VIVEKANANDHA COLLEGE OF
ARTS AND SCIENCES FOR WOMEN
[Autonomous]
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Elayampalayam - 637 205. Tiruchengode, Namakkal Dt., Tamil Nadu

1.1 Curriculum Design and Development

1.1.2

SYLLABUS REVISION

M. Sc., BOTANY

2018 - 19

PG AND RESEARCH DEPARTMENT

OF BOTANY

Vivekanandha

College of Arts and Sciences for Women, Elayampalayam, Tiruchengode

(Autonomous)

M. Sc., Botany – Outcome Based Education

(For the candidates admitted from the Academic year 2018 - 2019 Onwards)

Sem	Course	Code	Course Title	Inst. Hrs.	Credit	Exam Hrs.	Marks		
							CIA	EA	Total
I	Core Course I	18P1BO01	Diversity of Plants - I	5	5	3	25	75	100
	Core Course II	18P1BO02	Diversity of Plants - II	5	5	3	25	75	100
	Core Course III	18P1BO03	Taxonomy of Angiosperms	5	5	3	25	75	100
	Core Course IV (Practical I)	18P2BOP01	Comprising Core Course I & II (Examination at the end of II Semester)	6	3	4	40	60	100
	Core Course V (Practical II)	18P2BOP02	Comprising Core Course III (Examination at the end of II Semester)	6	3	4	40	60	100
	Elective I	18P1BOE01A/B	Herbal Botany/Plant Breeding and Evolution	3	3	3	25	75	100
			Total	**30**	**24**		**180**	**420**	**600**
II	Core Course VI	18P2BO04	Anatomy of Angiosperms, Embryology of Angiosperms and Plant Micro technique	6	5	3	25	75	100
	Core Course VII	18P2BO05	Cell and Molecular Biology and Genetics	6	5	3	25	75	100
	Core Course VIII (Practical III)	18P2BOP03	Comprising Core Course VI & VII	8	4	4	40	60	100
	Elective II	18P2BOE02A/B	Fundamentals of Computer Technology/Nanotechnology	5	4	3	25	75	100
	Elective III	18P2BOE03A/B	Plant Biotechnology and Bioinformatics/Genomics and Proteomics	5	4	3	25	75	100
			Total	**30**	**22**		**140**	**360**	**500**

III	Core Course IX	18P3BO06	Plant Physiology and Biophysics	6	5	3	25	75	100
	Core Course X	18P3BO07	Environmental Biology and Resource Management	5	5	3	25	75	100
	Core Course XI	18P3BO08	Microbiology and Plant Pathology	5	5	3	25	75	100
	Core Course XII(Practical IV)	18P4BOP04	Comprising Core Course IX, X & XI(Examination at the end of IV Semester)	8	4	4	40	60	100
	EDC	18P3BOED01	Herbal Botany	4	4	3	25	75	100
	Value Education	18P3HR01	Human Rights	2	1	2	25	75	100
			Total	**30**	**24**		**165**	**435**	**600**
IV	CoreCourse XIII	18P4BO09	Biochemistry and Biostatistics	5	4	3	25	75	100
	CoreCourse XIV	18P4BO10	Instrumentation Techniques	5	4	3	25	75	100
	Core Course XV (Practical V)	18P4BOP05	Comprising Core Course XIII & XIV	8	4	4	40	60	100
	Elective IV	18P4BOE04A/B	Pharmacognosy and Phytochemistry/Solid Waste Management	4	4	3	25	75	100
	Project Work	18P4BOPR01	-	8	4	-	40	60	100
			Total	**30**	**20**		**155**	**345**	**500**
							640	**1560**	
			Total No. of Hours and Credits	**120**	**90**		**2100**		

Deletion

M.Sc., Botany – CBCS Pattern

For Students Admitted from the academic year 2017 – 2018

Semester I – Core Course I (Paper code: 17P1BO01)

DIVERSITY OF PLANTS - I

(ALGAE, FUNGI, LICHENS AND BRYOPHYTES)

Max. Marks: 75

Credits : 5

Total hours : 75

Objectives:

- To understand the general characters, classification, ecology and economic importance of Algae
- To study the structure and reproduction of selected genera of algae
- To understand the general characters, classification, ecology and economic importance of Fungi
- To study the occurrence, structure and reproduction of selected genera of fungi
- To study about the lichens, history and classification of selected genera of Bryophytes

UNIT-I (15) hrs

Algae: General characteristics with reference to thallus structure, pigmentation and life cycle. Classification of algae (Bold and Wynne, 1978). Criteria used in algal classification. Ecology of algae. Economic Importance of algae.

UNIT-II (15) hrs

Structure and reproduction of the following genera of algae: *Lyngbya, Nostoc, Cladophora, Codium, Padina, Batrachospermum* and *Gracilaria*.

UNIT-III (15) hrs

Fungi: General characteristics of Fungi with reference to their occurrence, thallus structure and reproduction. Classification of Fungi by Alexopolous & Mims (1979). Nutrition in Fungi. Heterothallism- Parasexuality. Phylogeny and affinities of fungi Importance of Fungi.

UNTI -IV **(15) hrs**

Detailed study of the occurrence, thallus structure and reproduction of the following genera of fungi: *Pernospora, Aspergillus, Polyporus* and *Fusarium.*

UNTI-V **(15) hrs**

A general account of Lichens with special reference to their structure and reproduction. Life history and classification of Bryophytes (Watson, 1963). Ecology and evolution of Bryophytes. Fossil Bryophytes. A detailed study of *Targionia, Dumortiera* and *Funaria.*

Text Book:

1. Sharma, P. D. 2003. The Fungi. ELBS Publication, London

Reference books:

1 .Sohan Sharma, 2012. Advances In Mycology, Random Publications Publishers and Distributors, New Delhi.

2. Fritsch, F.E.1945, 1955. The structure and reproduction of Algae, (Vol-I and II). Cambridge University Press, London.

Addition

SEMESTER I

Programme Code	**M. Sc.**	**Programme Title**	**Master of Science (Botany)**	
Course Code	**18P1BO01**	**Title**	**Batch**	**2018 -2020**
Hours/Week	**5**	**Diversity of Plants - I**	**Semester**	**I**
			Credits	**05**

Course Objective

To study the general characters, classification, thallus structure, reproduction, life cycle and economic importance of algae, fungi, lichens and bryophytes.

Course Outcomes (CO)

K1	CO1	To acquire knowledge on Morphology, Ecology and Economic importance of Algal forms.
K2	CO2	To understand and analyse structure, Reproduction and Characteristic feature of Fungal Organisms.
K3	CO3	To develop an entrepreneurship skill among the plant Science graduates for the production of industrial products.
K4	CO4	To create awareness on conservation of lower plants of Thallophytes.

UNIT - I **(15Hours)**

Algae: General characteristics with reