following categories - Addition, deletion, inversion, subtraction, translocation

Unit IV: Evolution: Morphological, anatomical and physiological evidences for evolution. Lamarck's theory of inheritance of acquired characters; Darwin's theory of natural selection; Mutation theory of Hugo de Vries; Synthetic theory – Genetic drift.

Unit V: Biostatistics- Data – Definition – Data classification; Presentation of data – Table forms – chart types – scatter points, line, bar, histogram, pie; Descriptive statistics – Mean, Mode, Median, Standard Deviation (Direct Method only) – problems and solving method, Chi-square test – Application in Genetics and breeding experiments

Text Books:

1. Archunan. 2004. Genetics, Sarup & Sons, New Delhi.
2. Shukla, R.N. 2009. A Text Book of Genetics and Evolution, Daya Publishing House, New Delhi.
3. Arora, M.P and H. Arora. 2013. A Text Book of Organic Evolution, Daya Publishing House, New Delhi.
4. Sharma, A.K. 2005. Text Book of Biostatistics, Discovery Publishing House, New Delhi.

Reference Books:

1. Ringo, J. 2004. Fundamental Genetics, Cambridge University Press.
2. Barton, N. H. 2007. Evolution, Cold Spring Harbor Laboratory Press, New York
3. Ridley, M. 2009. Evolution, John Wiley Sons, USA.
4. Zar, J.H. 2010. Biostatistical Analysis, Prantice-Hall Inc.,

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Course: B.Sc., Botany	Code No	: MBL41
Semester: IV	No. of Hrs allotted	: 2hrs / week
Paper: Core Lab for MB41	No. of Credits	: 2
	Marks	: 40+60=100

Title of the Paper: **Genetics, Evolution and Biostatistics Practical**

I) Problems solving in the following topics:

- 1) Mendelian monohybrid ratio
- 2) Mendelian dihybrid ratio
- 3) Monohybrid reciprocal cross, back cross and test cross
- 4) Gene Interaction – i) Duplicatory gene, ii) Supplementary gene, iii) dominant epistasis, iv) recessive epistasis

II) Evolution and Biostatistics Experiments:

- 1) Natural Selection using beads
- 2) Genetic Drift, using beads
- 3) Chi-square test using beads to demonstrate population genetics
- 4) Descriptive statistics – Mean, mode and median calculation for leaf length of randomly selected *Polyalthia* leaves (or) *Albizia* pods

III) Models / spotters – Relevant to theory topics

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Course: B.Sc., Botany	Code No	: EMB 41(B)
Semester: IV	No. of Hrs allotted per week	: 3 hrs/Week
Paper: Major Elective III	No. of Credits	: 3
	Marks	: 25+75=100

Title of the Paper: **Basics of Computers applications**

Course Objectives:

- To learn about the Computer applications in various fields of Science and management.
- To understand the various parts of computers

Unit I: Introduction to Computers: Generations of Computer. Computer applications in various fields of Science and management. Information Concepts: Data and its representation.

Unit II: Information and its characteristics, Categories of information, Levels of information. Data storage and retrieval. Concept of file, record and field. Number System: Basic concepts, Binary, Octal, Decimal, and Hexadecimal numbering system, conversion from one system to another.

Unit III: Hardware: CPU, Primary and secondary storage, Input/Output devices. Computer Peripherals- VDU, Key board, Mouse, Printer, USB, Scanner.

Unit IV: Software: Introduction to Software: Definition, Types of Software, System software: Operating System, Functions of OS, Overview of DOS, Windows and Linux. Application software: Word Processor, MS-word, Excel and Powerpoint. Database concepts, Flat file versus Database.

Unit V: Computer Network Concepts: History and usage of Internet, Browser and its types, Domain Name System (DNS), WWW, Electronic Mail (e-mail), Search Engines and Intranets.

Text Books:

1. Suresh K, Pasandra. 1997. Computer today. Galcotia Publications, New Delhi.
2. Saxena, S. 2009. MS-Office for everyone, Vikas publishing House Pvt. Ltd., Noida, UP.
3. Sunkin, M.G. 1992. Introduction to computer information System for business. S.Chand & Co., New Delhi.

Reference books:

1. Mousumi-Debnath. 2005. Tools and Techniques of Biotechnology. Pointer publisher, Jaipur.
2. Taxali, R.K. 2000. PC software for Windows – Made simple, Tata McGraw-Hill publishing company Ltd., New Delhi.

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Course: B.Sc., Botany	Code No	: SBE2
Semester: IV	No of Hrs Allotted:	2Hrs/Week
Paper: Skill based elective II	No. of Credits	: 2
Title of the Paper: Mushroom Technology	Marks	: 15+35=50

Course Objectives:

- To acquire the basic knowledge and develop suitable skills involved in mushroom cultivation.
- To realize the nutritive and medicinal value of mushrooms.
- To study the common cultivation methods for mushrooms.

Unit I: Mushrooms-Introduction-Types of mushrooms: Edible, non-edible mushrooms and medicinal mushrooms. Morphology and internal structure of mushrooms. Favourable conditions for mushroom cultivation, different applications and importance of mushrooms. Mushroom food recipes.

Unit II: Mushroom- seed-spawn, spawn production-types and methods of spawning. Microbiological cultivation techniques for mushrooms-isolation and pure culturing methods-required media and maintenance of cultures. Commercial cultivation of mushrooms: *Agaricus* and *Pleurotus* – problems in cultivation-pests, diseases and microbes and its control measures. Post harvest technology and storage methods for mushrooms.

Text Books:

1. Nita Bahl. 1996, Hand Book On Mushrooms. Oxford and IBH Publishing Company Ltd., New Delhi.
2. Kapoor, J.N. 1989. Mushroom Cultivation, ICAR, New Delhi.

Reference Books:

1. Aneja, K.R.1993. Experiments in Microbiology, Plant pathology, Tissue culture and mushroom cultivation, Wishwa Prakashan, New Age International (P) Ltd., New Delhi.
2. Chang,S. and Miles, P.G. 2004. Mushrooms: Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact, CRC Press online.

http://ebookey.org/Mushrooms-Cultivation-Nutritional-Value-Medicinal-effect_1057637.html#bkllY6XAhkFEQLuS.99

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Course: B.Sc., Botany	Code No	: NME2
Semester: IV	No. of Hrs allotted	: 2Hrs/Week
Paper: Non Major Elective II	No. of Credits	: 2
Title of the Paper: Gardening	Marks	: 15+35=50

Course Objectives:

- To acquire knowledge about different components of home garden.
- To learn about Indoor garden, Bonsai and Kitchen garden.
- To imbibe knowledge about fresh flower arrangement, dry flower preparation techniques and arrangement and greeting card making.

Unit I: Ornamental garden and its components: Climbers & creepers- trees-shrubs- rock garden- water garden- Hedges & Edges- Lawn-Flower beds-Path- Indoor garden: Choice of plants and Maintenance

Unit II: Bottle garden-Hanging pots- Bonsai- Kitchen garden: Layout and choice of plants-Flower arrangement; Different designs and do's and don'ts – Dry flower preparation and arrangement- Preparation of Greeting cards.

Text Books:

- 1) Rao, K.M.1991. Text book of Horticulture. Mac Millan India Ltd. New Delhi.
- 2) Vishnu Swarup. 1999. Ornamental horticulture. Mac Millan India Ltd, New Delhi.
- 3) Chandha,K.L 2001. Hand book of Horticulture, ICAR, New Delhi.
- 4) Carrol, L., J.R. Shry and H.E. Reiley. 2012. Introductory Horticulture, Eighth Edition, <http://longfiles.com/dzmokym4pdli/Introductory.horticulture.8e.pdf.html>

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Course: B.Sc., Botany	Code	: MB51
Semester: V	No. of Hrs allotted	: 5hrs/week
Paper: Core 7	No. of Credits	: 4
	Marks	: 25 +75 = 100

Title of the Paper: **Morphology and Taxonomy of Angiosperms**

Course Objectives:

- To learn the systematic classification of angiosperms and to get acquainted with the local flora.
- To learn the principles of Systematics.

Unit I: Morphology – Modifications of tap root and fibrous root system – Modification of stem – aerial and underground stem – Modification of leaf; Inflorescence types – Racemose, Cymose, mixed and special types. Fruits – simple, aggregate and multiple fruits.

Unit II: Binomial Nomenclature, Herbarium technique – Classification – Bentham & Hooker – APG III (Outline only) - ICBN and its role, Botanical survey of India (BSI) - National herbarium– Regional Centers and their role.

Unit III: Study on the key features, vegetative and floral characters of the following families of Polypetalae and their economic importance

1. Annonaceae 2. Capparidaceae 3. Rutaceae 4. Ceasalpiniaceae 5. Cucurbitaceae

Unit IV: Study on the key features, vegetative and floral characters of the following families of Gamopetalae and their economic importance

6. Sapotaceae 7. Convolvulaceae 8. Asclepiadaceae 9. Acanthaceae 10. Lamiaceae

Unit V: Study on the key features, vegetative and floral characters of the following families of Monochlamydeae and Monocotyledons with their economic importance

11. Amaranthaceae 12. Euphorbiaceae 13. Orchidaceae 14. Amaryllidaceae 15. Poaceae.

Text Books:

1. Venkateswarlu, V. 1982. External morphology of Angiosperms, S.Chand and Co.Ltd., New Delhi.
2. Narayanswami, R.V., K.N. Rao and A.Raman. 1992. Outlines of Botany, S.Viswanathan Printers and Publishers, Chennai.
3. Singh, V. and K.Jain. 1991. Taxonomy of Angiosperms, Rastogi Publications, Meerut.
4. Vasishta, P.C.1992. Taxonomy of Angiosperms, R.Chand and Co. Ltd., New Delhi.
5. Lawrence, G.H.M. 1951. Taxonomy of Vascular plants. The Mac-Millan Co., New York.
6. Heywood, V.K. 1967. Plant Taxonomy Edward Arnold Pub. Ltd., London.

Reference Books:

1. Sharma, O.P. 2009. Plant Taxonomy, Tata McGraw-Hill publishers, New Delhi.
2. Pulliah, T. 2007. Taxonomy of Angiosperms, Third Edition, Regency Publication, New Delhi.
3. Tod, F. Stueesy, 2009. Plant Taxonomy; the systematic evaluation of comparative data. Columbia Uni. Press. NewYork.
4. Stace, C.A. 1980. Plant Taxonomy and Biosystematics, Edward Arnold Publishing Limited, London.

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Course: B.Sc. Botany	Code No	: MBL51
Semester: V	No. of Hrs allotted	: 3hrs/week
Paper: Core Lab for MB51	No. of Credits	: 2
	Marks	: 40 +60 = 100

Title of the Paper: **Morphology and Taxonomy of Angiosperms Practical**

Root, Stem and leaf modification of Angiosperms

Study on the morphological and floral characters of the following families using Gamble flora

Annonaceae	Sapotaceae	Amaranthaceae
Capparidaceae	Convolvulaceae	Euphorbiaceae
Rutaceae	Asclepiadaceae	Orchidaceae
Cesalpiniaceae	Acanthaceae	Amaryllidaceae
Cucurbitaceae	Lamiaceae	Poaceae

Field trip for Preparation of Herbarium (10 sheets)

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Course: B.Sc., Botany	Code No	: MB52
Semester: V	No. of Hrs allotted	: 5hrs/ week
Paper: Core 8	No. of Credits	: 4
	Marks	: 25 +75 = 100

Title of the Paper: **Plant Biochemistry and Biotechniques**

Course Objectives:

- To introduce to the students, the structure and properties of various biomolecules.
- To help the students learn the various biotechniques

Unit I: Biochemistry: definition and scope. Biomolecules and Biomacromolecules (Brief account). Carbohydrates – Classification – structure and properties of mono, di, tri saccharides. Starch and cellulose- structure and function. Lipids – Classification – Properties – saturated and unsaturated fatty acids. Pigments: structure of chlorophyll, carotenoids, phycobilins and anthocyanin.

Unit II: Amino acids – classification – properties – basic structure. Protein structure: primary, secondary, tertiary and quaternary structures – classification and properties, functions of protein. Secondary metabolites – alkaloids, terpenoids and flavonoids (a brief account).

Unit III: Enzymes - classification – physico-chemical properties – mechanism of enzyme action-factors affecting enzyme action – theories of enzyme action – enzyme activation and inhibition – co enzymes and isoenzymes. Enzyme regulation: Allosteric enzymes. Vitamins – classification – fat-soluble vitamins and water-soluble vitamins – deficiencies of vitamins – vitamins with coenzyme function.

Unit IV: Microscopy – principle –phase contrast, scanning electron microscope. pH meter – technique, operation and maintenance. Centrifugation – principle – sedimentation coefficient – Svedberg’s unit – technique and application.

Unit V : Chromatography – Principle, technique and applications of Paper chromatography and Thin layer chromatography. Colorimeter: Beer – Lambert’s law, principle, technique and applications of colorimetry. Electrophoresis – paper and gel electrophoresis.

Text Books:

1. Lea, P.J and Leegood, R.C. 2001. Plant Biochemistry and Molecular Biology, 2nd Ed. John Wiley and Sons Ltd., England.
2. Jain, J. L. 2000. Fundamentals of Biochemistry. S. Chand & Co. Ltd., New Delhi.
3. Satyanarayana, U. and U. Chakrapani, 2013. Biochemistry. Elsevier Co-published with Books and Allied Press, New Delhi

Reference Books:

1. Nelson, D. L. and M. M. Cox. 2008. Lehninger Principles of Biochemistry. W. H. Freeman Publishers, New York.
2. Berg, J. M., J. L. Tymoczko and L. Stryer, 2010. Biochemistry, W. H. Freeman Publishers, New York.

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Course: B.Sc., Botany	Code No	: MBL52
Semester: V	No. of Hrs allotted	: 3 hrs / week
Paper: Core Lab for MB52	No. of Credits	: 2
	Marks	: 40+60=100

Title of the Paper: **Plant Biochemistry and Biotechniques Practical**

1. Quantitative tests for amino acids
2. Quantitative tests for proteins.
3. Quantitative estimation of soluble sugars, soluble and insoluble starch.
4. Qualitative analysis of amino acids, protein and carbohydrates
5. Separation of amino acids and sugars by paper chromatography.
6. Enzyme activity – Amylase
7. Estimation of palmitic acid content
8. Saponification value of fat
9. Absorption spectrum of chlorophylls and anthocyanin.
10. Preparation of buffer solution
11. Measurement of pH
12. Histochemical analysis of secondary metabolites.

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Course: B.Sc., Botany	Code No	: MB53
Semester: V	No. of Hrs allotted	: 4 hrs/week
Paper: Core 9	No. of Credits	: 4
Title of the Paper: Ecology and Biodiversity	Marks	: 25 +75 = 100

Course Objectives:

- To understand the concept and varying features of ecosystem and biodiversity
- To know about organisms and their interaction with the environment
- To learn the principles and basic methods of conservation of biodiversity

Unit I: Ecology – Introduction, concept and scope. Ecosystem –types- aquatic, terrestrial Components and their interrelationships; Food chain, Food web; Energy flow in ecosystems, Ecological pyramid models; Biogeochemical cycles – Carbon cycle and nitrogen cycle

Unit II: Ecological succession – Definition and terminologies – Hydrosere and Xerosere; Autecology –Plant adaptations (External and internal morphology only) – Hydrophytes and Xerophytes, Synecology - Interrelationships among organisms – Mutualism and Parasitism

Unit III: Natural disasters (causal factors and impacts only) – Cyclones, landslides volcanic eruption – Pollution – Categories – Causal factors, effects and control measures – Air pollution, water pollution and noise pollution; Global Warming and Green House effect – Natural and man-made causes and impacts – preventive measures – Climate Change Summits - Rio Summit (1992) and Warsaw Summit (2013).

Unit IV: Biodiversity – Scope of the study – Components and Categories of biodiversity; Diversity Hotspots – Hotspots in India, Forest Types – Biodiversity values – Consumptive, productive, ethnobotanical values; – Methods of vegetation analysis – Quadrat method – frequency, density, abundance.

Unit V: Biodiversity conservation – Categories – *In-situ* and *ex-situ* methods: Reserve forests, National Park, Wildlife sanctuaries – *Ex-situ* methods: Botanical garden, seed bank, IUCN Red Data Book – Forest Protection Act and Biodiversity Protection Act (Key features only)

Text Books:

1. T.K. Saha. 2011. Text Book of Ecology & Environmental Biology, Books and Allied Publishers, Kolkatta.
2. Krishnamurthy, K.V. 2004. Text Book of Biodiversity, Oxford and IBH Publishing Company Pvt. Ltd., New Delhi.
3. Jeffries, M.J. and Jeffries, M.J. 2005. Biodiversity and Conservation, Routledge, Taylor & Francis Group, UK.

Reference Books:

1. Peter Stiling. 2002. Ecology: Theories and Applications, Prentice-Hall of India, New Delhi.
2. Daniels, R.J.B. and J.K. Krishnamoorthy. 2009. Environmental Studies, Wiley India, New Delhi.
3. Colin R., Townsend, M. Begon and J.L. Harper. 2006. Essentials of Ecology, Second Edition, Blackwell Publications, USA.
4. Dan L. Pelman and Glenn Adelson. 2007. Biodiversity: Exploring values and Priorities in Conservation. Blackwell Publishers, UK.
5. David William Pearce and Dominic Moran. 2013. The Economic value of Biodiversity, Routledge, Taylor & Francis Group, UK.

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Course: B.Sc., Botany	Code No	: MBL53
Semester: V	No. of Hrs allotted	: 2 hrs/week
Paper: Core Lab for MB53	No. of Credits	: 2
Title of the Paper: Ecology and Biodiversity	Marks	: 40 +60 = 100

1. Study of plant community by Quadrat method.
2. Calculation of important value index.
3. Determination of dissolved oxygen in the given water sample.
4. Determination of free CO₂ in the given water sample.
5. Determination of chlorides in the water sample.
6. Study of morphology and anatomy of hydrophytes: *Nymphaea* petiole.
7. Study of morphology and anatomy of xero

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Course: B.Sc. Botany	Code No	:
Semester: V	No. of Hrs allotted	:
Paper: Self Study	No. of Credits	: 5 (Extra)
Title of the Paper: Economic Botany	Marks	: 100

Course Objectives:

- To know the economically important groups of plants
- To acquire knowledge about the medicinal plants
- To learn the separation methods for certain commercially important plant products

Unit I: Introduction to Economic Botany – Classification of economically important plants: Food plants, Plants and plant products of commercial value, Medicinal plants, Food Adjuncts – Economic importance of lower plants: Food, medicinal, industrial and ornamental uses of Algae, Fungi, Lichens and Bryophytes.

Unit II: Morphology, useful parts and uses of the following

Food plants: *Oryza sativa* (Rice), *Triticum aestivum* (Wheat), *Vigna mungo* (Black gram), *Glycine max* (Soybean), *Prunis dulcis* (Almonds), *Cocos nucifera* (Coconut), *Manihot esculenta* (Tapioca), *Solanum tuberosum* (Potato), *Brassica oleracea* (Cabbage), *Solanum lycopersicum* (Tomato), *Mangifera indica* (Mango) and *Musa paradisiaca* (Banana)
Spices and Condiments: *Zingiber officinale* (Ginger) and *Cuminum cyminum* (Cumin)
Oil yielding plants: *Helianthus annus* (Sunflower), *Sesamum indicum* (Sesame), *Ricinus communis* (Castor), *Borassus flabellifer* (Palm), *Eucalyptus globulus* (Eucalyptus) and *Jasminum sambac* (Jasmine)

Unit III: Morphology, useful parts and uses of the following

Fibre and fibre yielding plants: *Gossypium hirsutum* (Cotton) and *Musa textilis* (Abaca Manila Hemp)
Wood and Cork: *Dalbergia latifolia* (Rose wood) and *Quercus suber* (Cork oak)
Morphology and useful parts of the following
Tannin and Dye yielding plants: *Albizia lebeck* (Vagai), and *Lawsonia inermis* (Maruthani)
Gums and Resins: *Acacia Senegal* (Sudday keeray) and *Pinus roxburghii* (Chir)

Unit IV: Morphology and uses of the following

Plantation crops: *Tectona grandis* (Teak) and *Coffea arabica* (Coffee)

Morphology, useful parts and uses of the following

Medicinal Plants: *Rauvolfia serpentina* (Serpentine), *Allium cepa* (Onion),
Cinnamomum zeylanicum (Cinnamon), *Ephedra sinica* (Ephedrine),
Ocimum tenuiflorum (Holy Basil), *Piper nigrum* (Pepper), *Curcuma longa*
(Turmeric) and *Azadirachta indica* (Neem).

Unit V: Commercial Plant Products: Extraction of Tannins and Dyes, Gums and Resins, Production of Agar and Alginate, Organic manures: Panchakavya - Biofertilizers: *Azolla* – Biopesticides: *Trichoderma* - Basket and Plate making from plant parts: *Borassus flabellifer* (Palmyrah palm) and *Areca catechu* (Areca nut palm)

Text Books:

1. Sambamurthy, A.V.S.S. and N.S. Subramanyam. 1989. A Text Book of Economic Botany, Wiley-Eastern Ltd, New Delhi.
2. Pandey, B.P. 2012. Economic Botany, S.Chand & Company Ltd, New Delhi.

Reerence Books:

1. Kochhar, S.L. 1995. Economic Botany in the Tropics, Macmillan India Ltd., Delhi.
2. Sharma, O.P. 1996. Hill's Economic Botany, Tata McGraw Hill Co. Ltd. New Delhi.
3. Peter B. Kaufman *et al.* 1999. Natural Products from Plants, Second Edition, Google e-book.
<http://trove.nla.gov.au/version/46518552>

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Class: B.Sc., Botany	Code No	: MB61
Semester: VI	No. of Hrs allotted	: 5Hrs/Week
Paper: Core 10	No. of Credits	: 4
Title of the paper: Plant Physiology	Marks	: 25+75 = 100

Course objectives:

- To help the students acquire the basic knowledge on the processes of plant functions.
- To make the students realize the importance of inter relationship between all plant physiological processes.

Unit I: Water relations in plants: water – properties – Its relation to plants, Water potential, osmotic potential, Imbibition, Diffusion and Osmosis – DPD. Absorption of water: Soil – Plant – Atmosphere – continuum (SPAC concept). Ascent of sap: Apoplast and symplast- Transpiration: stomatal physiology – types and mechanism of stomatal movement – Starch and sugar hypothesis – active K⁺ transport. Guttation

Unit II: Solute Translocation- Evidences and theories. Mineral nutrition: role of minerals in plants- major, minor and trace elements- mineral deficiency and symptoms- essentiality criteria of an element- deficiency symptoms of nutrients- active and passive absorption of minerals- Donnan's equilibrium.

Unit III: Photosynthesis: Chloroplast pigments- Photosystem I & II- quantum yield- Red drop effect and Emerson enhancement effect- Hill reaction- Z scheme of Photosynthesis- cyclic and non-cyclic photophosphorylation- Calvin & Benson (C3) cycle- C4 cycle and CAM pathway, factors affecting photosynthesis – photorespiration (in brief).

Unit IV: Respiration: aerobic respiration – Glycolysis – TCA cycle – Oxidative Phosphorylation. Factors affecting respiration- gluconeogenesis- fermentation. Nitrogen metabolism: source of nitrogen. Biological nitrogen fixation: asymbiotic and symbiotic, Nitrogen assimilation and recycling. Amino acid synthesis : reductive and transamination process.

Unit V: Growth regulation – auxins, gibberellins, cytokinins, abscissic acid and ethylene- bioassays and physiological role. Physiology of flowering: Photoperiodism- Phytochromes and Florigen concept - Vernalization. Seed dormancy and bud dormancy- methods of breaking dormancy- mechanism of seed germination. Chemical changes and hormonal regulation during fruit ripening, artificial fruit ripening.

Text Books:

1. Pandey, S. N and B. K. Sinha. 1989. Plant Physiology, Vikas Pub. House, New Delhi.
2. Noggle, G. R. and G. J. Fritz. Introductory Plant Physiology, Second Edition, Prentice-Hall of India Ltd., New Delhi.
3. Gupta, N. K. and S. Gupta. 2005. Plant Physiology, Oxford & IBH publishing Co. Ltd., New Delhi
4. Sundararajan, S. 2000. Plant Physiology, Anmol Publication Ltd., New Delhi
5. Mukherji. S. and Ghosh, A. K. 2005. Plant Physiology,. New Central Book Agency Ltd.,
a. New Delhi
6. Verma, S. K. A Text Book of Plant Physiology and Biochemistry, Fourth Edition, ISBN: 81-219-0627-X

Reference Books:

1. Salisbury, F. B. and Rose, C. W. 1992. Plant Physiology, Asia Ltd., Singapore.
2. Devlin, R. M. and Witham, F.H.1986. Plant Physiology, Fourth Edition, CBS Pub., Delhi.

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Course: B.Sc., Botany	Code No	: MBL61
Semester: VI	No. of Hrs allotted	: 3hrs / week
Paper: Core Lab for MB61	No. of Credits	: 2
	Marks	: 40+60=100

Title of the Paper: **Plant Physiology**

1. Demonstration of osmosis by potato osmoscope
2. Demonstration of water potential by gravimetric method
3. Demonstration of water potential by falling drop method
4. Effect of light intensity on photosynthesis
5. Effect of monochromatic light on photosynthesis
6. Effect of CO₂ concentration on photosynthesis
7. Determination of stomatal index
8. Determination of growth curve by leaf area method
9. Differentiation of C₃ and C₄ plants by starch test
10. Differential transpiration of leaf surfaces
11. Demonstration of fermentation using Kuhn's flask
12. Demonstration of Ganong's light screen experiment
13. Demonstration of growth measurement using Arc auxanometer
14. Demonstration of klinostat experiment
15. Demonstration of Thistle Funnel experiment
16. Demonstration of transpiration using Ganong's potometer
17. Demonstration of transpiration using Bell jar experiment
18. Anatomical Studies on root and stem nodules

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Course: B.Sc., Botany	Code No	: MB62
Semester: VI	No. of Hrs allotted:	5hrs/week
Paper: Core 11	No. of Credits	: 4
Title of the Paper: Biotechnology	Marks	: 25 + 75 = 100

Course Objectives:

- To learn the basic principles of the biotechnological innovations.
- To understand the techniques involved in gene transfer
- To know about the industrial applications of biotechnology

Unit I: Biotechnology-definition and application in various fields. Genetic engineering tools: restriction endo nuclease, DNA ligase, reverse transcriptase, alkaline phosphatase. Vectors-Plasmid vectors, lambda bacteriophage vectors, methods of transferring desired gene into vectors – transformation techniques. Screening for selection of clones – replica plating method, colony hybridization.

Unit II: Fermentation – solid state fermentation (SSF) – submerged state fermentation (SmSF) – Batch, Continuous, fed batch fermentation – design of batch fermentor. Alcoholic fermentation: industrial production of beer, wine and industrial alcohol.

Unit III: Biofuels: Methanogenesis and biogas production. Petrocrops. Biodegradable plastics. Biopesticides – *Bacillus thuringiensis*. Mass production of single cell protein: Yeast and *Spirulina*.

Unit IV: Plant genetic engineering using *Agrobacterium* for glyphosate resistance, golden rice, agar production, alginate production, Cultivation of sea weeds.

Unit V: Industrial production of organic acid (citric acid), amino acid (glutamic acid), vinegar, enzymes (protease), Immobilization of enzymes, antibiotics – penicillin, Monoclonal antibodies.

Text books:

1. Dubey R.C., 2002. A Text Book of Biotechnology, S. Chand and Co. New Delhi.
2. Kumar H.D., 2001. A Text Book on Biotechnology. 2nd Ed. East- West Press. New Delhi.
3. Subba Rao, N.S. 2001. Soil Microbiology, 4th Ed. Oxford and IBH Publishing Co. New Delhi.
4. Singh B.D., 1998. Biotechnology. Kalyani Pubs. New Delhi.
5. Patel A.H., 1996. Industrial Microbiology. Mac Millan India Ltd. Delhi.
6. Slater, A., N.W. Scott and M.R. Fowler. 2009. Plant Biotechnology: the genetic manipulation of plants, Oxford University Press, US.

Reference books:

1. Ignacimuthu, S.J., 1997. Plant Biotechnology, Oxford and IBH Publishing Company, New Delhi.
2. Kumaresan V. 1994. Biotechnology. Saras Publications, Nagercoil.

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DEPARTMENT OF BOTANY
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Course: B.Sc. Botany
Semester: VI
Paper: Core Lab for MB62

Code No : MBL62
No. of Hrs allotted : 3 hrs/Week
No. of Credits : 2
Marks: 40 +60 = 100

Title of the Paper: **Biotechnology Practical**

1. Isolation of genomic DNA from Onion
2. Demonstration of wine fermentation – estimation of ethanol
3. Yeast biomass estimation by turbidity method
4. Cell counting using haemocytometer
5. Immobilization of yeast cell
6. *Spirulina* culturing
7. Agar production using *Gracilaria*
8. Antibiotic disc diffusion using cultures of *Penicillium* and actinomycetes
9. Citric acid production using *Aspergillus niger*
10. Amylase production using fungi (Plate assay)
11. Replica plating method for identifying antibiotic resistant mutants

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Course: B.Sc. Botany	Code No	: MB63
Semester: VI	No. of Hrs allotted	: 4hrs/ week
Paper: Core 12	No. of Credits	: 4
	Marks	: 25 +75 = 100

Title of the Paper: **Horticulture and Plant Breeding**

Course Objectives:

- To understand the basic notion of Horticulture
- To learn the techniques of propagation, gardening and flower arrangement
- To know the concepts of plant breeding

Unit I: Importance of horticulture- Classification of horticultural crops -Garden implements- Transplanting- Pruning and Training- Irrigation methods- Manure: Types and application.

Unit II: Propagation techniques: Separation or division- Cutting: Root –Stem-Leaf cutting- Layering: Ground and Air layering-Grafting: Detached scion grafting-Approach grafting -Repair grafting - Budding

Unit III: Ornamental garden and its components: Climbers & creepers- trees-shrubs- rock garden- water garden- Hedges & Edges- Lawn-Flower beds-Path- Indoor garden: Choice of plants and Maintenance-Bottle garden-Hanging pots- Bonsai- Kitchen garden: Layout and choice of plants

Unit IV: Flower arrangement: methods and different designs –colour scheme, Ikebana- – Dry flower preparation: techniques & arrangement-Greeting card making-Processing of horticulture crop products: Jam-Jelly-Squash-Tomato ketchup –Citrus Pickle.

Unit V: Plant breeding: Plant introduction- procedure of plant introduction, Selection- mass, pureline, clonal- Hybridization- procedure- intergeneric, interspecific and intervarietal hybridization.with examples- heterosis in plant breeding.

Text Books:

1. Rao,K.M.1991. Text book of Horticulture, Mac Millan India Ltd., New Delhi.
2. Vishnu Swarup, 1999. Ornamental horticulture. Mac Millan India Ltd., New Delhi.
3. Chandha,K.L 2001. Hand book of Horticulture, New Delhi.
4. Kumar, N. 1994. Introduction to Horticulture. Rajalakshmi Publications, Nagarcoil.
5. Randhawa, G.S. and A. Mukhopadhyay. 1986. Floriculture in India. Allied Publishers Pvt. Ltd., Ahamedabad.
6. Sadhu, M.K. 1996. Plant propagation. New age international publishers, New. Delhi.
7. Sing.B.D.2009. Plant breeding principles and methods. Kalyani Publishers, New Delhi.6th revised ed.
8. Sinha,V and Sunita sinha., 1990. Cytogenetics, Plant breeding and Evolution,Vikas Publishing Home Pvt.Ltd.
9. Sundararaj, D., D, G.Thulasidas and M.Stephan Dorairaj. 1997. Introduction to cytogenetics and plant breeding, Popular Book Depot., Chennai.

Reference Books:

1. Adariana, ,F.R.W. and Brison. 1979. Propagation of Horticultural plants, Tata Mc Graw-Hill Publishing Company Ltd., New Delhi.
2. Acquaah, G.1999. Horticulture, Principles & Practices, Prentice Hall, New Jersey.
3. Prasad and Kumar,U. 2005. Commercial Floriculture, Agrobios (India). Jodhpur.
4. Pohelman J.M. and Borthakur.D.1969. Breeding Asian field crops, Oxford & IBH publishing Co. New Delhi.

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Course: B.Sc. Botany	Code No	: MBL63
Semester: VI	No. of Hrs allotted	: 2hrs/ week
Paper: Core lab for MB63	No. of Credits	: 2
	Marks	: 40 +60 = 100

Title of the Paper: **Horticulture and Plant Breeding**

1. Preparation of pot (Potting).
2. Cutting: Leaf, root and stem cutting.
3. Layering: Simple and Serpentine Layering.
4. Air Layering.
5. Grafting: Splice and Tongue grafting.
6. Grafting: Spliced approach and Tongued approach grafting.
7. Budding: ‘T’ budding and ‘⊥’ budding.
8. Budding : I budding and Patch budding.
9. Budding: Flap budding and Ring budding.
10. Layout of the kitchen garden and Home garden.
11. Layout of rock garden.
12. Demonstration and preparation of Jam and Jelly.
13. Demonstration and preparation of Tomato Ketchup and Pickles.

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Course: B.Sc. Botany	Code No	: SBE3
Semester: VI	No. of Hrs allotted	: 2hrs/ week
Paper: Skill Based Elective III	No. of Credits	: 2
Title of the Paper: Organic Farming and Biofertilizers	Marks	: 15+35 = 50

Course Objectives:

- To familiarize the students with the basic principles and techniques of Organic farming.
- To know the agronomic importance of Biofertilizers.

Unit I: Organic farming: Scope and Applications – types of organic fertilizers - Farm yard manure - Compost – Green manure and mulching - production and application methods of organic manures.

Unit II: Biofertilizer: Scope and Applications – types of biofertilizers – Algal biofertilizers - *Azolla* and its mass cultivation, Bacterial biofertilizers - *Rhizobium* and its mass multiplication, Phosphate solubilizing bacterial biofertilizers - *Pseudomonas* and its mass multiplication, Fungal biofertilizers – Mycorrhiza.

Text Books:

1. Dubey, R.C.2002. A Text book of biotechnology, S. Chand and Co., New Delhi.
2. Subba Rao. N.S. 1988. Biofertilizers in Agriculture, second Edition, Oxford & IBH Publishing Company Pvt. Ltd., New Delhi.
3. Nirmala, C.B., G. Rajalakshmi and C. Karthick. 2009. Plant Biotechnology. MJP publishers, Chennai.

Reference Books:

1. Subba Rao, N.S 1982. Advances in Agricultural Microbiology, Oxford & IBH Publishing Company pvt. Ltd., New Delhi.
2. Venkatraman, G.S. 1972. Algal Biofertilizer and Rice Cultivation, Today and Tomorrow printers and Publishers, New Delhi.
3. Tilak, K.V.B.R. 1991. Bacterial biofertilizer, Indian council for Agricultural Research, New Delhi.
4. Soman, L.L. 2007. A Handbook of biofertilizers. Agrotech Publishing Academy, Udaipur.

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DEPARTMENT OF BOTANY

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Allied Botany (for B. Sc., Industrial Microbiology – Semester III and IV)

Course: B.Sc. IMB	Code No	: AB31 (B)
Semester: III	No. of Hrs allotted	: 4hrs/ week
Paper: Ancillary	No. of Credits	: 4
Title of the Paper: Basics of Biotechnology	Marks	: 25 +75 = 100

Course Objectives:

- To enlighten the students on the basic principles of the biotechnological innovations.
- To familiarize the students with the basic principles and techniques in tissue culture.
- To know about the various microbes used as Biofertilizers.

Unit I: Introduction – Definition – Biotechnology as interdisciplinary field of science – scope, potentials and limitations. Genetic Engineering: tools and techniques for insertion of foreign DNA into vectors - transfer of recombinant DNA into host cells (transformation techniques) – selection of clones – cloning with reference to insulin gene.

Unit II: Plant tissue culture: Explant culture – callus formation, organogenesis and transgenic plants – Cloning of glyphosate gene. Protoplast culture: Protoplast fusion and somatic hybridization. Somatic embryogenesis, artificial seeds. Applications of plant tissue culture.

Unit III: Biological nitrogen fixation: Mechanism of nitrogen fixation in symbiotic legumes – bacterial system and nitrogenase complex – hydrogenase. Biofertilizers: Mass cultivation of *Rhizobia*, *Cyanobacteria* and *Mycorrhizae*.

Unit IV: Enzyme technology: Methods of enzyme production, purification of enzymes, fluid filtration and immobilization of enzymes. Biomass as energy source – energy plantations, petrocrops. Biofuels: Methanogenesis and biogas production, hydrogen production. Production of alcohol from molasses.

Unit V: Production of single cell protein: Yeast and *Spirulina*. Waste treatment and utilization: Mushroom production on agrowastes, Vermicomposting, Treatment and recycling of sewage and industrial effluents – primary, secondary and tertiary treatment. Biopesticides. Biodegradable plastics.

Text books:

1. Kumar, H.D. 2001. A textbook on Biotechnology, East – West Press, New Delhi.
2. Dubey, R.C. 2002. A textbook of Biotechnology, S.Chand and Company, New Delhi.
3. Ignacimuthu, S.J. 1997. Plant Biotechnology, Oxford and IBH Publishing Company, New Delhi.
4. Slater, A. Scott, N. and Fowler, M.2004. Plant Biotechnology, Oxford University Press, New York.

Reference books:

1. Subba Rao, N.S. 2001. Soil Microbiology, Oxford and IBH Publishing Company, New Delhi.
2. Yeoman, J.R.M.M. 1982. Cell and Tissue culture, Narosa Publishing House, New Delhi.
3. Nirmala, C.B. G. Rajalakshmi, Chandra Karthick. 2009. Plant Biotechnology, MJP publishers, Chennai.
4. Chawala, H.S. 2008. Introduction to Plant Biotechnology, Oxford & IBH publishing Company, Pvt. Ltd., New Delhi.

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Course: B.Sc. IMB

Semester: III & IV

Paper: Core Lab for AB31 (B)

Code No : ABL31

No. of Hrs allotted: 2hrs per week

No. of Credits :

Marks :

Title of the Paper: **Basics of Biotechnology**

1. Callus induction from carrot root explants.
2. Isolation of *Rhizobium* from root nodules.
3. Production of ethanol by Yeast- Estimation of alcohol.
4. Immobilization of microbes using calcium alginate beads.
5. Biodegradation of wastes using microbes.
6. Effect of treated effluent on seed germination.
7. Mushroom production from agro wastes.
8. Vermicomposting.
9. Effect of biofertilizer on plant growth.
10. Estimation of yeast biomass in broth culture by turbidity method.

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Course: B.Sc. IMB	Code No	: AB41 (B)
Semester: IV	No. of Hrs allotted	: 4hrs/ week
Paper: Ancillary Botany	No. of Credits	: 4
Title of the Paper: Economic Botany	Marks	: 25 +75 = 100

Course Objectives:

- To know the economically important groups of plants
- To study the morphology and useful parts commonly used plants
- To acquire knowledge about the medicinal plants
- To learn the separation methods for certain commercially important plant products

Unit I: Introduction to Economic Botany – Classification of economically important plants: Food plants, Plants and plant products of commercial value, Medicinal plants, Food Adjuncts – Economic importance of lower plants: Food, medicinal, industrial and ornamental uses of Algae, Fungi, Lichens and Bryophytes.

Unit II: Morphology, useful parts and uses of the following

Food plants: *Oryza sativa* (Rice), *Triticum aestivum* (Wheat), *Vigna mungo* (Black gram), *Glycine max* (Soybean), *Prunus dulcis* (Almonds), *Cocos nucifera* (Coconut), *Manihot esculenta* (Tapioca), *Solanum tuberosum* (Potato), *Brassica oleracea* (Cabbage), *Solanum lycopersicum* (Tomato), *Mangifera indica* (Mango) and *Musa paradisiaca* (Banana)

Beverages: *Coffea arabica* (Coffee) and *Camellia sinensis* (Tea)

Spices and Condiments: *Zingiber officinale* (Ginger) and *Cuminum cyminum* (Cumin)

Oil yielding plants: *Helianthus annuus* (Sunflower), *Sesamum indicum* (Sesame), *Ricinus communis* (Castor), *Borassus flabellifer* (Palm), *Eucalyptus globulus* (Eucalyptus) and *Jasminum sambac* (Jasmine)

Unit III: Morphology, process and uses of the following

Fibre and fibre yielding plants: *Gossypium hirsutum* (Cotton) and *Corchorus capsularis* (Jute), *Musa textilis* (Abaca Manila Hemp).

Wood and Cork: *Dalbergia latifolia* (Rose wood), *Tectona grandis* (Teak) and *Quercus suber* (Cork oak).

Morphology and useful parts of the following

Tannin and Dye yielding plants: *Albizia lebbek* (Vagai), *Cassia alata* (Seemai Agathi), *Acacia leucocephala* (Sarai) and *Lawsonia inermis* (Maruthani)

Gums and Resins: *Acacia senegal* (Sudday keeray), *Moringa oleifera* (Murungai), *Shorea robusta* (Sal) and *Pinus roxburghii* (Chir).

Unit IV: Morphology and uses of the following

Plantation crops: *Tectona grandis* (Teak) and *Hevea brasiliensis* (Rubber)

Morphology, useful parts and uses of the following

Medicinal Plants: *Rauwolfia serpentina* (Serpentine), *Allium cepa* (Onion), *Cinnamomum zeylanicum* (Cinnamon), *Ephedra sinica* (Ephedrine), *Ocimum tenuiflorum* (Holy Basil), *Piper nigrum* (Pepper), *Curcuma longa* (Turmeric) and *Azadirachta indica* (Neem).

Unit V: Commercial Plant Products: Extraction of Tannins and Dyes, Gums and Resins, Production of Agar and Alginate, Organic manures: Panchakavya - Biofertilizers: *Azolla* – Biopesticides: *Trichoderma* - Basket and Plate making from plant parts: *Borassus flabellifer* (Palmyrah palm) and *Areca catechu* (Areca nut palm)

Text Books:

1. Sambamurthy, A.V.S.S. and N.S. Subramanyam, 1989. A Text Book of Economic Botany, Wiley-Eastern Ltd, New Delhi.
2. Pandey, B.P. 2012. Economic Botany, S.Chand & Company Ltd, New Delhi.

Reference Books:

1. Kochhar, S.L. 1995. Economic Botany in the Tropics, Macmillan India Ltd., Delhi.
2. Sharma, O.P. 1996. Hill's Economic Botany, Tata McGraw Hill Co. Ltd., New Delhi.
3. Peter B. Kaufman *et al.*, 1999. Natural Products from Plants, Second Edition, Google e-book.
<http://trove.nla.gov.au/version/46518552>

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Course: B.Sc. IMB

Semester: III & IV

Paper: Core Lab for &AB 41(B)

Code No : ABL41

No. of Hrs allotted: 2hrs/week

No. of Credits :

Marks :

Title of the Paper: **Economic Botany**

1. Extraction of agar
2. Extraction of alginate
3. Qualitative analysis of bioactive compounds: Tannins, Alkaloids, Flavonoids
4. Separation of dyes
5. Morphology and economic important parts of the food and vegetable crops included in the theory.
6. Morphology and medicinal uses of herbs included in the theory.
7. Morphology of mushroom
8. Morphological study of economically important microscopic algae and fungi
9. Survey of important timber yielding trees of the region.
10. Demonstration of organic manure production.

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DEPARTMENT OF BOTANY
MASTER OF SCIENCE IN BOTANY
COURSE STRUCTURE (with effect from 2014-16 batch onwards)
SEMESTER –I

Course	Code No.	Subject	Contact Hrs/ Week	Credits	Total No. of Hrs Allotted	Max. Marks. CA	Max. Marks. SE	Total
Core -1	1PB1	Tahlllophytes, Bryophytes, Pteridophytes and Gymnosperms	7	5	105	25	75	100
Core -2	1PB2	Plant Cell and Molecular Biology	6	5	90	25	75	100
Elective -1	1PBE(D)	Developmental Botany	5	5	75	25	75	100
Lab	1PBL1	Practical - I	6	4	90	40	60	100
Lab	1PBL2	Practical - II	6	4	90	40	60	100
	Total		30	23	450	155	345	500

II Semester

Course	Code No.	Subject	Contact Hrs/ Week	Credits	Total No. of Hrs Allotted	Max. Marks. CA	Max. Marks. SE	Total
Core -3	2PB1	Biological chemistry and Biotechniques	7	5	105	25	75	100
Core -4	2PB2	Microbiology and plant pathology	6	5	90	25	75	100
Elective 2	2PBE(B)	Computer application in Biology and Biostatistics	5	5	75	25	75	100
Lab	2PBL1	Practical - I	6	4	90	40	60	100
Lab	2PBL2	Practical - II	6	4	90	40	60	100
	Total		30	23	450	155	345	500

III Semester

Course	Code No.	Subject	Contact Hrs/ Week	Credits	Total No. of Hrs Allotted	Max. Marks. CA	Max. Marks. SE	Total
Core -5	3PB1	Angiosperm taxonomy	7	5	105	25	75	100
Core -6	3PB2	Plant Physiology	6	5	90	25	75	100
Elective - 3	3PBE	Interdisciplinary paper : Applied Zoology	5	5	75	25	75	100
Lab	3PBL1	Practical – I	6	4	90	40	60	100
Lab	3PBL2	Practical – II	6	4	90	40	60	100
Total			30	23	450	155	345	500

IV Semester

Course	Code No.	Subject	Contact Hrs/ Week	Credits	Total No. of Hrs Allotted	Max. Marks. CA	Max. Marks. SE	Total
Core -7	4PB1	Biotechnology	6	5	90	25	75	100
Core -8	4PB2	Environmental biology and Evolution	6	5	90	25	75	100
Lab	4PBL1	Practical – I	6	4	90	40	60	100
Lab	4PBL2	Practical – II	6	4	90	40	60	100
PJ	PJ	Project	6	3	90	40	40+20	100
Total			30	21	450	170	330	500

Interdisciplinary paper : Applied Zoology offered by Dept. of Zoology

Theory: Internal: 25 Marks [Assignment 5 marks; Seminar 15 marks; Test 30 marks (duration 2 hrs). Total marks of 50 reduced to 25]. **External:** 75 marks (duration 3 hrs).

Practical: Internal: 40 marks (Record 15 marks; Test / continuous assessment :25 marks). **External:** 60 marks (duration 3 hrs).

Project: Internal 40 + External 40 + External Viva (closed/open) 20 = 100.

Interdisciplinary paper: offered by the Department of Botany to M. Sc., Zoology students
Semester III: *Plant Tissue Culture

A) Consolidation of Contact Hours and Credits: PG Botany

Semester	Contact Hrs/ Week	Credits
I	30	23
II	30	23
III	30	23
IV	30	21
Total	120	90

B) Curriculum Credits

Core --- 75Credits
Elective ---15 Credits

Total 90 Credits

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Course: M.Sc., Botany	Code No	: 1PB1
Semester: I	No. of Hrs allotted/semester	: 7 Hrs/Week
Paper: Core	No. of Credits	: 5
	Marks	: 25 +75 = 100

Title of the Paper: **Thallophytes, Bryophytes, Pteridophytes and Gymnosperms**

Course Objectives:

- To make the student understand the diversity, structural organization and reproduction of lower plants- Algae, Fungi, Lichens and Bryophytes.
- To make the students understand the diversity, structural organization and reproduction of Pteridophytes and Gymnosperms.

Unit I: Classification of algae by Chapman (1968) – General Characters of the following divisions: Cyanophyta, Chlorophyta, Phaeophyta and Rhodophyta – Various habitats of algae - Freshwater, Marine and Soil - Range of thallus construction in Chlorophyceae - Life cycle patterns in Phaeophyceae – Economic importance of Algae.

Unit II: Classification of fungi by Alexopoulos and Mims (1962) - General characters of the following classes : Myxomycetes, phycomycetes, Oomycetes, Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes. Economic importance of fungi. Lichens: nature and composition –classification – vegetative and sexual reproduction. Economic importance of Lichens.

Unit III: Classification of bryophytes by Watson (1968). Characteristic features of Hepaticopsida, Anthocertopsida and Bryopsida. Range of gametophytes and sporophytes in Bryophytes. Economic importance of Bryophytes.

Unit IV: Classification of Pteridophytes by Reimer (1954). General features of Psilopsida, Lycopsida, Sphenopsida and Pteropsida. Stelar evolution – Apospory and Apogamy- Heterospory and seed habit. Economic importance of Pteridophytes.

Unit V: Classification of Gymnosperms by Sporne (1965). Salient features of Pteridospermales, Cordaitales, Pentaxylales, Ginkgoales, Coniferales, Gnetales and Ephedrales. Organization of male and female cones in Coniferales, Gnetales and Ephedrales. Economic importance of Gymnosperms.

Text Books:

1. Kumar H.D. 1988. Introductory Phycology. East West Press, New Delhi.
2. Vashista B.R & A.K Sinha 2005. Botany for degree students – Algae, S. Chand & Co., New Delhi.
3. Alexopoulos, C.J., Mims, C.W. & Blackwell, M. (1996) - Introductory mycology, John Wiley & Sons Inc., Toronto.
4. Gupta, J.S. 1986. Textbook of fungi. Oxford and IBH publishing company Pvt. Ltd., New Delhi.
5. Vashista B.R & A.K Sinha 2005. Botany for degree students – Bryophyta, S. Chand & Co., New Delhi.
6. Chandrakant Pathak 2003. First Edition. Bryophyta, Dominant Publishers and Distributors, New Delhi.
7. Rashid, A. 1998. An introduction to bryophytes. Vikas Publishing House Pvt. Ltd., New Delhi.
8. Ahamadjian, V. 1973. The Lichens. Academic Press. New Delhi.
9. Vashista B.R., Sinha A.K., Kumar A. 2008. Botany for degree students - Pteridophyta, S. Chand & Co., New Delhi.
10. Sharma, O.P. 1990. Textbook of Pteridophyta. MacMillan India Ltd., New Delhi.
11. Vashista. P.C., A.K. Sinha and Anil Kumar. 2007. Botany for Degree students - Gymnosperms. S. Chand & Co., New Delhi.

Reference Books:

1. Fritsch, F.E. 1935. Structure and reproduction of the algae. Vol. I & II; Cambridge University Press, New York.
2. Sundaralingam, V. 1991. Marine algae. Bishen Singh and Mahendra Pal Singh Publishers, Dehradun.

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Course: M.Sc., Botany	Code No	: 1PB2
Semester: I	No. of Hrs allotted	: 6Hrs/Week
Paper: Core	No. of Credits	: 5
Title of the Paper: Plant Cell and Molecular Biology	Marks	: 25 +75 = 100

Unit I: Microscopy – light, phase contrast microscopy, TEM, SEM. Cell: Ultra structure of plant cell. Cell wall: Primary structure – secondary structure. Plasma membrane: Fluid Mosaic model-properties. Cytosol: cytoskeleton organisation. Cell organelles: – mitochondria – plastids – endoplasmic reticulum – Golgi complex, peroxisomes, ribosome.

Unit II: Nucleus: structure and function. Chromosome: Euchromatin and heterochromatin - polytene, lampbrush chromosome. Cell cycle. Cell division: Mitosis, Meiosis - Chiasma – Synoptemal complex. Nuclear DNA: Conformation-A, B, Z DNA. RNA conformation: t RNA, micro RNA, chloroplast and mitochondrial DNA. Cell signaling: Signal molecules, receptors, ligands, signaling pathways in plants.

Unit III: Genome: Replication of prokaryotic and eukaryotic DNA – enzymes involved – amplification and rearrangement – Bacterial genetic recombination: conjugation, transformation, transduction. DNA damage – endogenous damage – oxidation –alkylation - methylation – exogenous damage - effects of UV radiation on DNA. DNA repair – base excision repair – mismatch repair – SOS response.

Unit IV: Regulation of gene expression in Prokaryotes – induction and repression – lac operon: negative control – gene architecture – promoter, regulator, structural genes and mechanism of action. positive control – CAP-cAMP method – trp repressible operon - attenuation and antitermination– ara operon.

Unit V: Regulation of gene expression in Eukaryotes – mechanism of regulation – enhancers and silencers - activation of transcription by steroid hormones- methylation - post transcriptional modification: capping, polyadenylation, pre-mRNA splicing- regulation of mRNA stability - Introns and Exons. Post translational modifications.

Text Books:

1. Becker, W.M., L.J. Kleinsmith and J. Hardin, 2011. The world of the cell. Dorling Kindersley (India) Pvt. Ltd., New Delhi.
2. Verma, P S., 2006. Cell Biology Genetics Molecular Biology Evolution And Ecology. [S.Chand](#) and Co., New Delhi.
3. Singh, B. D., 2004. Genetics, Kalyani Publishers, New Delhi.
4. Sheeler, P. and D.E. Binachi. 2004. Cell and Molecular Biology, John Wile & Sons, New York.

Reference books:

1. Geoffrey M. Cooper, Robert, E. Hansman. 2007. The cell – A Molecular Approach, Sinauer Associates. USA
2. Miglani, G.S. 2002. Advanced Genetics, Narosa Publishing House, New Delhi.

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Course: M.Sc., Botany	Code No	: 1PBE (D)
Semester: I	No. of Hrs allotted/semester	: 5Hrs/Week
Paper: Elective paper I	No. of Credits	: 5
Title of the Paper: Developmental Botany	Marks	: 25 +75 = 100

Course Objectives:

- To understand the basic concepts of development in plants
- To acquire knowledge about morphogenesis and organogenesis in plants
- To study the structure of plant reproductive parts and the reproductive process

Unit I: Basic concepts of Embryo development: Potency, commitment, specification, induction, competence, determination and differentiation – morphogenetic gradients: polarity and symmetry – integration and organization of cells into tissues, tissues into organs, organs into whole plant – cytoplasmic determinants- programmed cell death – aging and senescence – plant tumors.

Unit II: Morphogenesis and Organogenesis in plants: Organization of root and shoot apical meristem – shoot and root development – leaf development and phyllotaxy – Transition from vegetative to reproductive phase: Morpho, histo and cytochemical changes in vegetative plant body - floral meristems – floral development in *Arabidopsis* and *Antirrhinum*.

Unit III: Male and Female reproductive structure in flowers: Structure of androecium and gynoecium - Anther: Structure and development of anther, origin, structure and function of anther wall and tapetum, ultra structure and germination of pollen - Ovule: structure and development of ovule, female gametophyte: ontogeny, nutrition and morphology of embryo sac - pollen-pistil interaction.

Unit IV: Fertilization and Embryo: Fertilization: ultrastructural studies on fertilization – sexual incompatibility – Endosperm: types, haustorial organization – Xenia and Meta xenia – Ruminant endosperm. Embryo: proembryo – development of dicot embryo (*Capsella burapastoris*) – development of monocot embryo (*Luzula*) – Agamospermy and Polyembryony.

Unit V: Fruit and Seed: Fruit: Biochemical, physical factors in fruit development – structure of pericarp – Parthenocarpy: stimulative and vegetative parthenocarpy – Apomixis: Non-recurrent apomixis, recurrent apomixis, vegetative apomixis and adventive embryony – seed structure and its development.

Text Books:

1. Maheswari, P. 1985. An Introduction to the Embryology of the Angiosperm, Tata McGraw-Hill Publishing Company, New Delhi.
2. Burgess, J. 1985. An Introduction to Experimental and Applied Embryology of Angiosperms, Oxford and IBH Publishing Company, New Delhi.
3. Bhojwani, S.S. and Bhatnagar, S.P. 1992. The Embryology of Angiosperms, Vikas Publishing Housing Pvt. Ltd., New Delhi.

Reference Books:

1. Wardlaw, C.W. 1955. Embryogenesis in plants, Methuen and Company Ltd, London.
2. Swamy, B.G.L. and Krishnamurthy, K.V. 1980. From Flower to Fruit, McGraw-Hill Publishing Company, New Delhi.
3. Wareing, P.F. Philips, I.D.J. 1981. Growth and Differentiation in plants, Pergamon Press, Kidlington.
4. Wolpert, L. 2002. Principles of Development, Second Edition, Oxford University Press, New Delhi.

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Course: M.Sc., Botany	Code No	: 1PBL1
Semester: I	No. of Hrs allotted	: 6Hrs/Week
Paper: Lab for 1PB1	No. of Credits	: 4
	Marks: 40 + 60 = 100	

Title of the Paper: **Thallophytes, Bryophytes, Pteridophytes and Gymnosperms**

1. Limnological study of the aquatic microalgae of temple tank, pond and lake.
2. Culture media preparation – Study of succession of algae in lentic waters.
3. Study of the terrestrial algae from red soil, clay soil, sandy soil, wet walls and bark of the trees.
4. Study of the structure of *Oscillatoria*, *Spirulina*, *Nostoc*, *Anabaena*, *Microcystis* and *Scytonema*.
5. Study of the structure of *Tolypothrix*, *Westiellopsis*, *Cylindrospermum*, *Chlorella* and *Diatoms*.
6. Study of the external and internal structure of macroscopic seaweeds – *Ulva*, *Caulerpa*, *Halimeda* and *Padina*.
7. Study of the external and internal structure of macroscopic seaweeds- *Dictyota*, *Sargassum*, *Polysiphonia* and *Gracilaria*.
8. Isolation and identification of fungi from bread, pickle, soil, seed and dung.
9. Identification and micropreparation of *Rhizopus*, *Mucor*, *Pilobolus*, *Aspergillus*, *Penicillium* and *Trichoderma*.
10. Identification and micropreparation of *Fusarium*, *Curvularia*, *Alternaria*, *Agaricus*, *Polyporus* and *Peziza*.
11. Isolation and identification of ecto and endomycorrhiza from soil.
12. Isolation and identification of AM spore from soil.
13. Study of the structure of Crustose, Foliose and Fruticose lichen thallus.
14. Study of the external and internal structure of *Marchantia*, *Porella* and *Pellia*.
15. Study of sporophyte and gametophyte structures of *Funaria*.
16. Study of the pteridophyte stele types using permanent slides.
17. Study of the external and internal structure of *Equisetum* stem.
18. Study of the structure of *Equisetum* cone.
19. Study of the external and internal structure of *Lygodium* rachis.
20. Study of the structure of *Lygodium* sorus.
21. Study of the external and internal structure of *Pteridium* rachis.
22. Study of structure of *Pteridium* sorus.
23. Study of the external and internal structure of *Ceratopteris* sorus.
24. Study of the external and internal structure of *Marsilea* rhizome, petiole and sporocarp
25. Study of Fossil slides of Psilophytales and Lepidodendrales
26. Study of fossil slides of Sphenophyllales and Coenopteridales
27. Study of internal structure of *Araucaria* stem.
28. Study of internal structure of *Cupressus* stem.
29. Study of internal structure of *Podocarpus* stem.
30. Study of fossil slides of *Lyginopteris*, *Lagenostoma* and *Medullosa*.

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Course: M.Sc., Botany	Code No	: 1PBL2
Semester: I	No. of Hrs allotted	: 6Hrs/Week
Paper: Lab for 1PB2	No. of Credits	: 4
	Marks: 40 +60 = 100	

Title of the Paper: **Plant Cell and Molecular Biology**

1. Isolation of genomic DNA from Onion/Cauliflower
2. Isolation of genomic DNA from bacteria
3. Quantitative estimation of DNA by CTAB method
4. Agarose gel electrophoresis of chromosomal and plasmid DNA from *Escherichia coli*
5. Demonstration of PCR
6. Quantative estimation of RNA
7. Electrophoretic separation of proteins
8. Mitosis cell division in onion root tips
9. Meiotic cell division in *Tradescantia* anthers
10. Isolation of antibiotic resistant bacterial mutants by gradient plate techniques
11. Isolation of UV- B resistant mutants bacterial mutants by gradient plate techniques.
12. Demonstration of bacterial conjugation by uninterrupted mating
13. T₇ plaque assay
14. Phage mediated generalized transduction.
15. Lac gene expression study through lactose utilization test

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Course: M.Sc., Botany	Code No	: 2PB1
Semester: II	No. of Hrs allotted:	7Hrs/Week
Paper: Core	No. of Credits	: 5
	Marks	: 25 + 75 = 100

Title of the Paper: **Biological chemistry and Biotechniques**

Course Objectives:

- To understand the structure & function of the Biomolecules.
- To understand the basic principles of Biotechniques.
- To apply Biotechniques to biological systems.

Unit I: Amino acids: Protein and non-protein amino acids – reductive amination and transamination –glutamate pathway: structure and biosynthesis of glutamic acid, serine, cysteine – shikimic acid pathway: structure and biosynthesis of phenylalanine, tyrosine and tryptophan – aminoacid breakdown – oxidative deamination, Urea cycle; Protein: Biosynthesis of protein - formation of peptide bonds and polypeptide chain - – molecular configuration and conformation of proteins – Primary, secondary, tertiary and quaternary structures – properties and types of proteins –simple, complex and derived proteins.

Unit II: Enzymes: classification, kinetics, mechanism of enzyme action – Michaelis-Menten constant- Lineweaver-Burk plot-Factors affecting enzyme action-enzyme inhibition – enzyme regulation – allosteric enzymes – isoenzymes – coenzymes – ribozymes. Vitamins: general characters, classification, vitamins with coenzyme function: NAD, NADP, FMN, FAD. Pigments:Structure and function of photosynthetic and non-photosynthetic pigments - Chlorophylls,carotenoids, phycobilins anthocyanins and betacyanins– secondary metabolites – Alkaloids:biosynthesis, structure and function of quinine, atropine, colchicine. Structure and function of Triterpenoids.

Unit III: Plant Lipids: Classification of Lipids. Structure of triglycerids – Fatty acids, Phospholipids, Structure and function of Ergosterol and Cholesterol. Structure and function of Glyoxysomes, Glyoxalate cycle - β -Oxidation of fatty acids. Carbohydrates: Classification of Carbohydrates. Monosaccharides - Glycosidic bond. Physico-chemical properties of Mono, di and trisaccharides. Structure of Starch and Cellulose. Chemistry of Peptidoglycan.

Unit IV: Principles, technique and applications of the following biotechniques:

1. Centrifugation - Ultracentrifuges: preparative and analytical- types of rotors
2. pH metry
3. Spectrophotometry: UV-Visible – IR Spectrophotometry
4. Chromatograpy: Gas-liquid chromatography (GLC) and High performance (pressure) liquid chromatography (HPLC).

- Unit V:** 1. Electrophoresis: Agarose, PAGE and immunotechniques (ELISA)
2. Blotting: Southern blot and Western blot
3. Flow Cytometry
4. Radiolabelling techniques: GM counter, Scintillation counter and Autoradiography.

Text books:

1. Nelson, D.L. and M.M. Cox. 2000. Lehninger – Principles of Biochemistry. Worth Publishers, New York.
2. Weil, J. H. 1997. General Biochemistry. New Age International Ltd., New Delhi.
3. Voet, D and J.H. Voet. 1995. Biochemistry. John Wiley and Sons, New York.
- 4 Campbell, M. K., and O. F Shawn. 2007. Biochemistry. Sixth Edition, Thompson. Brooks/Cole, USA
- 5 Gurumani, M. 2006. Research Methodology, MJP Publishers, Chennai.

Reference Books:

1. Berg, J.M., J.L. Tymoczko, and L., Stryer, 2001. Biochemistry. Freeman and Company, New York.
2. Lea, P.J. and R.C. Leegood, 2001. Plant Biochemistry and Molecular Biology, John Wiley and Sons, New York.
3. Garrett, R. G. and. C. M. Grisham, 2010. Biochemistry. Mary Fimch Publishers, Boston.
4. Wilson, K. and Walker, J. 2000. Practical Biochemistry- Principles and Techniques. Cambridge University Press, Cambridge, U.K..

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Course: M.Sc., Botany	Code No	: 2PB2
Semester: II	No. of Hrs allotted	: 6Hrs/Week
Paper: Core	No. of Credits	: 5
Title of the Paper: Microbiology and Plant Pathology	Marks	: 25 +75 = 100

Course objectives:

- To understand the classification, nutrition and growth of microbes.
- To understand the development of disease, host – pathogen interaction and the reasons for an epidemic disease.
- To imbibe the knowledge of different control methods of plant diseases and etiology of some plant diseases.

Unit I: General account of microbes, Brief history of microbiology, Whitaker’s five kingdom concept-Prokaryotic and eukaryotic microbes-Bacteria: Ultra structure of bacteria-Classification (Bergey’s manual of systematic Bacteriology) - General account of Archaeobacteria, Eubacteria and cyanobacteria. Viruses:general structure-classification-transmission-multiplication (bacteriophage)-Viroids and Prions- Phytoplasma (including mycoplasma).

Unit II: Sterilization techniques and different types of staining methods-Microbial nutrition: nutritional groups-cytoplasmic membrane architecture in Bacteria-transport of nutrients across membrane. Culture media-types. Microbial growth-growth curve measurement of microbial growth by cell numbers and cell mass. Continuous growth: Chemostat, Turbidostat. Environmental factors affecting growth in natural environments.

Unit III: Soil microbiology: Microbial interactions-Mutualism, Commensalism, Parasitism and symbiosis. Microbial associations: Neutral, negative. Microbial fermentations - food contamination and its preservation. Aquatic microbiology-Microbes in fresh water and marine environment-Water borne pathogens and its infection-Water analysis-Waste water treatment, Biomining – biofilms - superbugs.

Unit IV: General principles and concepts in plant pathology-classification of plant diseases based on symptoms, detection and diagnosis of plant diseases. Infection process: Entry of pathogen-establishment of pathogen (enzymes and toxins). Defence mechanism: Structural and biochemical. Epidemiology: Forms of epidemics, conditions governing epidemics, reasons for progressive severity of epidemics and decline of epidemics-concept of post harvest diseases.

Unit V: Control methods: Cultural practices, Quarantine, Chemical control (Pesticide, fungicide and antibiotics), Biological control of pest and pathogens-transgenic plants diseases: symptoms causative organism, disease cycle and control of following diseases. A) Red rust of tea b) Fungi: Blast disease of Paddy, wheat rust. C) Bacteria: Cotton blight, Citrus canker, d) Virus: Bendi Yellow vein clearing virus, cucumber mosaic virus e) Phytoplasma: Brinjal little leaf, *Sesamum* phyllody.

Text Books:

1. Prescott, L.M. and D.A.Harkey. 1996. Microbiology. Ww. C. Brown Publishers, London.
2. Pommerville, J.C.2006. Alcoma’s Fundamantals of Microbiology. Jones and Bertlett Publishers, London.
3. Atlas, R.M.1995. Principles of Microbiology. Morby Publishers, St. Louis.
4. Pelczer,M.,E.C.S.Chan nad N.R.Krieg.1993.Microbiology-concepts and Applications. Tata Mc-Graw Hill Ltd., Inc., NewYork.
5. Stanier, R.Y., J.L.Ingrahm, M.L. Wheelis and P.R. Painter.1990. The Microbial World, Prentice Hall of India Pvt. Ltd. New Delhi.

6. Mehrotra, R.S.1980. Plant Pathology. Tata McGraw-Hill Publishing Company Ltd., New Delhi.
7. Pandey, B.R.1997. Plant Pathology. S. Chand and company, New Delhi.
8. Agrios,G.N. 2006. Plant Pathology, Fifth Edition, Academic Press, New York.
9. Bhatia, A.L. 2005. Handbook of Microbiology, Pointer Publishers, Jaipur.

Reference Books:

1. Alexopolus, C.J. and Mims, C.W.1979. Introductory Mycology. III Edition. Wiley Eastern Ltd. New Delhi.
2. Rengasamy, G. 1979. Disease of crop plants in India. III edi., Prentice Hall of India, Pvt Ltd .New Delhi.
3. Prescott, L.M., Harley , J.P. nad Klein, P.A. 1993. Microbiology. W.M.C. Brown publishers, IOWA, USA.
4. Patel, A.H. 1985. Industrial Microbiology, Macmillan India Ltd. New Delhi.
5. Purohit, S.S.1995. Microbiology-Fundamantals and applications, V Ed. Agrobotanical Publishers, Bikaner.

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Course: M.Sc., Botany
Semester: III
Paper: Elective Paper II

Code No : 2PBE (B)
No. of Hrs allotted : 5 Hrs/Week
No. of Credits : 5
Marks: 25 +75 = 100

Title of the Paper: **Computer Applications in Biology and Biostatistics**

Course Objectives:

- To get acquainted with computer software applications skill in biology
- To learn bioinformatics principle
- To understand the statistical principles and to apply the statistical procedures
- To develop knowledge in biological sampling and data representation, using statistical methods

Unit I: Introduction to computer – Computer Operating Systems - Windows and Linux – Search engines: Google and Yahoo - Internet and its application - Basics of Bioinformatics – Database concepts: Biological Sequence Databases: Primary, Composite, Secondary or Pattern databases (General Account). Information retrieval systems: PubMed, NCBI.

Unit II: – Nucleotide Sequence databases: DDBJ, Protein sequence databases: SWISS PROT – Pairwise sequence alignment – FASTA and BLAST, Multiple sequence alignment. Secondary and composite databases- SCOP. Protein structure databases: PDB. Homology Modelling, Phylogeny Tree Analysis – Treeview and Phylip.

Unit III: Biostatistics – Scope and application. Data collection and Sampling Methods – Merits and demerits, Data presentation methods. Measures of central tendency: Mean median and mode, - Concept, formula with problems and solving methods; Measures of dispersion: Mean deviation, Standard deviation, Co-variance, Coefficient of variations – Concept, formula with problems and solving methods – Computer Application programmes for statistics – EXCEL and SPSS package

Unit IV: Correlation – concept and applications – Karl Pearson coefficient of correlation – Formula with problems and solving method. Regression: linear regression – concept and application – Formula with problems and solving method. Hypothesis testing - null and alternative hypothesis – Errors – Type I and Type II; Test of Significance: Student’s ‘t’ Test, F test and chi-square test (derivations not required) – Formula, problems with solving methods – Application in Biological Sciences

Unit V: Probability theory – Basic concept - Probability distributions: Binomial, Poisson and Normal – Problems with solving procedure - Applications, ANOVA – Principle – One-way, Two-way and MANOVA methods – Comparison of means: LSD and DMRT - Problems with solving methods – Applications in Biological research.

Text Books:

1. Chiranjib Chakraborty. 2010. Bioinformatics: Approaches & Applications, Daya Publishing, New Delhi.
2. Arora, P.N. and Malhan, P.K. 2011. Biostatistics, Himalaya Publishing House, New Delhi,
3. Bryan Bergeron. 2006. Bioinformatics Computing, Prantice-Hall of India Pvt. Ltd., New Delhi
4. Chiranjib Chakraborty. 2010. Bioinformatics: Approaches & Applications, Daya Publishing, New Delhi.
5. Khan, I.D. and Khanum, A. 2004. Fundamentals of Biostatistics, Ukasz Publications, Hyderabad, India, 2004

Reference Books:

1. Hooman Rashidi and Lukas K. Buehler. 2005. Bioinformatics Basics: Applications in Biological Science and Medicine, Second Edition, CRC Press, Taylor & Francis.
2. Mount, D.W. 2006. Bioinformatics: Sequence and Genome Analysis, University of Arizona, Tucson.
3. Stephen A. Krawetz and David D. Womble. 2003. Introduction to Bioinformatics: A Theoretical and Practical Approach, Humana Press.
4. Khan, I.D. and Khanum, A. 2004. Fundamentals of Biostatistics, Ukasz Publications, Hyderabad, India
5. Zar, J.K. 2011. Bio statistical Analysis, Fourth Edition, Prantice-Hall International, New Jersey, USA.

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Course: M.Sc., Botany	Code No	: 2PBL1
Semester: II	No. of Hrs allotted	: 6Hrs/Week
Paper: Lab for paper 2PB1	No. of Credits	: 4
	Marks	: 40 +60 = 100

Title of the Paper: **Biological chemistry and Biotechniques**

1. Preparation of titration curve and pKa value determination.
2. Determination of isoionic pH of amino acid.
3. Determination of isoelectric pH of protein.
4. Estimation of protein content in legume.
5. Estimation of free amino acids content in plant source.
6. Estimation of soluble sugars content in plant source.
7. Estimation of Vitamin C (Ascorbic acid) in fruits- titrimetric method.
8. Estimation of anthocyanins.
9. Determination of palmitic acid content.
10. Estimation of cholesterol content
11. Determination of saponification value of fat
12. Paper chromatographic identification of amino acids.
13. Paper chromatographic identification of plant pigments.
14. Thin Layer chromatographic identification of sugars.
15. Effect of temperature on nitrate reductase/ amylase activity.
16. Effect of substrate concentration on nitrate reductase/ amylase activity.
17. Effect of pH on nitrate reductase / amylase activity
18. Effect of inhibitor concentration on nitrate reductase / amylase activity

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DEPARTMENT OF BOTANY
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Course: M.Sc., Botany	Code No	: 2PBL2
Semester: II	No of Hrs Allotted	: 6Hrs/Week
Paper: Lab for 2PB2	No of Credits	: 4
	Marks	: 40+60=100

Title of the Paper: **Microbiology and Plant Pathology**

1. Preparation of media.
2. Isolation and maintenance of pure culture.
3. Acid fast staining
4. Gram staining.
5. Negative staining.
6. Endospore staining.
7. Staining of poly- β hydroxyl butyrate granules.
8. Motility of bacteria-Hanging drop method.
9. Determining bacterial growth-turbidometric and haemocytometer method.
10. Bacterial analysis of water-coliform test- presumptive, confirmative and completed test.
11. Microbial production of extra cellular enzymes-Amylase and catalase.
12. Dye reduction test for milk.
13. Isolation of microbes from food samples, soil and air.
14. Isolation of bacteriophages from sewage.
15. Isolation of *Rhizobium* and *Frankia* from the nodules.
16. Isolation of rhizobacteria from rhizosphere samples.
17. Isolation of plant pathogens from infected plant materials.
18. Isolation of AM spores by wet sieving-decanting method.
19. Study of diseased materials- Rust by *Puccinia*.
20. Red rust and White rust.
21. Leaf spot of ground nut.
22. Canker and Red rot.
23. Collection of plant pathology specimens-10 sheets to be valued externally.

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Course: M.Sc., Botany	Code No	: 3PB1
Semester: III	No. of Hrs allotted	: 7Hrs/Week
Paper: Core	No. of Credits	: 5
	Marks: 25 +75 = 100	

Title of the Paper: **Angiosperm Taxonomy**

Course Objectives:

- To understand the taxonomic principles and to understand the different systems of plant classification
- To learn the method of using flora and keys for the correct identification of plants
- To develop skill in plant identification using specific morphology and floral characters

Unit I: Angiosperm classification: Basic principle, outline, merits and demerits for the following Systems: Bentham and Hooker, Charles E. Bessey, Engler and Prantl and Hutchinson. Angiosperm Phylogeny group (APG III, 2009): Features, merits and demerits

Unit II: ICBN – Nomenclature Principles – Nyms concept: Synonym, Homonym, Tautonym – Principle of priority – Effective and valid publication – Author citation – Retention and rejection of names; Typification concept and application; Chemotaxonomy and numerical taxonomy – DNA bar coding – Taxonomy data bases

Unit III: Key family characters, floral characters, floral variations, affinities with other families and economic importance of the following families, grouped under Polypetalae of dicotyledons: Magnoliaceae, Nymphaeaceae, Brassicaceae, Sterculiaceae, Sapindaceae, Zygophyllaceae, Rhamnaceae, Combretaceae, Aizoaceae, Passifloraceae

Unit IV: Key family characters, floral characters, floral variations, affinities with other families and economic importance of the following families, grouped under Gamopetalae of dicotyledons: Rubiaceae, Asteraceae, Apocynaceae, Gentianaceae, Boraginaceae, Bignoniaceae, Scrophulariaceae, Verbenaceae

Unit V: Key family characters, floral characters, floral variations, affinities with other families and economic importance of the following families, grouped under Monochlamydeae of Dicots and Monocotyledonous families: Nyctaginaceae, Piperaceae, Loranthaceae, Causarinnaceae, Liliaceae, Commelinaceae, Araceae, Cyperaceae

Text Books:

1. Vasishta, P.C.1992. Taxonomy of Angiosperms, R.Chand and Co., New Delhi.
2. Lawrence, G.H.M. 1951. Taxonomy of vascular plants. The Macmillan Co., New York.
3. Heywood, V.K. 1967. Plant Taxonomy Edward Arnold Pub.. Ltd. London.
4. Rendle, A.B. 1925. The classification of flowering plants. Vol II Dicotyledons. Cambridge University Press. London.

Reference Books/Research Articles:

1. Simpson, M.G. 2006. Plant Systematics, Academic Press, UK.
2. Pulliah, T. 2007. Taxonomy of Angiosperms, Third Edition, Regency Publication, New Delhi
3. Johri, R.M. 2005. Taxonomy, Vol. I to V, Sonali Publication, New Delhi.
4. Battacharyya, B. 2005. Systematic Botany, Narosa Publishing House, New Delhi
5. Angiosperm Phylogeny Group, 2009. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III , *Botanical Journal of the Linnean Society*, **161** (2): 105–121, doi:10.1111/j.1095-8339.2009.00996

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Course: M.Sc., Botany	Code No	: 3PB2
Semester: III	No. of Hrs allotted	: 6Hrs/Week
Paper: Core	No. of Credits	: 5
Title of the Paper: Plant Physiology	Marks: 25 +75 = 100	

Course Objectives:

- To understand the physiological processes in plants.
- To understand the concept of metabolic activities in plants.
- To understand the functional aspects of various processes in plants.
- To understand the interaction and functioning of various organelles.

Unit I: Water movement in plants: Mechanism of absorption of water – apoplast and symplast concept – Ascent of sap – SPAC concept. Transpiration: Stomatal physiology and mechanism – Transpiration and guttation. Absorption of mineral salts – mechanism. Mechanism of organic solute transport : pressure flow mechanism, phloem loading and unloading.

Unit II: Photosynthesis: Pigment systems in Photosystem I and Photosystem II – light reaction – Z – scheme of photosynthetic electron transport chain and photophosphorylation – Carbon assimilation C3, C4 and CAM pathways – Photorespiration and its significance. Respiration: Glycolysis and TCA cycle – Oxidative Phosphorylation – alternative respiration (Cyanide) – Nitrogen, Phosphorus and sulphur metabolism.

Unit III: Plant hormones: Structure, Physiological role and mode of action (in brief) of Auxins, Gibberellins, Cytokinins, Ethylene, Abscisic acid and Brassinosteroids – Growth retardants – polyamines, and morphactins. Phytochromes : Photochemical and biochemical properties, photomorphogenetic effects, mode of action. Flowering : Photoperiodism and its significance, - Short day, long day and day neutral plants – regulation of flowering – Vernalization .

Unit IV: Dormancy: Seed, bud, and tuber dormancy. Seed germination – hormonal regulation of germination and dormancy. Senescence : Physiology of senescence, delay of senescence – Fruiting – mechanism of fruiting –role of ethylene- hormonal control of fruiting and storage of fruits

Unit V: Stress Physiology : Classification of stress – response of plants to salt, drought, freezing, heat, oxidative and UV stresses – mechanism of stress resistance. Biological rhythms : Endogenous clock mechanism – Circadian rhythm.

Text books:

1. Kumar, A. and S.S.Purohit. 2005. Plant physiology, Agrobios (India), Jodhpur.
2. Mukherji S. and A.K. Ghosh. 2005. Plant Physiology, First Central Edition. New Central Book Agency (P) Ltd., Kolkata.
3. Noggle, G.R. and G.J. Fritz. 1986. Introductory Plant Physiology. Prentice – Hall India Pvt. Ltd., New Delhi.
4. Taiz. L. and E. Zeiger. 2003. Plant Physiology, Third Edition, Panima Publishing Corporation, New Delhi.
5. Salisbury, F.B. and C.N. Ross. 2003. Plant physiology, CBS Publishers and Distributors, New Delhi.

Reference Books:

1. Bidwell, R.G.S., 1979. Plant Physiology, Second Edition, McMillan Publishers, New York.
2. Goodwin, F.W. and F.I. Mercer. 1983. Introduction to Plant Biochemistry, Second Edition, Pergamon Press, New York.
3. Wilkins, M.B. 1984. Advanced Plant Physiology, Pitman Publication Limited, London.
4. Hopkins, W.G. 1995. Introduction to Plant Physiology. John Wilery & Sons Inc., USA.
5. Zeiger, L.T.E. 2010. Plant physiology, Sinauer Associates, UK.
6. Nobel, P.S. 2009. Physicochemical and Environmental Plant Physiology, Fourth Edition. Academic press, U.K.

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DEPARTMENT OF BOTANY
(From 2014-16 batch onwards)

Course: M.Sc., Botany	Code No	: 3PBE (I)
Semester: III	No. of Hrs allotted	: 5 Hrs/Week
Paper: Interdisciplinary paper	No. of Credits	: 5
	Marks	: 25 +75 = 100

Title of the Paper: **Plant Tissue Culture (offered to M.SC., Zoology Students)**

Course Objectives:

- To familiarize the students with the basic principles and techniques in tissue culture
- To know about the various techniques employed in plant tissue culture

Unit I: History of plant cell and tissue culture, Culture media, The concept of totipotency of cells, various types of cultures: callus, cell suspension, root, meristem, *In vitro* culture: physical, genetic, chemical and genotypic factors, *In vitro* differentiation: Organogenesis and somatic embryogenesis, Assessment of growth and development *in vitro*, Problems in plant tissue culture (Recalcitrance, Contamination, Phenolic browning, and Seasonal variation).

Unit II: Molecular basis of plant organ differentiation: Micropropagation-plant multiplication, hardening, transplantation, genetic fidelity, scales up and cost reduction, bioreactor, artificial seeds, Applications of tissue culture, *In vitro* pollination and fertilization, Embryo rescue.

Unit III: Androgenesis, Anther and pollen culture, Gynogenesis, ovule and ovary culture, dihaploids and their applications in genetics and plant breeding, Protoplast isolation and purification, Protoplast viability test, Protoplast culture and regeneration, Somatic hybridization - methods and applications, Cybrids, Somaclonal and gametoclonal variations, *In vitro* selection.

Unit IV: Large scale production of alkaloids and other secondary metabolites through cell culture techniques, high yielding cell lines, factors affecting production, Biotransformation, Hairy root culture and production of secondary metabolites, Immobilization of plant cells.

Unit V: Plant Genetic resources, Germplasm conservation and cryopreservation, Cryoprotectants, Gene bank, Transgenic plants, Selectable marker genes and their uses.

Text books:

1. Smith, R. H. 1992. Plant Tissue Culture: Techniques and Experiments, Academic Press, San Diego.
2. Gupta, P. K . 2000. Elements of Biotechnology, Rastogi Publications, Meerut.
3. Dubey, R .C. 2001. A text book of biotechnology, S Chand & Co., New Delhi.
4. Ignacimuthu, S. J. 2003. Plant Biotechnology, Oxford & IBH Publishing, New Delhi.
5. John Jothi Prakash, E. 2005. Outlines of Plant Biotechnology, Emkay Publishers, New Delhi.
6. Kalyankumar De, 2008. Plant tissue culture, New Central Book Agency, Calcutta.

Reference books:

1. Bhojwani, S. S. and M. K. Razdan. 2004. Tissue Culture: Theory and Practice, Elsevier, New Delhi.
2. Purohit, S. S. 2010. Plant tissue culture, Student edition, S.S. Publication, Jodhpur.
3. Smith, R. 2012. Plant Tissue Culture, Techniques and Experiments, Third Edition, Academic Press, San Diego.
4. Bhojwani, S. S. and P.K. Dantu. 2013. Plant Tissue Culture: An Introductory Text, Springer, India.

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Course: M.Sc., Botany	Code No	: 3PBL1
Semester: III	No. of Hrs allotted	: 6Hrs/Week
Paper: Lab for paper 3PB1	No. of Credits	: 4
	Marks	: 40 +60 = 100

Title of the Paper: Angiosperm Taxonomy

1) Identification of the family for the given fresh plant specimen by describing the key morphological and floral characters with diagrams and constructing the floral formula

Plants belong to Polypetalae of Dicots: Magnoliaceae, Nymphaeaceae, Brassicaceae, Sterculiaceae, Sapindaceae, Zygophyllaceae, Rhamnaceae, Combretaceae, Aizoaceae, Passifloraceae

Plants belong to Gamopetalae of Dicots: Rubiaceae, Asteraceae, Apocynaceae, Gentianeae, Boraginaceae, Bignonaceae, Verbanaceae

Plants belong to Monochlamydeae of Dicots, and Moncots: Nyctaginaceae, Piperaceae, Loranthaceae, Causarinaceae, Liliaceae, Commeliniaceae, Araceae, Cyperaceae

2) Preparation of Yoked and Indent keys for the given plants to group them into genus level taxon

3) Identification of the given fresh plants using Gamble's flora - 'Presidency of Madras' (3 Vol.)

4) Identification of the family for a given fresh plant specimen, using Punch Cards

5) Solve the taxonomic problem, based on 'Nym' concept

6) Identify the binomial for the given two fresh plant specimens/herbarium specimens

7) Submission of i) Records, ii) Field observation note and iii) minimum of 20 Herbarium sheets stacked with the dried plant specimen with appropriate identification label for external evaluation.

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Course: M.Sc., Botany	Code No	: 3PBL2
Semester: III	No. of Hrs allotted	: 6Hrs/Week
Paper: Lab for 3PB2	No. of Credits	: 4
Title of the Paper: Plant Physiology	Marks: 40 +60 = 100	

1. Water potential by gravimetric method.
2. Water potential by falling drop method.
3. Osmotic potential by plasmolytic method.
4. Quantitative estimation of total chlorophyll content in leaves.
5. Quantitative estimation of carotenoid content in flowers
6. Absorption spectrum of chlorophylls and Action spectrum of Photosynthesis
7. Absorption spectrum of β – carotene.
8. Effect of temperature on membrane permeability
9. Effect on detergent on membrane permeability
10. Estimation of proline content in normal and senescent leaves
11. Determination of nitrogen content in roots and root nodules
12. Measurement of Stomatal Index
13. Measurement of Stomatal area
14. Mesophyll cell isolation and chlorophyll fluorescence
15. UV-B effect on nitrate reductase activity (Stress activity)
16. Differentiation of C_3 and C_4 plants by starch test.

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Course: M.Sc., Botany	Code No	: 4PB1
Semester: IV	No. of Hrs allotted	: 6Hrs/Week
Paper: Core	No. of Credits	: 5
Title of the Paper: Biotechnology	Marks	: 25 +75 = 100

Course Objectives:

- To study the techniques involved in plant genetic engineering
- To understand the principle of genetic engineering and tissue culture
- To apply the knowledge of biotechnology in exploitation of plants for human welfare

Unit I: Genetic Engineering : Scope, applications and limitations. Tools: Type-I, II and III Restriction Endonucleases, Modification Methylases – Alkaline phosphatases – Ligases – Reverse transcriptases. Vector: Plasmid and Bacteriophage vectors. Techniques: Types of restriction – Ligation– Techniques of transformation of microbes. Methods of identifying clones: Insertional inactivation– Blotting techniques – Southern, Western blotting, Colony hybridization. Gene banks and genomic libraries.

Unit II: Plant Biotechnology: Plant Tissue culture – Totipotency and plasticity – Media preparation (MS medium) – Explants and their preparation. Culture types – Callus culture – suspension culture – Meristem culture. Micropropagation- Anther and Embryo culture – Organogenesis – Hardening. Somatic hybridization: Somatic embryogenesis and protoplast fusion. Germplasm conservation: Seed bank, Pollen bank. *Agrobacterium* mediated plant genetic engineering for Glyphosate resistance.

Unit III: Agricultural Biotechnology: Applications of Biotechnology in crop improvement: Antisense RNA Technology, Terminator seed Technology – Role of MNCs in Agribusiness. Transgenic plants for diseases resistance, stress tolerance and strain improvement – Bt Cotton, Golden rice. Molecular farming: Plantibodies, Edible Vaccines, Bioplastics. Biofertilizers: Mass cultivations and application of nitrogenous and phosphatic biofertilizers. Biopesticides.

Unit IV: Industrial Biotechnology : Fermentor- Structure, Design and Types - Microbial fermentation process: Production of industrial alcohol, wine, beer. Production of Amino acids: Glutamic acid- Production of organic acids: Citric acid, itaconic acid. Industrial enzymes: Methods of production of amylases and proteases. Production of Antibiotics: Penicillin, Streptomycin. Industrial production of bacterial biomass- *Lactobacillus* for Probiotic approach, *Spirulina* for Single cell protein.

Unit V: Environmental Biotechnology : Biodegradation and Bioconservation. Biomass and Bioenergy: Petrocrops (*Euphorbia*, *Hevea* rubber, Algal hydrocarbons) - Gasification, pyrolysis. Biofuels: Photobiological hydrogen production. Industrial Alcohol production. Biogas: Models of biogas plants. Mechanisms and techniques of biogas production. Sewage and effluent treatment: Activated sludge treatment

Text books:

1. Kumar H.D. 2001. A textbook on Biotechnology. East-west Press, New Delhi.
2. Dubey, R.C.2002. A textbook of Biotechnology. S. Chand and Company, New Delhi.
3. Ignacimuthu, S.J. 1997. Plant Biotechnology. Oxford and IBH Publishing Company, New Delhi.
4. Nirmala,C.B., G. Rajalakshmi, Chandra Karthick. 2009. Plant Biotechnology. MJP publishers, Chennai
5. Singh,R. 2011. “Plant Biology and Biotechnology”, Educational Publishers and Distributors, New Delhi.
6. Smith , R. H . 2000 “Plant Tissue Culture - Techniques and Experiments”, Academic Press, New York.
7. Trivedi, P.C. 2010. “Plant Tissue Culture and Biotechnology”, Second Edition, Pointer Publication, Jaipur.

9. Rana, S.V.S. 2012. "Biotechnology-Theory and practical", Third Edition, Elective Press, Meerut.

Reference books:

1. Subba Rao, N.S. 2001. Soil Microbiology, Oxford and IBH Publishing Company, New Delhi
2. Yeoman, J.R.M.M. 1982. Cell and Tissue culture, Narosa Publishing House. New Delhi
3. Chawla, H.S. 2008. Introduction to plant Biotechnology. Oxford & IBH publishing co., Pvt.Ltd. New Delhi.
4. Glick, B.R. and J.J. Pasternak. 2003. Molecular Biotechnology – Principles and Applications of Recombinant DNA, Third Edition, ASM Press, Washington, USA
5. Primrose, S., R.Twyman and P.Old.2005. Principles of Gene Manipulation, Blackwell Science Ltd, Oxford.

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DEPARTMENT OF BOTANY
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Course: M.Sc., Botany	Code No	: 4PB2
Semester: IV	No. of Hrs allotted	: 6Hrs/Week
Paper: Core	No. of Credits	: 5
	Marks: 25 +75 = 100	

Title of the Paper: **Environmental Biology and Evolution**

Course Objectives:

- To understand the basic concepts of ecology and evolution
- To acquire knowledge about the concept of biodiversity and its conservation measures
- To understand environmental problems and their management strategies

Unit I: Basic concepts in Ecology: Physical environment – biotic environment – biotic and abiotic interactions – habitat and niche – ecosystem structure and function: forest, grassland, freshwater, marine and estuarine – energy flow – mineral cycling: Carbon, Nitrogen and Phosphorus – primary productivity – ecological succession: types: primary and secondary succession and climax concept.

Unit II: Population and Community Ecology: Characteristics of a population – population growth curves – population regulation – life history strategies (r and k selection) – concept of meta population – nature of communities – community structure and attributes – methods of studying communities: floristic method, physiognomic method, phyto-sociological method – Diversity indices: Berger-Parker Index, Shannon’s Diversity Index, Simpson’s Dominance Index, and Margalef’s Richness Index.

Unit III: Biodiversity and Conservation: Categories of biodiversity – species concepts: keystone, flagship, dominant and co-dominant species – Biogeography: Major terrestrial biomes – theory of island biogeography – Biogeographical zones of India – Principles and approaches of conservation – *In-situ* conservation: National parks, Wildlife Sanctuaries, Biosphere reserves – *Ex-situ* conservation: Botanical and herbal gardens, zoological parks, seed orchards and gene banks.

Unit IV : Environmental problems and Management: Pollution: primary and secondary pollutants - Global warming and green-house effect, Ozone depletion, Habitat changes, GMO’s, Invasive species, El-nino and El-sano - Environmental impact assessment – Bio-remediation and phyto-remediation – Biosensors – application of remote sensing and GIS in environmental management.

Unit V: Evolution: Evolutionary time-scale (Major events) – concept of Oparin and Haldane – experiment of Miller (1953) – origin of eukaryotic cells and aerobic metabolism – gene pool, gene frequency, Hardy-Weinberg Law - rate of change in gene frequency through natural selection, migration and random genetic drift - founder effect - convergent evolution and divergent evolution: allopatric, peripatric, parapatric and sympatric speciation – adaptive radiation - co-evolution – altruism – group and kin selection .

Text Books:

1. Subramanyam, N.S. and A.V.S.S. Sambamurthy. 2000. Ecology, Narosa Publishing House, New Delhi.
2. Chiras, D.D. 2012. Environmental Science, 9th edition, Jones and Bartlett India Pvt.Ltd., New Delhi.
3. Verma, P.S. and V.K. Agarwal. 2006. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S.Chand & Company Ltd., New Delhi.
4. Krishnamurthy, K.V. 2004. Text Book of Biodiversity, Oxford and IBH Publishing Company Pvt. Ltd, New Delhi.
5. Dobzhansky, T., F.J. Ayala, G.L.Stebbins and J.W. Valentine. 1973. Evolution, Surjeet Publications, Delhi.
6. Bhatta, B. 2009. Remote Sensing and GIS, Oxford University Press, New Delhi.

Reference Books:

1. Peter Stiling, 2002. Ecology, Theories and Applications, Prentice-Hall of India, New Delhi.
2. Jeffries, M.J. and M.J. Jeffries. 2005. Biodiversity and Conservation, Routledge Taylor & Francis Group, UK.
3. Saha, T.K. 2011. Ecology and Environmental Biology, Books and Allied (P) Ltd, Delhi.
4. Townsend, C.R., M. Begon and J.L.Harper, 2000. Essentials of Ecology, Blackwell Publishing Company, USA.
5. Russell, P.J., S.L.Wolfe, P.E. Hertz, C.Starr and Mcmillan.2008. Ecology, Cengage Learning India Pvt. Ltd, New Delhi.

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DEPARTMENT OF BOTANY
(From 2014-16 batch onwards)

Course: M.Sc., Botany
Semester: IV
Paper: Core

Code No
No. of Hrs allotted
No. of Credits
Marks:

: Project
: 6 hours per week
: 3

Project

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(From 2014-16 batch onwards)

Course: M.Sc., Botany	Code No	: 4PBL1
Semester: IV	No. of Hrs allotted	: 6Hrs/Week
Paper: Lab for paper 4PB1	No. of Credits	: 5
Title of the Paper: Biotechnology	Marks	: 40 +60 = 100

1. Fermentation by Yeast – Estimation of alcohol content.
2. Citric acid production by *Aspergillus niger* – estimation of citric acid content.
3. Production of itaconic acid by *Aspergillus terreus*
4. Isolation of cellulolytic organisms by enrichment culture method.
5. Alcohol fermentation by immobilized yeast cells.
6. Measurement of yeast biomass production by turbidity method.
7. Measurement of bioconversion efficiency of bacteria, yeast and fungi.
8. Immobilization of microbes in calcium alginate beads.
9. Effect of biofertilizers on plant biomass.
10. Biodegradation of cellulosic wastes.
11. Isolation of nitrogen fixing and phosphate solubilizing bacteria from soil.
12. Demonstration of Vermicomposting.
13. Induction of callus in *Daucas*, *Datura* and *Nicotiana*.
14. Isolation of Protoplasts and protoplast fusion
15. Production of antibiotics by using actinomycetes

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Course: M.Sc., Botany	Code No	: 4PBL2
Semester: IV	No. of Hrs allotted	: 6Hrs/Week
Paper: Lab for paper 4PB 2	No. of Credits	: 5
	Marks	: 40 +60 = 100

Title of the Paper: **Environmental Biology and Evolution**

1. Estimation of Primary productivity using light and dark bottle method.
2. Preparation of Survivorship curve using available data.
3. Classification of plant life-forms using Raunkaier's frequency class distribution.
4. Vegetation analysis using Quadrat and Transect (Line & Belt) method. Calculation of Important Value Index.
5. Soil analysis: Soil moisture, Soil pH, Organic Carbon, Nitrogen, Phosphate-Phosphorus, Calcium and Magnesium.
6. Water analysis: Salinity, Alkalinity, BOD, COD, DO and free CO₂.
7. Demonstration of Natural Selection.
8. Demonstration of Genetic Drift.
9. Field visit and field note book submission.
10. Submission of Environmental Diary.

M.Phil Botany

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DEPARTMENT OF BOTANY
M.Phil Course
Course scheme and scheme of valuation
From 2008-2009 batch onwards

I semester

Course	Code	Subject/Paper	Cont Hrs/w	T.No Hrs	Max Mark CA	Max Mark SE	Total
Core	1 MB1	Research Methodology	6	90	100	100	200
Core	1MB2	Biodiversity and Conservation	6	90	100	100	200
		Total			200	200	400

II semester

Course	Code	Subject/Paper	Cont Hrs/w	T.No Hrs	Max Mark CA	Max Mark SE	Total
Core	2MB1	Biomolecules and Signal transduction	6	90	100	100	200
Core		Dissertation*				100	100
		viva voce**			50	50	100
		Total			150	250	400

*Dissertation to be valued by two external examiners separately for 50 marks each.

** There will be a viva voce examination after valuation of dissertation, to be conducted by the board of examiners comprising of internal examiner (guide) and external examiner.

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DEPARTMENT OF BOTANY
(From 2014-2015 batch onwards)

Course: Botany

Int.Marks: 100

Class: M.Phil

Ext.Marks: 100

Title of the paper: Research methodology

Total marks: 200

Semester: 1

Contact hours per week: 6

Sub code: 1MB1

Objectives: To understand the basic principles of Biotechniques.

To apply Biotechniques in different fields of Plant research

Unit 1: Microscopy: Dark field, Phase-contrast, and Fluorescence microscope- Transmission electron microscope (TEM) – Scanning microscope (SEM), Preparation of slides for SEM and TEM, Spectrophotometer: UV- Visible, FTIR and NMR Spectrophotometer, Mass Spectroscopy- MALDI-TOF.

Unit 2: Ph Metry: Types of electrodes: Glass, reference and combined electrodes – working and applications of pH meter. Centrifugation: Types of centrifugation: High speed and Ultracentrifugation, Preparative centrifugation – Differential, Rate zonal and isopycnic – Analytical centrifugation. Radiography: measuring radiography – Scintillation counters – Geiger Muller – Autoradiography – Application of radioactivity.

Unit 3: Chromatography: Principles and applications of chromatography: Paper, thin layer, HPLC and Gas chromatography. Electrophoresis: Agarose gel electrophoresis, Polyacrylamide gel electrophoresis, PCR Technique, X-Ray crystallography, EPR, ESR analysis.

Unit 4: Statistical methods: Simple and linear regression- simple and linear correlation- tests of significance: analysis of variance test; non parametric test: Kruskal-wallis and Wilcoxon signed ran test. Computer applications: Microsoft Word: text format, table format. MS Excel- Power point, SPSS Software for statistical analysis.

Unit 5: Presenting Research Work: Literature collection- E-Journal- Literature citation. Research report- Components, tables,figures-Chart types-Column-bar-line-pie.Thesis format- Journal format. Research paper presentation at a seminar- Oral and Poster presentation.

References:

1. Anderson.J.,B. H, Durston and M.Poole. 1970. *Thesis of assignment writing*. Wiley EASTERN Private Limited, New Delhi.
2. Gurumani, N. 2006. *An introduction to Biostatistics* (second edition). MJP Publishers, Chennai.
3. Gurumani,N. 2006. *Research Methodology for biological Sciences*. MJP Publishers, Chennai.
4. Jayaraman.J.1981. *Laboratory Manual in Biochemistry*.Wiley Eastern Limited, New Delhi.
5. Shaw, V. 1977. *Reporting Research Papers on Survey Research Methodology Series*. The Agricultural Development Council, New York.
6. Webster. J.G. 2004 (editor). *Bioinstrumentation*. John Wiley & sons (Asia) Pvt..Ltd., Singapore.
7. Whitney, F.L.2004. *The Elements of Research*. Prentice- Hall, Englewood, N.J.

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DEPARTMENT OF BOTANY
(From 2014-2015 batch onwards)

Course: Botany

Class: M.Phil

Title of Paper: Biodiversity and Conservation

Sub code: 1MB2

Int.Marks:100

Ext.Marks: 100

Semester : I

Total marks: 200

Contact hour per week: 6

Objectives: To understand various aspects of biodiversity.

To educate the significance of biodiversity and its conservation

Unit 1: Biodiversity- introduction- current state of biological diversity-Global patterns of species richness-Abiotic and biotic theory for species richness gradients-Rain forest as centers of diversity – Ecological diversity in coastal zones and oceans. Measures of Biodiversity: Alpha. Beta and gamma diversity. Diversity indices: Dominance and evenness. Diversity crises in the geological past.

Unit 2: Values of biodiversity-ecosystem services- screening plants for medicines- New agricultural and industrial products from the tropics- identifying and protecting the origin of food crops. Speciation- species area relationship: productivity- diversity relationship - Biodiversity hot spot.

Unit 3: The effect of global climatic change on natural communities- IUCN categories of extinction- red data book – causes for species extinction – impact of exotic species on native species – GMOs and biosafety – Intellectual property rights- GATT,WTO, farmers and breeders rights- Biodiversity act -2002.

Unit 4: Remote sensing : Introduction-Analysis techniques-Digital image processing- Role of remote sensing in biodiversity management-GIS and biodiversity, landscape elements Oceans colour and fishery, water security. Environment assessment and monitoring.

Unit 5: Conservation : *In situ* and *Ex situ* conservation methods- conservation of biological diversity in Botaniocal gardens- Information management for the conservation of biodiversity. Cryobiology-Agro ecology and *in situ* conservation of native crop diversity- International development and the protection of biodiversity.

References:

1. Stiling, P. 2002. Ecology – Theory and applications. Prentice-Hall of India Pvt. Ltd., New Delhi.
2. Gurevitch, J., Scheiner S.M and Fox G.A. 2002. The Ecology of Plants. Sinauer Associates Inc Publishers, Massachusetts.
3. Cunningham, W.P. and Cunningham, M.A. 2002. Principals of environmental science. Tata McGraw-Hill Publishing Company Ltd., New Delhi.
4. Agarwal, K.C. 2000 Biodiversity. Agrobios (India). Jodhpur.
5. Odum, E.P. 1971 Fundamentals of Ecology. W.B. Saunders Company, London.
6. Colinvaux, P. 1986. Ecology John Wiley and sons, Singapore.
7. Krishnamoorthy, K.V. 2004 An advanced Text Book of Biodiversity. Oxford & IBH Publishing Co, Pvt. Ltd., New Delhi.
8. Meffe, G.K. and Carrol, R.C. 1994. Principles of Conservation of Biology, Sinauer Associates, Inc., Publishers, Saund

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Course: M.Phil Botany	Code No	: 2MB1
Semester: II	No. of Hrs allotted	: 6Hrs/week
	Marks	: 100+100 = 200

Title of the Paper: **BIOMOLECULES AND SIGNAL TRANSDUCTION**

Course Objectives:

- To understand the structure and functions of biomolecules
- To acquire knowledge about bioactive molecules
- To study the principles and mechanisms involved in cell signaling and cell communication
- To obtain the information about signal transduction in Plants

Unit I: Biomolecules and biomacromolecules (brief account) – secondary metabolites and their characteristic features – major groups of plant and microbial secondary metabolites – Bioactivities: antimicrobial, antioxidant, pharmacological, agricultural activities, microbial regulators, and biophysical effects – Bioactive compounds as nutraceuticals, functional foods and dietary supplements.

Unit II: Cell Signaling molecules: Bioactive molecules in cell signaling – G-proteins, Phosphoinositides, ITP, MAP and CD Kinases – Second messengers- Calcium and calmodulin protein. Plant hormones as signal molecules: Salicylic acid, Jasmonic acid, Ethylene, Auxin, Abscisic acid, Brassinosteroids and Systemin – Signal receptors: Cell surface receptors and signaling through G-protein coupled receptors – Signal transduction pathways – regulation of signaling pathways.

Unit III: Principles of Cell Communication: Abiotic influence on organisms – trans- organismic communication – intra- organismic communication – cell adhesion and roles of different adhesion molecules – gap junctions – extra-cellular matrix – integrins – bacterial , plant two component systems – bacterial chemotaxis and quorum sensing.

Unit IV: Light signaling in plants: photobodies, photoreceptors-types, photosynthetic pigments, phytochromes, cryptochromes. Florigen concept. UV-RB protein in UV-B signaling. Symbiotic nitrogen fixation – role of signaling molecules and receptors in nodule induction.

Unit V: Signal transduction in plants: Host parasite interaction – Recognition and entry processes of different pathogens like fungi, bacteria, viruses into plant host cells, alteration of host cell behaviour by pathogens, virus- induced cell transformation, cell-cell fusion in both normal and abnormal cells.

Reference Books:

1. Watson, J.D., Hopkins, N.H., Roberts, J.W., Steitz, J.A. and Weiner, A.M. 1987. Molecular Biology of the Gene, 4th Edition, Benjamin/ Cummings Publishing Company, California.
2. Kendrick, R.E. and Kronenberg, G.H.M.1994. Photomorphogenesis in plants, 2nd Edition, Kluwar Academic Publishers, Dordrecht.
3. Taiz, L. and Zeiger, E. 2002. Plant Physiology. The Benjamin and Cummings Publishers, California.
4. Mc.Donald, M.S. 2003. Photobiology of Higher Plants, John Wiley & Sons, Inc., West Sussex.
5. Roy, S.C.and Kalyan Kumar De. 2005. Cell Biology, 2nd Edition, New Central Book Agency (P) Ltd, Kolkata.
6. Desikar, R.N. 2005. Cell and Development Biotechnology, Dominant Publishers and Distributors, New Delhi.
7. Jamesway, C.A., Travers, P. Walport, M. and Sholmchik, M.J. 2005. Immunobiology and the Immune System in Health and Diseases, Garland Science Publishers, New York.
8. Bradshaw, R.A. and Dennis, E.A. 2008. Handbook of Cell Signaling Three-Volume Set (e book). http://ebookey.org/Handbook-of-Cell-Signaling-Three-Volume-Set_175281.html
9. Baluka, F. and Vivanco, J. 2012. Signaling and Communication in Plants (e book). <http://freshbookers.com/ebook/9783642230462/ISBN>

**B.Sc.,
Biotechnology**

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B.Sc Biotechnology

Course Structure (w.e.f 2014 – 17 Batch Onwards)

SEMESTER-I

COURSE	CODE NO	SUBJECT	CONTACT Hrs/week	CREDITS	TOTAL NO OF Hrs OF ALLOTTED	MAX MARKS CA	MAX MARKS SE	TOTAL
Part I Tamil	P121	Ikkala Ilakkiyam	6	3	90	25	75	100
Part II English	P221	English Through Prose	6	3	90	25	75	100
Core 1	SMB 11	General Microbiology	6	4	90	25	75	100
Allied 1	SAB 11	Analytical Biochemistry	4	4	60	25	75	100
Core Lab	SMBL11	Core Practical 1	2	2	30	40	60	100
Allied Lab	SABL11	Allied Practical 1	2	1	30	40	60	100
Value Education I	VE 1	Value Education I	2	2	30	15	35	50
Environmental Studies	ES 1	Environmental Studies	2	2	30	15	35	50
TOTAL			30	21	450	210	490	700

SEMESTER-II

COURSE	CODE NO	SUBJECT	CONTACT Hrs/week	CREDITS	TOTAL NO OF Hrs OF ALLOTTED	MAX MARKS CA	MAX MARKS SE	TOTAL
Part I Tamil	P121	Bhakthi Illakiyamum Sitrillakiyam	6	3	90	25	75	100
Part II English	P221	English Through Drama	6	3	90	25	75	100
Core 2	SMB 21	Basics of computers and Bioinformatics	5	4	75	25	75	100
Allied 2	SAB 21	Bio molecules	4	4	75	25	75	100
Core Elective 1	SEB 21	Food Biotechnology	3	3	45	45	75	100
Core LAB	SMBL21	Core Practical 2	2	2	30	40	60	100
Allied Lab	SABL21	Allied Practical 2	2	1	30	40	60	100
Skill Based Elective I	SBE 1	Clinical Lab Technology	2	2	30	15	35	50
TOTAL			30	22	450	240	530	750

SEMESTER- III

Course	Code No	Subject	Contact Hrs/Week	Credits	Total No Of Hrs Of Allotted	Max Marks CA	Max Marks SE	Total
Part I Tamil	P131	Kappiya Illakiyam	6	3	90	25	75	100
Part II English	P231	English Through Poetry	6	3	90	25	75	100
Core 3	SMB 31	Immunology	4	4	60	25	75	100
Allied 3	SAB 31	Genetics and Biostatistics	4	4	45	25	75	100
Core Elective 2	SEB 32	Infectious Disease	3	3	45	25	75	100
Core Lab	SMBL 31	Core Lab 3	2	2	30	40	60	100
Allied Lab	SABL 31	Allied Lab 3	2	1	30	40	60	100
Value Education II	VE 2	Value Education II	2	2	30	15	35	50
Non Major Elective 1	NME 1	Vocational Biotechnology	2	2	30	15	35	50
TOTAL			30	24	450			

SEMESTER - IV

Course	Code No	Subject	Contact Hrs/Week	Credits	Total No Of Hrs Of Allotted	Max Marks CA	Max Marks SE	Total
Part I Tamil	P141	Pandai Illakiyam	6	3	90	25	75	100
Part II English	P241	English Through Fiction	6	3	90	25	75	100
Core 4	SMB 41	Molecular biology	4	4	60	25	75	100
Allied 4	SAB 41	Cell Biology and Physiology	3	4	45	25	75	100
Core Elective 3	SEB 43	Metabolic Pathways	3	3	45	25	75	100
Core Lab	SMBL 41	Core Practical 4	2	2	30	40	60	100
Allied Lab	SABL 41	Allied Practical 4	2	1	30	40	60	100
Skill Based Elective 2	SBE 2	Mushroom Technology	2	2	30	15	35	50
Non Major Elective II	NME 2	Food Processing Technology	2	2	15	15	35	50
TOTAL			30	24	450	235	565	800

SEMESTER - V

COURSE	CODE NO	SUBJECT	CONTACT Hrs/week	CREDITS	TOTAL NO OF Hrs OF ALLOTTED	MAX MARKS CA	MAX MARKS SE	TOTAL
Core 5	SMB 51	Genetic Engineering	5	4	60	25	75	100
Core 6	SMB 52	Industrial Biotechnology	5	4	60	25	75	100
Core 7	SMB 53	Plant Biotechnology	5	4	60	25	75	100
Core 8	SMB 54	Genomics & Proteomics	4	4	60	25	75	100
LAB	SMBL 51	Core Practical 5	3	2	45	40	60	100
	SMBL 52	Core Practical 6	3	2	45	40	60	100
	SMBL 53	Core Practical 7	3	2	45	40	60	100
Value Education III	VE 3	Value Education III	2	2	30	15	35	50
Self Study Paper	SS	Botanical World	-	(Extra5)*	-	-	100	100
TOTAL			30	24	450	180	570	750

* Carries Extra 5 credits that do not form part mandatory credits (140) required for completion of the course.

SEMESTER - VI

COURSE	CODE NO	SUBJECT	CONTACT Hrs/week	CREDITS	TOTAL NO OF Hrs OF ALLOTTED	MAX MARKS CA	MAX MARKS SE	TOTAL
Core 9	SMB 61	Marine Biotechnology	5	4	60	25	75	100
Core 10	SMB 62	Animal Biotechnology	5	4	60	25	75	100
Core 11	SMB 63	Environmental Biotechnology	5	4	60	25	75	100
Core 12	SMB 64	Bio Safety and IPR	4	4	60	25	75	100
Lab	SMBL 61	Practical 8	3	2	45	40	60	100
	SMBL 62	Practical 9	3	2	45	40	60	100
	SMBL 63	Practical 10	3	2	45	40	60	100
Skill Based Elective III	SBE3	Organic Farming	2	2	30	15	35	50
TOTAL			30	24	450	180	470	650
Part V				1				
Total Credits for Semester I to IV			140					

A) CONSOLIDATION OF CONTACT HOURS AND CREDITS: UG

Semester	Contact Hrs/ Week	Credits
I	30 hrs.	21
II	30 hrs.	22
III	30 hrs.	24
IV	30 hrs.	24
V	30 hrs.	24
VI	30 hrs.	24
Part – V	--	1
Total	180 hrs	140

B) Curriculum Credits: Part wise

Part I	Tamil	4x3 = 12 Credits
Part II	English	4x3 = 12 Credits
Part III	Core	= 68 Credits (6+6+6+6+22+22)
	Allied	5x4 = 20 Credits
	Core Electives	3x3 = 09 Credits
Part IV	Value Education	3x2 = 06 Credits
	Environmental studies	1x2 = 02 Credits
	Skill Based Electives	3x2 = 06 Credits
	Non – Major Electives	2x2 = 04 Credits
Part V		1x1 = 01 Credits
	Total	<hr/> 140 Credits <hr/>

**Non Major Elective Offered By BSc Biotechnology
Semester III**

COURSE	CODE NO	SUBJECT	CREDITS	TOTAL NO OF Hrs OF ALLOTTED	MAX MARKS CA	MAX MARKS SE	TOTAL
Non Major Elective 1	NME 1	Vocational Biotechnology	2	30	15	35	50

Semester IV

COURSE	CODE NO	SUBJECT	CREDITS	TOTAL NO OF Hrs OF ALLOTTED	MAX MARKS CA	MAX MARKS SE	TOTAL
Non Major Elective 2	NME 2	Food Processing Technology	2	30	15	35	50

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Blue Print For The Course Structure

Course Structure (w.e.f 2014 – 17 Batch Onwards)

Sem	Part 1	Part II	Core Theory	Core Practical	Allied Theory	Allied Practical	Major Elective	Skilled Based Elective	NME	VE	ES	SS	Total
I	1	1	1	1	1	(1)				1	1		8
II	1	1	1	1	1	1	1	1					8
III	1	1	1	1	1	(1)	1		1	1			9
IV	1	1	1	1	1	1	1	1	1				9
V			4	3						1		1	9
VI			4	3				1					8

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Course : B.Sc., Biotechnology (S.F)

Code No : SMB11

Semester: 1

No. of Hrs allotted: 6hr/week

Paper: Core 1

No. of Credits : 4

Title of the Paper: GENERAL MICROBIOLOGY

Marks: 25 + 75 = 100

Course Objective

- To get an exposure to the classification of microorganisms, diversity of microbial structure and their role.
- To motivate the students to appreciate the importance of microbes.

Unit :I

Introduction to microbes: Prokaryotes - Algae, fungi, protozoa, and mycoplasma. Differences between prokaryotes and eukaryotes. Important milestones in microbiology: spontaneous generation theory- contributions of Leewenhock, Pasteur, Koch, Paul Ehrlich, Joseph Lister, Tyndall, Jenner, Winogradsky, Beijerinck, Beadle and Tatum, Avery.

Unit: II

Classification of Bacteria: Characters used in classification. Approaches to Classification-Natural approach, Phylogenetic approach, Numerical approach and Molecular approach. Outline of bacterial classification as per Bergey's manual of determinative bacteriology, eighth edition.

Unit: III

Morphology and fine structure of bacteria: Structures outer to cell wall, capsule, slime, flagella and pili; structures inner to the cell wall - plasma membrane, cytoplasmic matrix, Cytoplasmic inclusions (PHB), glycogen, ribosomes, brief account on chromosomes, plasmids and endospore - cell wall-peptidoglycan structure.

Culture media: complex & defined media, differential and enriched media- sterilization methods- pure culture techniques.

Unit: IV

Microbial Nutrition: Macro and Micro Nutrients – nutritional types of bacteria – uptake of nutrients: simple diffusion, facilitated diffusion, ABC transporter and group translocation. Microbial growth: sigmoid growth - diauxy growth- generation time- measurement of microbial growth – continuous growth – synchronous growth - factors affecting growth.

Unit: V

Structure and multiplication of viruses: Classification of Viruses. Plant virus (TMV), Bacteriophage (T4), Animal virus (Pox), Viroids and Prions.

Text Books:

- Sharma, P.D. 2004. Microbiology, Second edition. Rastogi publication, Meerut.
- Daniel Lim. 1998. Microbiology, Second edition. McGraw Hill publications, New York.
- Pelczar, M. J. Jr., E. C. S. Chan. and N. R. Krieg. 2001. Microbiology, 5th edition. Tata McGraw Hill publication, New Delhi. 900pp.
- Stanier, R. Y. and J. L. Ingraham. 1987. General microbiology, 5th edition, Macmillan press Ltd. London.

Reference Books:

- Prescott, L.M., J. P. Harley and D. A. Klein. 2003. Microbiology 5th Edition. McGraw Hill, New York.
- Atlas, R. M. 1998. Principles of Microbiology, First edition. Mosby yearbook publication, Missouri.

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Course: B.Sc., Biotechnology (S.F)	Code No	:SAB11
Semester: 1	No. of Hrs allotted	:4hr/week
Paper: Allied -1	No. of Credits	:4
Title of the Paper: ANALYTICAL BIOCHEMISTRY	Marks: 25 + 75 = 100	

Course Objective:

To make students understand the principles and working mechanisms of most common laboratory instruments.

Unit 1:

Microscopy: Principles, instrumentation and applications of simple, compound and electron microscopes.

pH metry: Principles, Operation method and uses. Buffer solutions for biological investigations.

Colorimetry: principles, instrumentation and applications. Spectroscopic techniques: General principles-UV-visible spectrophotometer- principles, instrumentation and applications.

Unit 2:

Chromatography: Principles and applications of paper chromatography, thin layer chromatography, adsorption chromatography, ion exchange chromatography, molecular sieve chromatography, affinity chromatography, gas chromatography and high performance liquid chromatography (HPLC).

Unit 3:

Centrifugation techniques: Basic principles and sedimentation coefficient – Types of centrifuges and centrifugation: different types: differential centrifugation, density gradient centrifugation, - applications of centrifuge.

Unit 4:

Radio isotope techniques: The nature of radioactivity – Detection and measurement of radioactivity – Liquid Scintillation counting – Geiger-Muller counting of radioactivity – Autoradiography Applications of radioisotopes in Biological sciences.

Unit 5:

Extraction of DNA, RNA and Protein – principle – method. Purification of DNA, RNA and Protein – principle – method.

Electrophoresis: Principles–Types: Paper electrophoresis, Agarose Gel Electrophoresis (AGE) Polyacrylamide gel electrophoresis (PAGE) and Capillary electrophoresis (CE). Applications of electrophoresis.

Text Books:

- Plummer, D. 1988. An introduction to Practical Biochemistry, Tata McGraw – Hill Publishing Company Ltd., New Delhi.
- Rodney Boyer, 2000. Modern Experimental Biochemistry, 3rd Edition. Published by Addison Wesley Longman. Singapore.
- Palanivelu, P. 2004. Laboratory Manual for analytical biochemistry and separation techniques, School of Biotechnology, Madurai Kamaraj university, Madurai.

ReferenceBooks:

- Wilson, K and J. Walker. 2005. Principles and Techniques of Practical Biochemistry, 5th Edition. Cambridge University press, New York.
- Williams, B. L. and K. Wilson. 1983. A Biologist's guide to Principles and Techniques of Practical Biochemistry, Edward Arnold Publishers Ltd., London

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Core lab : 1 SML11 SMB 11 -General Microbiology –Lab Course –
Contact hours/week: 2

1. Preparation of culture media
2. Isolation of microbes from soil and drinking water.
3. Pure culture techniques: Pour, Spread, Streak plate method, mycelia agar plug method.
4. Micrometry
5. Observation of motility of Bacteria – Hanging drop method
6. Bacterial Staining methods: a) Simple b) Negative c) Acid fast d) Gram’s e) spore
f) Capsule Staining.
7. Fungal staining with lactophenol cotton blue.
8. Measurement of microbial count: a) Bacteria-viable count method and b) haemocytometer
method.
9. Growth curve.
10. Carbohydrate fermentation
11. IMVIC test
12. Starch hydrolysis
13. Catalase activity
14. Oxidase activity
15. Cellulose hydrolysis.

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Allied Lab 1 :SABL11- Analytical Biochemistry

Contact hours/week: 2

1. Determination of pH in various samples
2. Buffer preparation (verification of Handerson-Hasselbalch equation)
3. Separation of amino acids by paper chromatography
4. Separation of leaf pigments by Column chromatography
5. Separation of sugars by TLC
6. Isolation and quantification of proteins(Lowry method)
7. Demonstration of SDS PAGE
8. Demonstration of Agarose gel electrophoresis
9. Electrophoresis of RNA
10. Demonstration of dialysis.

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Course: B.Sc., Biotechnology (S.F)	Code No	:SMB21
Semester: 2	No. of Hrs allotted	:5hr/week
Paper: Core – 2	No. of Credits	:4
Title of the Paper: BASICS OF COMPUTER AND BIOINFORMATICS Marks: 25 + 75 = 100		

Course Objective:

- To understand the role of computer in biological research.
- To learn about the basics of computing, internet and literature Search. To have training in biological databases and types of data analysis.

Unit I

Components of computer: input / output devices, storage devices, Graphic devices. Generation of computers - classification and characteristics of computers. Operating system: MS, DOS & Windows. Networks: Intranet, Internet –search engines; Google,yahoo.

Unit II

MS Word: Getting to know word - Basic text manipulation – formatting text -working with a document – automatic features – graphical features. MS Excel: worksheet basics – copy / move formatting cell referencing function – cell errors – workbook security – data analysis, Sum, Formulae format, Creation of charts – graphs. MS Power Point.

Unit III

Introduction, Scope and application of Bioinformatics – useful Bioinformatics web sites. Acquiring and using of public data bases.

Unit IV

Databases: Types of databases – Biological databases. DNA data bases, Protein data base – primary,secondary and composite databases – Retrieval of databases – FASTA, BLAST – types of Blast.

Unit V

Sequence analysis – DNA, protein sequence analysis. Sequence alignment – Multiple sequence analysis – CLUSTAL W. Phylogenetic analysis – Phylo draw. Analysis of 3D structure of DNA & Proteins using RASMOL.

Text Books

- Sundararajan, S. and R. Balaji. 2002. Introduction to Bioinformatics. Himalaya Publishing house, Bangalore.
- Kothekar, V. 2004. Introduction to Bioinformatics. Dhruv Publications, New Delhi.
- Sanjay Saxena. 2003. First course on computers. Vikas publishing house Pvt. Ltd., New Delhi.
- Raja Ram, F.V. 2003. Fundamentals of Computers. Printice – Hall of India Pvt. Ltd., New Delhi.
- Rawlings, R.J. 1986. Software Directory for Molecular Biologists. Stockton press, Mac Millan publishers, New Delhi.

Reference Books:

- Cohen, N.C. 2006. Guide book on molecular modeling in drug design. Elsevier, New Delhi.
- P.K. Singh. 2010. Basics of computer- V.K. (India) Enterprises. New Delhi.

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Course: B.Sc., Biotechnology (S.F)	Code No : SAB21
Semester 2	No. of Hrs allotted: 4hr/week
Paper: Allied -2	No. of Credits:4
Title of the Paper: BIOMOLECULES	Marks: 25 + 75 = 100

Course Objective:

To understand the molecular architecture of biomolecules.

To learn the various concepts involved in the mechanism of enzyme action.

Unit: 1

Carbohydrates: Structure and function of Monosaccharides (Glucose, fructose) – Disaccharides (Sucrose, lactose) – Cell wall polysaccharides (Cellulose, peptidoglycon) – storage polysaccharides (Starch, glycogen) General account on chitin, pectin and lignin.

Unit:2

Aminoacids: General properties – Classification – based on polarity – protein and non-protein aminoacids. Proteins – Structure , properties and functions of Protein. Primary structure , Secondary structure, tertiary and quaternary structure

Unit:3

Enzymes: Classification and nomenclature — Mechanism of enzyme action – Factors affecting enzyme action - enzyme inhibition – Michaelis Menten constant-Theories on enzyme action.

Unit 4:

Structure and functions of Nucleic acids: Nucleosides – Nucleotides – Purines and pyrimidines – phosphodiester bonds-histones – role of histones in DNA packaging. DNA double helix (Watson & Crick Model) – A, B, Z forms of DNA – RNA types: mRNA, tRNA, rRNA, and hnRNA.

Unit 5:

Lipids: Classification (outline) –Saturated and unsaturated fatty acids -Simple non-saponifiable lipids: terpenes, steroids,sterols – Cholesterol, Ergosterol - phosphotidylcholine – complex saponifiable lipids: triglycerides, phosphoglycerides - membrane lipids – lipoprotein complex.

Text Books:

- Zubay, G. 1993. Biochemistry, third edition. W. H. Freeman publishers, London.
- Conn. E. E., P. K. Stumpf, G. Bruening and R.H. Doi, 1997. Out line biochemistry, John Wiley & sons Inc., New York.
- McKee and J.R. McKee, 1996. Biochemistry and introduction. W. H. Freeman publishers, London.
- S.R. Mishra. 2003. Biomolecules. Discovery publishing house.

Reference Books:

- Stryer, L. 2000. Biochemistry, Fourth edition .W.H. Freeman and company, New York.
- Voet, and J. G. Voet, 1995. Biochemistry, Second edition. John Wiley & Sons Inc, New York.
- Nelson, D. L. and M. M . Cox, 2002. Lehninger Principles of biochemistry, third edition. Worth publishers, New York.

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Course: B.Sc., Biotechnology (S.F)
Semester 2
Paper: Elective-1
Title of the Paper: FOOD BIOTECHNOLOGY

Code No : SEB21
No. of Hrs allotted: 3hr/week
No. of Credits:3
Marks: 25 + 75 = 100

LEARNING OBJECTIVES:

- Students will learn pertinent facts concerning the role of microorganisms in food preservation, spoilage, and food poisoning.
- Students will learn the role and significance of various indicator and disease-producing microorganisms in food, water, and wastewater.
- Students observe standard procedures to detect microorganisms in food , water, and wastewater.

Unit I

Introduction to food microbiology - Scope of food microbiology, food as a Substrate for microorganisms, microorganisms important in food industry,

Unit II

Microbial production: Process of Bread Production - Fermented Dairy Products – Cheese Production and Types, Buttermilk, Sour cream, Yoghurt .

Unit III

Fermented vegetables: Sauerkraut, Olives, Soy Sauce & Pickles. Other food Products: Fermented meat, Idli batter. Microbes as food, SCP. Intrinsic and Extrinsic parameters of foods that influence microbial growth. Oriental Fermented food.

Unit IV

Food Spoilage: Spoilage of vegetables and fruits. Spoilage of meat & canned food. Spoilage of Milk and Milk products. Indicators of pathogens associated with Food. Food poisoning: by *Aspergillus flavus* & *Clostridium botulinum*

Unit V

Food Preservation: Physical methods: Asepsis, filtration & centrifugation, high & low temperature & Pasteurization, desiccation, radiation, anaerobiosis, canning and controlled atmosphere. Chemical preservation: Salt, Sugar, organic acid (Benzoic acid, Sorbic acid, propionates, acetic acid & lactic acid), nitrates, nitrites, sulfur dioxide, ethylene dioxide, propylene oxide, wood smoke and antibiotics

Text Books:

- Adams, M.R and M.O.Moss, 1996, Food microbiology, New Age international (P) Ltd., New Delhi.
- Frazier, W.C., and D.C. Westhoff, 1988, (Reprint 1995), Food Microbiology, Fourth edition, Tata McGraw-Hill Publishing Ltd., New Delhi.
- Reference Books:
- Atlas, R.M., 1997, Principles of Microbiology, Second edition, WCB/McGraw Hill, U.S.A.,
- Banwart, G.J., 1987, Basic Food Microbiology, CBS Publishers & Distributors, New Delhi.
- Deak, T, and L.R. Beuchat, 1996, Hand Book of Food Spoilage Yeasts, CRC Press, New York.

Reference Books:

- Garbutt, J., 1997, Essentials of Food Microbiology, Arnold-International Students' edition, London.
- Jay, J.M, 1996, Modern Food Microbiology, CBS Publishers & Distributors, New Delhi.
- Joshi, V.K. and Ashok Pandey (Eds), 1999, Biotechnology: Food fermentation Vol.II, Educational Publishers and Distributors, New Delhi.
- Kulshreshtha, S.K. 1994, Food Preservation, Vikas Publishing House Pvt. Ltd., New Delhi

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Core Lab 2 : SMBL 21- Lab course Basics of computers and Bio-informatics

Contact hours/week: 2

Formatting text: i) editing-moving and coping text ii) paragraph formatting-left alignment, Right alignment, center alignment and justification. iii) spacing and margins-single line spacing, double line spacing. Paragraph spacing iv) indent-First line indent, hanging indent.

Use of symbols and pictures: v) effects-subscripts, superscripts vi) All caps and Dropped caps vii) spell check-grammar check..i) create a table-number of columns ii) insert a row and delete a column iii) splitting and merging cells iv) sort the table v) prepare the chart using the database. 2.

Formatting document: I) borders and shading ii) find and replace iii) date and

time iv) formatting characters –bold, italics, underline v) bullets and numbering. 3. M S

excel: worksheet i) creating worksheet ii) inserting column and deleting a row iii) selecting cells iv) selecting rows and columns v) saving a worksheet vi) cut copy paste. Maths functions: sum, max, min, average. Creating a chart using database. Power point – simple presentation – sound effect – animation. 4.Bioinformatics-Retrieval of databases. Searching: sequences, sequence analysis – protein, DNA (FASTA), BLAST P , BLASTn.

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Allied Lab 2- SABL2 - Lab course Biomolecules Contact hours/week:2

1. Measurement of pHi of aminoacid
2. Quantitative estimation of soluble sugars by anthrone method
3. Quantitative Estimation of Protein by Lowry's Method
4. Quantitative estimation of DNA by Diphenylamine method.
5. Quantitative estimation of RNA by Orcinol method.
6. Quantitative estimation of glucose by anthrone method.
7. Quantitative estimation of glycogen
8. Quantitative estimation of total amino acids – ninhydrin method.
9. Saponification of fats –titration method.
10. Effect of Substrate concentration, pH and Temperature on Amylase enzyme activity.

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Course: B.Sc., Biotechnology (S.F)	Code No	: SBE 1
Semester: 2	No. of Hrs allotted	: 2hr/week
Paper: Skill Based Elective-1	No. of Credits	: 2
Title of the Paper: CLINICAL LABORATORY TECHNOLOGY	Marks: 15 + 35 = 50	

Course Objectives:

To understand the normal health parameters.

To learn the different methods of analyzing urine and sputum sample.

Unit I

Hematology: Composition of Blood – Plasma and corpuscles – cell study- counting of cells – TC and DC, Platelets, ESR, Hb, BT & CT.

Blood Banking: Rh Typing – Slide test, Blood transfusion – Compatibility testing. Cholesterol, Bilirubin.

Serology: Widal test, VDRL, Rheumatoid factor, A.S.O. titre. Blood culture and sensitivity.

Unit II

Urine and Sputum:

Physical properties of Urine – Colour, Volume, Specific gravity, Odour, Turbidity and pH.

Chemical examination – urine sugar, albumin, bile salts, Bile pigments, urobilinogen

Microscopic Examination of Urine deposits – Cast Crystals – Cells. Principles in Pregnancy Test.

Urine – Microbial culture and sensitivity. Sputum – Microbial analysis, Culture and sensitivity.

Text Book:

- Sood, R, 1999, Medical Laboratory Technology – methods and interpretations – Fifth edition, Jaypee, New Delhi.
- Mukherjee, L.K. 1988, Medical Laboratory Technology – Vol.3 – 2nd ed. – Hill Publishing Ltd., New Delhi.
- Connie R. Mahon. Diane G. Tice. 2006. Clinical Laboratory Immunology. Pearson Prentice Hall. 325 pp.

Reference Books:

- Rapael, S.S, 1983, Lynch Medical Laboratory Technology, Fourth edition, W.B. Saunders Co, Singapore.
- Woohan, I.D.P., Heather Freeman, 1990, Micro Analsis in Medical biochemistry, sixth edition, Churchil Livingstone Publishing Ltd., USA.
- John Ridley 2010. Essentials of clinical laboratory science. CLIA. Compliance guide.
- Ochei, J and Kolhattar, A. 2000. Medical Laboratory Science – Theory and Practice. Tata Mc Graw - Hill Publishing Company Ltd., New Delhi. India.

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Course: B.Sc., Biotechnology (S.F)	Code No	: SMB31
Semester: 3	No. of Hrs allotted	:4hrs/week
Paper: Core 3	No. of Credits	: 4
Title of the Paper: IMMUNOLOGY	Marks: 25 + 75 = 100	
Course Objective:		

- To understand the basic principles and techniques of immunology.
- To learn the significance of immunology for human health.

Unit I

Elements of immunology – Primary and secondary lymphoid organs, Thymus, Bone marrow, Bursa of Fabricus, lymph node and spleen. Cells of the lymphoreticular system. Immunoglobulins - structure, functions, classes, isotypes, allotypes and idiotypes. Theories of antibody formation. Antibody diversity- Mechanism contributing diversity. Class switching.

UNIT: 2

Types of immunity: innate and acquired immunity – active and passive immunity - Humoral immunity and cell-mediated immunity. Cytokines. T-cell and B -cell receptors. Antigen, antigenicity, epitopes and haptens . Antigen processing and presentation. Immunological memory –immunological tolerance.

UNIT: 3

Immunization practices- (Active and passive immunization), Vaccines: - Toxoids, killed and attenuated vaccines, Recombinant vaccines, subunit vaccines, antiidiotypic antibodies, chimeric antibodies and plantibodies. Monoclonal antibodies - production and applications.

UNIT : 4

Complement system, components, nomenclature, and activation of complement-classical and alternate pathway. MHC complex-gene organization. HLA genes class I & class II antigens: structure and function - Histocompatibility testing.

UNIT: 5

Hypersensitivity and types. Autoimmunity – Autoimmune disease - . Immunodeficiency disease - AIDS. Radio immunoassay. ELISA, Complement fixation test. Transplantation-types, graft versus host reactions.

Text Books:

- Rao, C.V. 2002. Introduction to Immunology. Narosa publishing House, Delhi.
- Abbas, L. And Prber. 1997. Essentials of Immunology. W.B Saunders Company New York
- Tizard, I. R. 1998. Immunology: An Introduction, 4th edition. W.B. Saunders Company, Philadelphia.

REFERENCE BOOKS:

- Abbas, A.K. 2004. Basic Immunology 2nd edition. Saunders – Eilsevier, Philadelphia
- Kuby, 1997. Immunology 3rd edition. Freeman Publishers, New York.
- Klaus.D.Elgert. 2009. Immunology: understanding the immune system. Wiley-Blackwell Inc. N.Y.

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Course: B.Sc., Biotechnology (S.F)	Code No	: SAB31
Semester: 3	No. of Hrs allotted	: 4
Paper: Allied-3	No. of Credits	: 4
Title of the Paper: GENETICS AND BIOSTATISTICS	Marks: 25 + 75 = 100	

Course Objective:

To understand and apply the various concepts involved in Genetics.

To learn the various statistical principles and methods in biology.

Unit: I

Mendelian Genetics: Mendel's laws – monohybrid and dihybrid crosses – test cross and backcross– Incomplete dominance & Co-dominance. Interaction of genes: Supplementary genes (9:3:4), Dominant Epistasis (12:3:1.), Duplicatory genes (15:1).

Unit: II

Multiple alleles: Blood group inheritance in humans Rh & ABO incompatibility. Erythroblastosis foetalis, Polygenic inheritance: Wheat kernel color and Ear length in maize. Sex determination: XO, XY, ZW & ZO, methods, Genic balance concept - Sex determination in plants.

Unit: III

Extra chromosomal inheritance: Plastid color inheritance in plants, kappa particles of *Paramecium*, coiling in snail and streptomycin sensitivity in algae. Sex linked inheritance: X – linked - eye color in *Drosophila*, color blindness in man – Hemophilia, Y- linked inheritance: Ear , Hypertrichosis. Sex limited inheritance: Breast. Sex influenced inheritance: Baldness and length of index finger.

Unit: IV

Linkage & crossing over: Mechanism of linkage - Complete & incomplete linkages. Linkage in maize –Crossing over mechanism, theories explaining mechanism of crossing over- types: Simple, Double & Multiple crossing over – importance of crossing over- interference and coincidence – gene mapping – population Genetics

Unit: V

Biostatistics: Collection, Classification tabulation, graphic and diagrammatic presentation of data – Measures of central tendency: mean, mode and median; Measures of dispersion - Range and Standard deviation. Standard error. Correlation and regression analysis – chi square test. Student t test. One way ANOVA.

Text Books:

- Sarin, C.1989. Genetics. Tata McGraw- Hill Publishing company Ltd. New Delhi.
- Palanichamy, S. and M. Manoharan. 1994. Statistical Methods for Biologists. Palani Paramount Publications, Palani.
- Gupta, S. P. 1977. Statistical methods, 9th edition. S. Chand & Sons Publishers, New Delhi.

Reference Books:

- Strickberger, M.W., 1985. Genetics, 3rd Ed., MacMillan Publishing, New York.
- Gardner, E.J. and J. Michael Simmons. 2003. Principle of genetics 8th edition, John Wiley & Sons, New York.
- Burton Guttsnan. 2011. Genetics:The code of Life. Prentice Hall.

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Course: B.Sc., Biotechnology (S.F)	Code No	:SEB32
Semester: 3	No. of Hrs allotted	: 3
Paper: Elective paper-2	No. of Credits	: 3
Title of the Paper: INFECTIOUS DISEASES	Marks: 25 + 75 = 100	

Course Objective:

To create an awareness among the students about the human, animal and plant diseases.

UNIT – 1

Symptoms, Epidemiology, Diagnosis, Prevention and Control of the following Human diseases:- Flu, Rabies, AIDS. Tuberculosis, Leprosy and Meningitis.

UNIT – 2

Symptoms, Epidemiology, Diagnosis, Prevention and Control of the following Animal diseases:- Anthrax, Black water, Scrapie, Rinder pest, Foot and Mouth, Blue tongue.

UNIT – 3

Plant diseases:- Entry of the plant Pathogen, Establishment of Plant pathogens (Enzymes and Toxins). Interaction between host and pathogen (Physical and Biochemical defense)

UNIT – 4

Control methods of plant diseases:- Cultural methods , Quarantine method , Biocontrol method, Chemical methods (Insecticides & Fungicides) – Disease resistant Transgenic Plants.

UNIT – 5

Study of the following Plant diseases: Causal organism, Symptoms, Disease cycle and Control. Wheat rust, Cotton blight, Bhendi yellow vein mosaic, Brinjal little leaf, Root knot disease of Tomato and Red rust of Tea.

Text Books:

- Mehrotra , R .S 1980 Plant pathology . Tata Mc Grew Hill Publishing Company Ltd., New Delhi.
- Pandey, B. P. 1997. Plant pathology. S. Chand & Company, New Delhi.
- Arora . R. 1998 Microbiology and diseases. Anmol Publications, New Delhi.
- Sharma , P. D 2004 . Plant pathology. Rastogi publications, Meerut.
- Ananthanarayan . R and C. K. J. Paniker. 2000 Text book of Microbiology. Orient longman Publishing Company, Hyderabad.

Reference Books :

- Schaechter, M., N.C. Englberg., B. I. Eisenstein and G. Medoff . 1999. Mechanisms of Microbial diseases, 3rd edition. Lippincott Williams and Wilkins. Philadelphia.

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Core Lab 3 : SMBL 31 -LabCourse – Immunology
Contact hours/week: 2

1. Total RBC count
2. Observation of different white blood cells.
3. Differential cell count
4. Preparation of complement
5. Preparation of serum
6. Isolation of DNA from human blood
7. Electrophoretic separation of serum protein
8. Haemagglutination – Blood grouping and Rh typing
9. Diffusion techniques;-single immuno diffusion technique
10. Double immuno diffusion technique

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Allied Lab 3 : SABL 31 - LabCourse –Genetics and Biostatistics
Contact hours/week: 2

To work out

1. Problems in Monohybrid cross
2. Problems in Dihybrid cross,
3. Problems in Test cross,
4. Problems in Back cross
5. Problems in Incomplete dominance.
6. Problems in interaction of genes
7. Problems in multiple alleles
8. Problems in sex determination and sex linkage
9. Problems in linkage and three point test cross
10. Problems in cytoplasmic inheritance.
11. Problems in Mean , Median , Mode
12. Problems in Standard Deviation
13. Problems in Chi square Test

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Course: B.Sc., Biotechnology (S.F)
Semester: 4
Paper: Core 4
Title of the Paper: MOLECULAR BIOLOGY

Code No : SMB41
No. of Hrs allotted: 4
No. of Credits : 4
Marks: 25 + 75 = 100

Course Objective

To appreciate the life process at the molecular level.

To understand the regulatory mechanisms in the flow of genetic information.

Unit :I

Molecular basis of life, principle, scope and application. circular, nicked, super coiled & covalently closed circular DNA – DNA properties – DNA denaturation & renaturation kinetics - melting curve. Hyperchromicity, C-value paradox.

Unit: II

Gene transfer mechanism: Transformation, Conjugation & Transduction- transposable elements – IS elements – transposons. Mutation:- gene mutation – spontaneous and induced mutagenesis – Types of mutagens - molecular basis of mutation.

Unit :III

DNA Replication: Prokaryotic and Eukaryotic DNA replication – Role of replicating enzymes, four models of replication – Conservative, semi conservative, rolling circle model, unidirectional, bidirectional and Okazaki fragments.

Unit: IV

Mechanism of transcriptions: Transcription cycle in prokaryotes and Eukaryotes. Role of RNA polymerases in transcription. RNA splicing, Spliceosome machinery.

Unit: V

Translation; initiation, elongation and termination. Regulation of gene expression in Prokaryotes and Eucaryotes: lac, ara & trp operons – Catabolite repression in Eukaryotes– Post transcriptional and post translational modifications - Hormonal regulations.

Text Books:

- Freifelder, D. 1990. Molecular Biology, 2nd edition. Narosa Publishing House, New Delhi.
- Turner, P. C. 2001. Plant Molecular Biology, 2nd edition. Bios scientific publishers, Oxford
- DeRobertis, E.D.P. and DeRobertis, E.M.F. 2006. Essentials of Cell and Molecular Biology. Holt Saunders Publication, Philadelphia..
- Lee, P. J. 1999. Plant Biochemistry and Molecular Biology, 2nd edition. John Wiley and Sons, New York.

Reference Books:

- James Watson, D. 2004. Molecular Biology of Gene, 5th edition. Pearson education publication, Singapore.
- Benjamin Lewin. 2008. Gene IX. Oxford university press, Oxford

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Course: B.Sc., Biotechnology (S.F)	Code No	: SAB41
Semester: 4	No. of Hrs allotted:	3
Paper: Allied-4	No. of Credits	: 4
Title of the Paper: CELL BIOLOGY AND PHYSIOLOGY	Marks: 25 + 75 =	100

Course Objective:

To understand the basic structure and function of a cell and to appreciate the cell as the basic and fundamental unit of an organism.

To make the students aware of the cellular organization and cell cycle. .

UNIT-I

Cell as a basic unit of function – cell theory. Ultra structure and functions of plant cell and animal cell. Cell wall: Ultra structure, chemical nature, origin and functions.

Bio-Membrane : structure fluid mosaic model. Ultra-structure and chemical composition of Mitochondria

UNIT-II

Organelles: Ultra-structure and chemical composition of Chloroplast, endoplasmic reticulum, microsomes, golgi complex lysosomes and ribosomes. Non-living inclusions or ergastic substances. Nucleus: Morphology and ultrastructure. Chromosomes: morphology of eukaryotic chromosomes, heterochromatin, euchromatin. Cell cycle: Mitosis and meiosis.

UNIT III

Water potential and its components – Absorption of water: apoplast and symplast concept – active and passive mechanism – Transpiration: Mechanism of opening and closing of stomata (theory of K⁺ Transport and hormonal regulation only). Absorption of minerals: Mechanism (Carrier concept Only) – Translocation of organic solutes: Mechanism (electro osmotic theory only)

UNIT IV

Photosynthesis - Cyclic and non-cyclic photophosphorylation. Carbon fixation: C₃, C₄ and CAM pathways – Photorespiration. Respiration: Respiratory substrates – RQ – Aerobic respiration – Glycolysis – TCA cycle – Electron transport and oxidative phosphorylation – pentose phosphate pathway. Respiration: Respiratory organs – Physiology of respiration.

UNIT V

Digestion: Physiology of digestion and enzymes involved; liver & pancreas – Excretion: Structure and Functions of Kidney and nephron . Brain and its function. Circulation: Composition of blood - structure of heart – double circulation. (Mammalian circulation) . Neurotransmitter system; Cell signaling in animals.

Text Books:

- Becker, W.M., Kleinsmith, L.J. and Hardin, J. 2007. The World of the cell, sixth edition, Pearson Education, Inc.
- Noggle, G .R. and G. J. Fritz. 1986. Introductory Plant Physiology. Prentice Hall of India Pvt. Ltd, New Delhi.
- Devlin, R.M, and F. H. Witham. 1986. Plant Physiology. CBS publishers and Distributors, New Delhi.
- Sastry, K.V. 2004. Animal Physiology, first edition. Rastogi Publications, Meerut.
- Verma, P.S. and B. S. Tyagi. 2002. Animal Physiology, sixth edition. S. Chand & Company, New Delhi.

Reference Books:

- DeRobertis, E.D.P. and DeRobertis, E.M.F. 2006. Essentials of Cell and Molecular Biology, Saunders College Publishing, Japan.
- Salisbury, F.B. and C. N. Ross. 2004. Plant Physiology. CBS publishers and Distributors. New Delhi.
- Kavija Juneja, 2002. Animal Physiology, first edition. Anmol Publications, New Delhi.

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Course: B.Sc., Biotechnology (S.F)	Code No : SEB43	<u>Cou</u> <u>rse</u> <u>Obj</u> <u>ecti</u>
Semester: 4	No. of Hrs allotted: 3	
Paper: Elective-3	No. of Credits : 3	
Title of the Paper: METABOLIC PATHWAYS	Marks: 25+75=100	

ves:

To understand the types of metabolic pathways and the role of common intermediate compounds.

To learn the biosynthesis and breakdown of biomolecules.

Unit I

Introduction –Types of metabolic pathways: Catabolic, anabolic, cyclic, anaplerotic, amphibolic Pathways, Bioenergetics: Laws of thermodynamics – First and Second Law ,Redox reactions- Redox potential-coupled reactions, High energy compounds: Standard free energy- ATP biosynthesis

Unit II

Metabolism of carbohydrates:Glucose- Glycolysis - Gluconeogenesis, Glycogen m- Glycogenesis- glycogenolysis, Pentose phosphate pathway, Pyruvate oxidation and Citric Acid cycle. Interrelationship between pathways of glucose metabolism.

Unit III

Metabolism of Lipids; Biosynthesis- Fatty acid – Triacyl glycerols –Cholesterol. Oxidation of Saturated acids fatty acids and unsaturated fatty acid: β oxidation, α oxidation.

Unit IV

Biosynthesis of Aminoacid (Overview) – Protein degradation, oxidative deamination – Urea cycle – transamination.

Unit V

Metabolism of nucleic acids . Purine – Biosynthesis – Catabolism, Pyrimidine – Biosynthesis - Degradation, salvage and denovo pathway of nucleic acids.

Text Book:

- Lehninger, A.L. 2005. Biochemistry V edition, Kalyani Publishers, Ludhiana.
- Zubay, G.L., Pason, W.W. and Vane, D.E. 1995. Principles of Biochemistry W.W.C Brown Publishers , Oxford.

Reference Books:

- Stryer, L. 1995. Biochemistry, Fourth edition. W.H. Free Man & Company New York.
- Voet , D. and Voet, J.D. 1990. Biochemistry. John Wily & Sons, New York.

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Core Lab 4 : SMBL 41 -LabCourse – Molecular Biology
Contact hours/week: 2

1. Isolation of chromosomal DNA in *E. coli*
2. Isolation of RNA from leaf tissues
3. Isolation of plasmids from *E.coli*
4. Phage isolation
5. Transformation experiments in *E.coli*
6. Separation of protein by Polyacrylamide gel electrophoresis
7. Replica plating technique
8. Demonstration of Conjugation
9. Screening of Lactose utilizers
10. Gradient plate technique

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Allied Lab 4 : SABL 41 - LabCourse – Cell Biology and Physiology

Contact hours/week: 2

1. Blood smear preparation: observation of different cells
2. Estimation of blood sugar
3. Demonstration of salivary amylase activity
4. Observation of Haemin crystals.
5. Determination of stomatal index
6. Determination of water potential of potato using falling drop method.
7. Determination of Osmotic potential of cell sap using plasmolysis method.
8. Study of Mitosis in onion root squash
9. Study of Non living inclusions: Starch grain of potato tuber, rice and banana. Cystolith of *Ficus* – raphide of *Acalypha*, Crystals of dry onion peel
10. Haemocytometer – Cell counting
11. Measurement of cell dimension by Micrometry .

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Course: B.Sc., Biotechnology (S.F)	Code No : SBE2
Semester: 4	No. of Hrs allotted: 2
Paper: Skill based Elective-2	No. of Credits : 2
Title of the Paper: Mushroom Technology	Marks: 15 + 35 = 50

Course Objectives:

- To acquire basic knowledge and develop suitable skills involved in mushroom cultivation.
- To learn to occupy oneself during leisure time.

Unit I

History of mushroom Cultivation – Nutritional value of mushrooms, Morphology of mushrooms – Life cycle of mushrooms – Mushroom Cultivation – Temperature, Moisture, Ventilation, growing space. Compost for mushroom cultivation. Preparation of mother Spawn – Spore Culture and Tissue culture method.

Unit II

Cultivation of *Pleurotus* sp and *Agaricus* sp. Spawn and methods of spawning – grain spawn , – storage of spawn – casing – cropping and harvesting – Diseases - Preservation – Do's and don't's of mushroom growing - Analysis of nutrients in fruiting body – Economics of mushroom cultivation - Delicious mushroom recipes

Text Books

- Nita Bahl. 1984. Hand Book of Mushroom. Oxford & IBH Co Ltd, New Delhi.
- Kapoor, J.N.1989. Mushroom cultivation ICAR. New Delhi.
- Banwari George, J. 1998. Basic food microbiology, 2nd Edition. CBS publishers and distributors, New Delhi.

Reference Books:

- Aneja, K.R. 1996. Experiments in Microbiology, Plant pathology. Tissue culture and Mushroom cultivation. Wishwa Prakashan, (New Age International (p) Ltd), New Delhi

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Course: B.Sc., Biotechnology (S.F)	Code No : SMB51
Semester: 5	No. of Hrs allotted: 5
Paper: Core Paper -5	No. of Credits : 4
Title of the Paper: GENETIC ENGINEERING	Marks: 25 + 75 = 100

Course Objective:

- To learn the recent development in gene technology. To appreciate the advancement in genetic engineering.
- To acquire knowledge about the various methods of gene transfer and manipulation.

Unit I

Principles of genetic engineering , Restriction enzymes – nomenclature , classification , types. DNA modifying enzymes – ligases – alkaline phosphatase – DNA polymerase, Holoenzyme – RNases – reverse transcriptase – Poly(A) polymerase, S1 nuclease, terminal deoxy nucleotide transferase.

Unit II

Gene cloning vectors – plasmids: types – isolation and amplification – bacterial plasmids as cloning vectors. pBR322, pUC18 and Col E1. Bacteriophage vector for *E. coli* – lambda phage as a vector – Lambda replacement and insertion vectors and their uses. Shuttle vectors – expression vectors. Cosmid & Phasmid vectors.

Unit III

Core techniques in gene manipulation: Cloning strategies, sticky and blunt end cloning. Cloning from mRNA – synthesis of cDNA, cloning of cDNA using plasmid and phage vectors – Cloning from genomic DNA. Construction of genomic libraries and cDNA libraries.

Unit IV

Methods of selection and screening of recombinant DNA: α -complementation. Hybridization - colony & plaque. Marker inactivation – insertional inactivation – expression screening techniques, radio-labeling. Blotting techniques: Southern, Northern and Western. Chromosome walking & jumping.

Unit V

Gene amplification: Basic principles and applications of PCR - primer designing and optimization. Types of PCR. DNA foot printing, finger printing, Mapping of human genes – human genome project.

Text Books:

- Primrose, S.B. and R.M. Twyman, 2007. Principles of Genome Analysis and genomics, Blackwell publishing, USA.
- Old R. W and S. B. Primrose. 1996. Principles of gene manipulations, Black well Science Publications, London.
- Sandya Mitra, 1998. Genetic engineering, Mac India ltd., New Delhi.
- Watson, J. D., N. H. Hopkins, J.W. Roberts, J.A. Steitz and A .M . Weiner, 1998. Molecular Biology of the gene, fourth edition, The Benjamin / Cummings Publishing Company Inc., Tokyo.

Reference Books:

- Brown. T. A., 2000. gene cloning, Fourth edition, Chapman and Hall Publication, USA.
- Lewin B., 2008. Genes IX, Oxford University Press, Oxford, U.K.
- Winnaker, E.L., 2003. From Genes to Clone: Introduction to Gene Technology, VCH publications, Weinbeim Fedrerel Republic German.

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Course: B.Sc., Biotechnology (S.F)	Code No	: SMB52
Semester: 5	No. of Hrs allotted:	5
Paper: Core Paper-6	No. of Credits	: 4
Title of the Paper: INDUSTRIAL BIOTECHNOLOGY	Marks: 25 + 75 =	100

Course Objective:

- To understand the principles and strategies involved in using biological systems for technological applications.
- To develop an appreciation of the complex strategies involved in a biotechnological process.

Unit I

Definition and scope of industrial biotechnology. Industrial fermentation: Upstream processes – media formulation – media sterilization – inoculum development – screening of industrially important microbes – Strain improvement – Types of fermentation – batch, fed batch, continuous processes.

Unit II

Downstream processing: Biomass separation methods – centrifugation, precipitation, filtration (membrane filtration, gel filtration and fluid filtration) - cell disruption – product recovery - liquid-liquid extraction, chromatography purification, concentration and crystallization.

Unit III

Fermentors or Bioreactors – Principles of chemostat and turbidostat – designs of Batch, Continuous stirrer type fermentor, Tower, Fluidized bed fermentors – operation and control . Industrial alcohol production – gasohol – fermentation of wine and beer

Unit IV

Amino acid fermentation (L – Glutamic acid and L- Lysine). Fermentation of antibiotics [Penicillin & Streptomycin] – organic acids [Citric acid, Lactic acid, Vinegar & Kojic acid] - Vitamins [Riboflavin & Cyanocobalamine] and steroids.

Unit V

Enzyme biotechnology – Principles – Industrial enzyme production methods: tray and deep bed cultivation – enzyme recovery and purification – methods of enzyme immobilization. Production of α – amylase, protease and cellulase - application of industrial enzymes.

Text Books:

- Casida, L.E. Jr. 2001. Industrial Microbiology. New age International Publishers, New Delhi.
- Patel, A.H. 2004. Industrial Microbiology. Macmillan India Ltd, Delhi.
- Crueger, W. and A. Crueger. 2000. Biotechnology: A Textbook of Industrial Microbiology. Panima publishing corporation, New Delhi.
- Reed, G. 1987. Prescott and Dunn's Industrial Microbiology. CBS publishers and Distributors, New Delhi.

Reference Books:

- Stanbury, P.F., A. Whitaker. and S.J. Hall. 2009. Principles of Fermentation Technology. Aditya Books (P) Ltd, New Delhi.

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Course: B.Sc., Biotechnology (S.F)

Code No : SMB53

Semester: 5

No. of Hrs allotted: 5

Paper: Core-7

No. of Credits : 4

Title of the Paper: PLANT BIOTECHNOLOGY

Marks: 25 + 75 = 100

Course Objective:

- To familiarize the students with the basic principles and techniques in tissue culture.
- To impart knowledge on safe handling and maintenance of transgenic plants and products.

Unit: I

Tissue culture: Introduction to *in vitro* methods – use of growth regulators –Callus culture – organogenesis - Somatic embryogenesis –encapsulated seeds and applications. Micropropagation: apical and axillary bud culture - meristem culture. Protoplasts: isolation and culturing of protoplast-Somatic hybridization.

Unit: II

Gene transfer in plants - *Agrobacterium* mediated gene transfer — Ti Plasmid –*Ri* Plasmid Vectors- cointegrate vectors – shuttle vector. Virus mediated gene transfer – plant virus as vectors – Gemini viral vectors – CaMV Vectors

Unit III

Vector less gene transfer - Microinjection, Electroporation and Biolistics. Marker genes for plant transformation – antibiotic – antimetabolite – herbicide resistance markers. Reporter genes- Transgene stability, Expression and gene silencing.

Unit IV

Transgenic plants – resistance to biotic stresses – pest resistance – Bt crops – viral resistance – resistance against fungal and bacterial diseases – Resistance to abiotic stress – herbicides – drought resistance – Improving crop yield - cytoplasmic male sterility – delayed fruit ripening – flavr savr tomato – golden rice.

Unit V .

Bio-pharming – plant as bioreactors- Plantibodies – Plantigens - edible vaccines, interferon production in plants. Transgenic plant as bioreactors. Future prospects for GM Crops.

Text Books:

- Old, R. W. and S. B. Primrose. 2000. Principles of gene manipulation. An introduction to genetic engineering, 5th edition. Blackwell Science Ltd., Oxford
- Winnacker, E. N. 2003. From genes to clones. Panama publishing corporation Pvt., Ltd., New Delhi..
- Subha Rao, N. S. 2003. Soil Microbiology 4th edition. Oxford & IBH Publishing Co, Pvt Ltd, New Delhi.

Reference Books:

- Chawla, H.S. 2004 Introduction to Plant Biotechnology, 2nd edition. Oxford publishing Co. Pvt Ltd, New Delhi.
- Bhojwani, Razdan and M. K. Razdan. 1994. Plant Tissue culture. Elsevier North Holland

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Course: B.Sc., Biotechnology (S.F)	Code No	: SMB54
Semester: 5	No. of Hrs allotted:	4
Paper: core -8	No. of Credits	: 4
Title of the Paper: GENOMICS AND PROTEOMICS	Marks: 25 + 75 =	100

Course Objective:

- To have basic knowledge on Genomics.
- To study the tools for genome analysis.
- To have a basic idea on computational analysis of genome.

Unit I

Introduction to Genomics – Structure and organization of prokaryotic and eukaryotic genomes – nuclear mitochondrial and chloroplast genomes – interaction between nuclear and chloroplast genome.

Unit II

Structural genomics; Automated DNA sequencing - Genome mapping projects – Human, microbes, plants and animals – viral genome - comparative genomics of Prokaryotes and Eukaryotes.

Unit III

Functional genomics: Gene prediction methods Classical – Novel methods; Neural networks Micro array – cDNA, Oligo nucleotide Microarray.

Unit IV

Introduction to Proteomics – Genome – Transcriptome – Proteome - Metabolome – Interactome. Characterization of protein complexes : Protein – Protein interactions – Amino and carboxy terminal sequence analysis – Applications of proteomics.

Unit V

Proteomic Tools – Identification and analysis of protein by 2D PAGE analysis – Mass spectrophotometry, MALDI-TOF, NMR, FTIR, Differential display proteomics.

Text Book:

- Cantor. C and C.W. Smith, 2000, Genomics: The Science and Technology Behind the Human Genome Project, Wiley – Interscience, New York.
- Arthur M Lesk, 2008. Introduction to genomics. Oxford University Press, Oxford.
- Primrose, S.B. and R.M. Twyman, 2007. Principles of Genome Analysis and genomics, Blackwell publishing, USA.
- Wilkins. M. R., K. L. Wilkins., R.D. Appel and Hochstrasser, 1997. Proteome Research and New Frontiers in Functional Genomics Springer – Verlag New York,.
- Walsh G and Haeden, 1994. Protein Biotechnology, John Wiley and sons.

Reference Books:

- Davies. J.M. 1995. Genome Analysis – A Practical Approach, Oxford University Press. Oxford.
- Dear. P.H. 1997. Genome Mapping _ A Practical Approach, Oxford University Press, Oxford.
- Vestermeier, R and T Naven. 2002. Proteomics in practice: a laboratory manual of genome analysis . Wiley – VCH, Weinheim ISBN 357303545.
- Liebler, C. C. 2002 Introduction to proteomics : Tools for the new biology Human, press, Totowa, NJ. ISBN 0585418799
- Link A.L., 1998 2-D Proteome Analysis Protocols, Human press, Totowa, NJ.

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(From 2014-2017 batch onwards)

Core Lab 5 : SMBL 51 -LabCourse – Genetic Engineering

Contact hours/week: 3

1. Separation of bacterial genomic DNA by Agarose Gel electrophoresis.
2. RNA separation by Agarose gel electrophoresis.
3. Isolation and estimation of Cyanobacterial DNA
4. Isolation of plasmid DNA (pDNA) from bacteria
5. Demonstration of Restriction digestion
6. Demonstration of Ligation process
7. Demonstration of Southern blotting of DNA
8. Demonstration of Northern blotting of RNA

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Core Lab 6 : SMBL 52 -LabCourse – Industrial Biotechnology
Contact hours/week: 3

1. Giant colony technique for antibiotic producing organisms.
2. Isolation of antibiotic producing organism
3. Isolation of cellulolytic organisms from soil
4. Mutant strains by UV irradiation
5. Immobilization of cells in calcium alginate beads
6. Alcohol fermentation by yeast and quantification of ethanol.
7. Citric acid production by *Aspergillus niger*
8. Extracellular enzyme fungal amylase.
9. Demonstration of wine production
10. Production of lovastatin by solid state fermentation

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Core Lab 7 : SMBL 53 -LabCourse – Plant Biotechnology
Contact hours/week: 3

1. Preparation of tissue culture medium (MS medium).
2. Preparation of explant.
3. Callus induction from the leaf explants of *Datura*.
4. Shoot initiation from *Datura* callus.
5. Root initiation from *in vitro* formed shoots of *Datura*.
6. Hardening and transplanting.
7. Isolation of nitrogen fixing *Rhizobium*, *Azotobacter*, *Azospirillum* and Phosphate solubilizing bacteria from soil.
8. Isolation of secondary metabolites from callus – TLC method.
9. Demonstration of PCR techniques –RAPD analysis in plants.

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Course: B.Sc., Biotechnology(SF)

Code No :SS

Semester: V

No. of Hrs allotted:

Paper: Self study

No. of Credits:5

Title of the Paper: BOTANICAL WORLD

Marks: 100

Objective :

- To acquire the basic knowledge of plants.
- To understand the role of plants in day-to-day life.

UNIT I :

Plant Science : Origin , some important landmarks in development of Botany. Branches of Botany : Phycology, mycology, bryology, embryology, anatomy , cytology, taxonomy, genetics, paleo botany, agriculture , horticulture, plant breeding

Unit II

Classification and General Characters of Thallophytes, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms.

Unit III

Wonder Plants : Tree fern, Tallest tree (*Sequoia*), century plant (*Agave*), Bamboo, biggest flower (*Rafflesia arnoldii*), Largest leaf (*Victoria regia*), Neelakurinji flower (*Strobilanthes kunthianus*) , Sensitive plant (*Mimosa pudica*), Orchids, Insectivorous plants.

Unit IV

Plant Animal interaction : Symbiosis, Myrmecophily, lac insect, Pollination mechanism and honey.

Plant Propagation: Cutting , Layering and Grafting. Seed Propagation. Silviculture and Nursery Management.

UNIT V :

Plants as : Food makers (primary producers), Scavengers (decomposers), Purifiers (air, water), Industrialists (antibiotics, vaccines, vitamins, beverages, biofertilizers). Medicine (Tulsi, Pepper, Ginger, Eucalyptus, Kilanelli and Turmeric). Plants of the Past : Fossil fuels.

Text Books:

1. G. Brum, L. Mc Kane and G. Karp. 1995. Biology Fundamentals, John Wiley & Sons, Inc., Canada.,
2. D. K. Northington, E. L. Schneider. 1996. The Botanical World, Wm. C. Brown Publishers., .
3. B. Stadler and T. Dixon, 2008. Mutualism: Ants and their insect partners, Cambridge: Cambridge University Press,

Reference Books:

- Charles Darwin, 1908. Insectivorous Plants, London, John Murray.,
- Hendry N. Andrews, JR. 1961. Studies in Paleobotany, John Wiley & Sons INC, New York, London.,
- Attenborough, David, *The Private Life of Plants*, ISBN 0-563-37023-8
- Bellamy, David, *Bellamy on Botany*, ISBN 0-563-10666-2 - An accessible and short introduction to various botanical subjects

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DEPARTMENT OF BOTANY
(From 2014-2017 batch onwards)

Course: B.Sc., Biotechnology (S.F)	Code No	: SMB61
Semester: 6	No. of Hrs allotted:	5
Paper: core -9	No. of Credits	: 4
Title of the Paper: MARINE BIOTECHNOLOGY	Marks: 25 + 75 =	100

Course objective:

- To understand the ecological importance of oceanic habitat.
- To appreciate and admire artistic beauty of marine seaweeds peculiar to themselves. To stimulate the curiosity of the students to unfold the Marine biotechnology in the wider biological sense.

Unit I

Different strata of Oceanic habitat- Physical, chemical and biological aspects and their interaction with marine life- Marine flora: Phytoplankton, Benthos, Seaweeds and Sea grasses - Distribution pattern of sea weed resources in Indian Seas .

Unit II

Marine Pollution: Major pollutant – Biodegradation of waste materials by sea weeds. Biological indicators: Marine microbes and Algae. Monitoring of heavy metal pollution using phytoplankton and seaweeds – Algal bloom – Red tide – Toxic Dinoflagellates – exo and endo toxins – Bioluminescence.

Unit III

Warm water Mariculture: Seaweed farming in India, Japan and Thailand – Methods of seaweed cultivation : Lagoon culture, Coir rope culture, ‘Net’ cultivation method, Seaweed culture by spores method . Indoor & Outdoor mass cultivation & harvesting strategies of marine species of *Spirulina subsalsa*..

Unit IV

Commercial exploitation of Micro & Macro algae: Sources, chemistry and extraction of Phycocolloids: Alginates, Agar-agar and Carrageenan. Seaweed manure and Seaweed liquid fertilizers for agriculture.

Unit V

Utilization of Micro & Macro algae : Major uses of *Porphyra*, *Gracilaria*, *Undaria*, *Laminaria*, *Hypnea* and *Ulva* - Edible seaweeds. Nutraceuticals : Micro algal products – Pigments, Anti-oxidant, Omega-3 Fatty acids and Immune system stimulant. Fodder: Seaweed meal for Pisciculture, Poultry feed and other farm animals .Uses of Diatomite.

Text Books:

- Austin.1992. Marine Microbiology. Camabridge press. London
- Raymont.J. 1963. Plankton and productivity in the Ocean, Pergamon press. London
- Venkataraman,G.S. 1974. Algae: Form and Function. Today's & Tomorrow's publishers, New Delhi.
- Imai, LT. 1982. Progress in shallow sea culture techniques of seaweed culture. Tokyo: Koseisha Koseika publishers (English translation
- Sundaralingam,V. 1991. Marine Algae, Bishan Singh and Mahendra Pal Singh Publishers, Dehradun.

Reference Books:

- Venkataraman,L.V.2002.Application of algal Biotechnology in the next millennium. In: A.Anand (ed.) Algal research in India. Dehradun.India.
- Subramanian G. 1998. Marine Cyanobacteria for feed, fine chemicals & Pharmaceuticals. Cyanobacterial Biotechnology.Oxford IBH Co.pvt.Ltd., New Delhi. ISBN 81-2041269-9.
- Subba Rangaiah, G. 1999. Recent trends in Algal Research. Publisher-Marine Algal Laboratory. Visakapatnam.A.P.
- Krishnamurthy,V. 2000. Algae of India and neighbouring countries. Oxford & IBM Publ

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Course: B.Sc., Biotechnology (S.F)	Code No : SMB62
Semester: 6	No. of Hrs allotted: 5
Paper: Core 10	No. of Credits : 4
Title of the Paper: ANIMAL BIOTECHNOLOGY	Marks: 25 + 75 = 100

Course Objective:

- To understand the mammalian cell culture and transgenic animal technology
- To acquire knowledge on the production of biotechnological molecules and pre implanted genetic diagnosis in human beings.

Unit :I

History & development of cell culture. Simulating natural conditions for growing animal cells. Types of media - Importance of growth factors. Primary culture anchorage dependent and non anchorage dependent cells. Secondary culture, transformed animal cells –established / continuous cell lines. Commonly used animal cells lines – their origin and characteristics. Application of animal cell culture .

Unit :II

Transfection of mammalian cells: Calcium phosphate mediated co- transfection – microinjection – liposome mediated – electroporation - ultrasonication – detergent mixture– use of viruses – viral vectors –SV40 and adenovirus – improved strains – basic properties.

Unit :III

Transgenic animal technology: concept of transgene and transgenics- Expression of foreign genes in transgenic mice –production of transgenic sheep for growth hormone genes – Insertion and expression of transgenes – production of transgenic cattle by pronuclear injection – collection, culture and transfer of embryos. Advantages and disadvantages of transgenesis. Transgenic animals as a model for human disease diagnosis.

Unit :IV

Production of biotechnological molecules : Hybridoma technology.Steps involved in production of recombinant pharmaceuticals – recombinant insulin and interferons. Human growth hormone: Somatostatin and Somatotrophin – Blood products.

Unit: V

Pre implanted genetic diagnosis in human beings: Introduction, Methods and applications – IVR technology-embryo transfer technology: Gamete intra fallopian transfer technology (GIFT) and Zygote intra fallopian transfer technology (ZIFT), Multiple Ovulation Embryo Transfer (MOET). Stem cell culture. Embryonic stem cells and their applications.

Text Books:

- Ranga M. M. 2002 Animal biotechnology 2nd edition. Agrobios, Jodhpur
- Prakash. M, and K. Arora. 1998. Cell & tissue culture 1st Edition, Anomol publication, New Delhi.
- Jogdand, S. N. 2001. Advances in Biotechnology 3rd edition. Himalaya Publishing House, Mumbai.

Reference Books:

- Glick, B. R. and J. J. Pasternak. 2003. Molecular biotechnology. Principles and application of Recombinant DNA; 3rd edition. ASM press Washington D.C

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Course: B.Sc., Biotechnology (S.F)	Code No : SMB63
Semester: 6	No. of Hrs allotted: 5
Paper: Core- 11	No. of Credits : 4
Title of the Paper: ENVIRONMENTAL BIOTECHNOLOGY	Marks: 25 + 75 = 100

Course Objective:

- To learn the principles and concepts of environmental biotechnology.
- To impart knowledge on waste disposal and bioleaching.
- To introduce the concept of bioremediation.

Unit :I

Introduction and Scope of environmental biotechnology. Domestic sewage treatment –Oxidation pond - trickling filter. Activated sludge process - aerated lagoons. Drinking water treatment - Reverse Osmosis.

Unit :II

Industrial effluent treatment: Treatment of waste from dairy, poultry, meat processing, canning, breweries, dye industries and radioactive product wastes.

Unit :III

Biofuel : Biogas- construction of biogas plant – composting – biogas slurry – use of compost in organic farming – Coir pith compost. Biodiesel – bioconversion of cellulose to ethanol – Hydrogen production from microbes.

Unit :IV

Microbial mining — microbial recovery of mineral resources - bioleaching of metals: copper, and uranium - Biodegradable and ecofriendly products – Bio pesticides and Bioplastics.

Unit :V

Bioremediation – types of bioremediation: *in situ* and *ex situ* - application . Phytoremediation. Xenobiotics : Microbial degradation of xenobiotics – Superbug Construction - Biodegradation of pesticides.

Text books:

- Subba rao, N.S. 2001. Soil microbiology. Raju Primlani Publishing Pvt. Ltd., New Delhi.
- Dash, M.C. 2001. Fundamentals of ecology, 2nd edition, Tata McGraw Hill Publishing company Ltd., New Delhi.
- Alexander Glazer, N. 2001. Microbial biotechnology, Third reprint. W.H. Freeman & Company, New York.
- Dubey, R.C. 2001. A text book of microbiology, second reprint. S. Chand and Company Ltd., New Delhi.
- Pradipta Kumar Mohapatra, 2006. Text book of environmental biotechnology, I.K. International publishing house, New Delhi.

Reference Books:

- Jogdand, S. N.2006. Environmental biotechnology,3rd edition. Himalaya Publishing House, Mumbai.
- Markandy, D.K and N. Rajvaidys. 2004. Environmental Biotechnology. APH Publishing Corporation, New Delhi.

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Core Lab 9 : SMBL 61 -LabCourse – Marine Biotechnology
Contact hours/week: 3

1. Study of external morphology and micro preparations of the marine seaweeds: *Ulva*, *Caulerpa*, *Sargassum*, *Turbinaria*, *Padina* and *Gracilaria*
2. Laboratory cultivation of marine cyanobacteria.
3. Extraction and processing of agar agar and carrageenan from red seaweeds.
4. Extraction and processing of alginates from marine kelp.
5. Extraction of chlorophylls and carotenoids from macroscopic marine green algae
6. Bioremediation of oil spilled effluent using marine cyanobacteria.
7. Biosorption of heavy metal from ore effluent using seaweeds and cyanobacteria.
8. Preparation of sea weed liquid fertilizers (SLF) from brown and red seaweeds.
9. Effect of SLF of on seed germination.

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Core Lab 10 : SMBL 62 -LabCourse – ANIMAL BIOTECHNOLOGY
Contact hours/week: 3

1. Blood grouping.
2. Haemagglutination – Immuno electrophoresis
3. Preparation of antigens-methods of bleeding-preparation of serum.
4. Complement fixation.
5. Antibody titration
6. Lymphocytes isolation from spleen.
7. Lymphocytes isolation from blood.

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Core Lab 11 : SMBL 63 -LabCourse – ENVIRONMENTAL BIOTECHNOLOGY
Contact hours/week: 3

1. Physico -chemical characterization of effluents – colour, pH, Temp. COD & BOD.
2. Biological treatment of oil spilled effluent.
3. Bioremediation of heavy metal .
4. Biological treatment of leather effluent.
5. Study of effect of treated effluent on seed germination / plant growth
6. Demonstration of Biogas production
7. Demonstration of composting of Agricultural wastes.
8. Demonstration of composting from coir pith compost.
9. Extraction of Biodiesel.
10. Demonstration of bioconversion of cellulose to ethanol.

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Course: B.Sc., Biotechnology (S.F)
Semester: 6
Paper: Skill based Elective-3
Title of the Paper: Organic Farming

Code No : SBE 3
No. of Hrs allotted: 2
No. of Credits : 2
Marks: 35+15=50

Course Objectives

- To know about the organic farming and their role in the maintenance of soil fertility
- To orient student learning towards application and career options in the field of biofertilizers.

Unit I

Composting: Types of composting, materials for composting, composting process, , decomposition stages in composting, vermicomposting - Vermiwash, Coir pith composting. Preparation of Panchakavya and its applications.

Unit II

Biofertilizers: Definition – Organisms involved – Bacteria: *Rhizobium*, *Azotobacter*, *Azospirillum* and Phosphobacteria. Isolation, characterization, identification, mass cultivation and inoculation method. Genetics of Nitrogen fixation- *Klebsiella pneumoniae* – Symbiotic bacteria – *Rhizobium*.

Cyanobacterial Biofertilizer: Algalization – mass cultivation of cyanobacterial biofertilizers – mass production of carrier – based, immobilized cyanobacterial inoculants. *Azolla* – Morphology – Mass cultivation and Application.

References:

- Kannaiyan, S. 2002 Biotechnology of Biofertilizers. Narosa publishing house, New Delhi.
- Dubey, R.C. 2001. A text book of microbiology, second reprint. S. Chand and Company Ltd., New Delhi.

Refernce Books

- Ann Larkin Hansen, 2010, The Organic Farming Manual: A Comprehensive Guide to Starting and Running a Certified Organic Farm. Storey Publishing LLC.

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Course: B.Sc., Biotechnology (S.F)	Code No : NME1
Semester: III	No. of Hrs allotted: 2
Paper: Non major Elective -1	No. of Credits : 2
Title of the Paper: VOCATIONAL BIOTECHNOLOGY	Marks: 35+15=50

Course Objectives:

- To know about the organic farming and their role in the maintenance of soil fertility.
- To acquire basic knowledge and develop suitable skills involved in microbial protein production.
- To learn to occupy oneself during leisure time.

Unit 1:

Organic farming Technology : Composting methods – Indoor and Berkely method – Vermiculture. Vermicomposting – Vermiwash - Preparation of panchakavya and its applications. Advantages of Organic farming.

Unit 2:

Microbial protein production technology: cultivation methods for Algal-*Spirulina* , Fungal-yeast –importance of single cell proteins. Microbes as probiotics-*Lactobacillus*

Text Books:

Dubey, R. C. 2002. A text book of Biotechnology S. Chand & Co, New Delhi.
Casida, L.E. 2001 Industrial Microbiology New age International publication. New Delhi.

Reference Books:

Venkataraman, L.V. and E.W. Beaker 1985. Biotechnology and utilization of Algae. The Indian experience. CFTRI Mysore pp 257

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Course: B.Sc., Biotechnology (S.F)	Code No	: NME2
Semester: IV	No. of Hrs allotted	: 2hrs
Paper: Non major Elective -2	No. of Credits	: 2
Title of the Paper: FOOD PROCESSING TECHNOLOGY	Marks: 15 + 35 =	50

Course Objectives:

- To acquire basic knowledge & develop suitable skills involved in microbial protein production.
- To have training in food processing technology.
- To learn to occupy oneself during leisure time.

Unit 1:

Mushroom technology: spawn preparation and cultivation methods of *Pleurotus* sp. And *Agaricus* sp Nutritional and Medicinal value of mushrooms –Delicious mushroom recipe.

Unit 2:

Vegetable and fruit processing technology Preparation of jam, jelly, squash and pickle. Preservation: low temperature, high temperature chemical preservation. Milk products: Cheese production technology.

Text book:

- Casida, L. E. 2001. Industrials Microbiology. New age International publication. New Delhi.
- Frazier, P.C and P.C. Weathoft ..1988. Food Microbiology. Compass Ltd, New Delhi.
- Nita Bahl. 1984. Hand Book on Mushrooms. Oxford & IBH Publishing Ltd, New Delhi.

Reference Books:

- Kapoor, J.N.1989. Mushroom cultivation ICAR. New Delhi.
- Banwari George, J. 1998. Basic food microbiology, 2nd Edition. CBS publishers and distributors, New Delhi.
- Aneja, K.R. 1996. Experiments in Microbiology, Plant pathology. Tissue culture and Mushroom cultivation. Wishwa Prakashan, (New Age International (p) Ltd), New Delhi

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Course: B.Sc. Botany
Semester: I&II semester
Paper: Certificate Course
Title of the Paper: **Biopesticides**

Contact hours per week: 2
Contact hours per semester: 20Hrs
Marks : 25+75=100

Course Objectives:

- To understand the principles of biological control
- To know about various bio-control agents.

Unit I: Types of Plant pests: Insects & Nematodes, Biopesticides: Introduction, importance and classification. Biological control of Insect pests: Scope and principles, factors affecting biological control— living creatures to control pests—Biological control of weeds.

Unit II: Botanical principles: Present status and future prospects; opportunities for botanical pesticides in crop rotation; multiple cropping for controlling pests. Plants as a source of natural pesticides: Mustard, Chrysanthemum, Pepper, Garlic, Turmeric and Citronella.

Unit III: Biocontrol agents: Isolation, identification, mode of action and mass production of *Pseudomonas fluorescense* (bacterial agent), *Trichoderma viride* (fungal agent); application against seed borne and soil borne diseases.

Unit IV: Biological Pesticides: Isolation, identification, Bacterium as biopesticide: *Bacillus thuringiensis*; Fungus as biopesticide (entomophagous); *Beauveria bassiana* and *Arthrobotrys*. Insect as biopesticide: *Trichogramma*. Virus as biopesticide: Baculovirus: NPV.

Unit V: Production methods of biopesticides: Liquid culture fermentation – Types of biopesticide formulations; Dry inoculum, Granules, Pellets, Capsules, Wettable powder and liquid formulations. Genetic engineering and pest resistant plants (outline only).

Text Books:

1. Ghosh, G.K. 2000. Biopesticide and Integrated pest management, APH Publishing corporation, New Delhi.
2. Subba Rao, N.S. 1982. Advances in Agricultural Microbiology, Oxford & IBH Publishing Company, Chennai.

Refernce Books:

1. Hell, F.R. and Menn, J.J. 1999. Biopesticides – Use and delivery, Humene Press, New Jersey.
2. Dent, D. 2000. Insect Pest Management, Second Edition, ABI Publishers, UK.

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DEPARTMENT OF BOTANY
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Course: M.Sc. Botany	Contact hours per week	: 3
Semester: I	Contact hours per semester	: 30
Paper: Diploma Course	Marks	: 25+75=100
Title of the Paper: Medicinal Botany		

Course Objectives:

- To motivate the students to identify and make use of medicinal plants.
- To impart knowledge on medicinal plant conservation

Unit I: Medicinal Botany – History, importance, present status and future prospects.

Introduction to system of medicines - siddha, ayurveda, homeopathy and unani, development and control; bio- resource of botanical medicine – terrestrial and aquatic origin.

Unit II: Medicinal plant diversity, distribution, availability; systematic of medicinal plants and allied drug – medicinal plants classification – morphology, pharmacognosy, chemical compounds.

Unit III: Study of the following plants with reference to the habit, systematic position, morphology of useful parts; cultivation, collection and drug preparation, utilization of *Tylophora asthmatica*, *Digitalis purpurea*, *Ocimum sanctum*, *Catharanthus roseus*, *Phyllanthus amarus* and *Andrographis paniculata*.

Unit IV: Adulteration of crude drugs- methods of adulteration, type of adulteration, detection methods; major medicinal plants and its adulterants (*Gymnema sylvestre*, *Curcuma langa*, *Piper nigrum*, *Cassia senna* and *Withania somnifera*).

Unit V: Conservation of medicinal plants – *in situ* and *ex situ* – herbal gardens, sacred groves, Conservation through biotechnology and genetic engineering; medicinal plant policy and IPR in India.

Text Books:

1. Srivastava, A.K. 2006. Medicinal plants, International Book Distributors, Dehradun.
2. Yoganarasimhan, S.N. 2000. Medicinal plants of India, Vol.2. Tamil Nadu, Inderline Publishing Private Ltd., Bangalore.
3. Joshi, S.G. 2000. Medicinal Plants. Oxford and IBH company private Ltd., New Delhi.

Reference Books:

1. Bhattacharjee, S.K. 2004. Handbook on Medicinal Plants. Pointer Publishers, Jaipur.
2. Farooqi A.A and B.S. Sreeramu. 2001. Cultivation of Medicinal and Aromatic Crops, University Press, Delhi.
3. Kokate *et al.* 1994. Pharmacognosy Nirali Prakashan, Delhi.

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Course: M.Sc. Botany	Contact hours per week	: 3
Semester: II	Contact hours per semester	: 30
Paper: Diploma Course	Marks	: 25+75=100
Title of the Paper: Herbal Technology		

Course Objectives:

- To educate medicinally important plants
- To educate the significance of health foods and condiments.
- To study the plant constitutions – Alkaloid, Terpenoids & Glycosides

Unit I: Introduction and classification of medicinal plants; poisonous plants; Ethnobotany ; myth and drug discovery; Indian trade – resources of medicinal and aromatic plants; homemade medicine (juice, infusion, paste, tincture, soup, tonic, decoction, medicated oil), herbal active principles in recent pharmaceutical industry.

Unit II: Herbs in cosmetic industry and commercial products – face creams, oral cares (mouth wash, tooth paste, tooth powder), flavor and fragrance; single and polyherbal formulations of drugs – for nutritional, tropical and sub-tropical diseases and ailments (skin diseases, diabetics, laxatives, fever, cold and cough, urinary infection, etc.).

Unit III: Aroma therapy – introduction and significance, extraction procedure of aroma or essential oil from plants. Eucalyptus oil, Turpentine oil, Citronella oil, Sandal wood oil, Geranium oil, Winter green oil, Menthol, Clove oil.

Unit IV: Quality control of herbal raw materials, extracts and final products – Pharmacognosy and biochemistry; identification, solubility (water and ethanol), total ash, acid insoluble ash, pH heavy metal analysis, microbial limit; Qualitative and Quantitative identification and estimation of active principle.

Unit V: Herbal industrial process – standard operating procedures (SOPs)- grinding, formulation, mixing, capsulation and packing; clean air environment – sterilization and cleaning of work space and machinery; Food and Drug (FDA) certification bodies (national and international level) – National rules and regulation on herbal products.

Text Books:

1. Srivastava, A.K. 2006. Medicinal plants, International Book Distributors, Dehradun.
2. Yoganasimhan, S.N. 2000. Medicinal plants of India, Vol.2. Tamil Nadu, Inderline Publishing Private Ltd., Bangalore.
3. Joshi, S.G. 2000. Medicinal Plants. Oxford and IBH company private Ltd., New Delhi.

Reference Books:

1. Bhattacharjee, S.K. 2004. Handbook on Medicinal Plants. Pointer Publishers, Jaipur.
2. Farooqi A.A & Sreeramu. B.S. 2001. Cultivation of Medicinal and Aromatic Crops, University Press.
3. Pharmacognosy – Kokate et. al., (1994). Nirali Prakashan, Delhi.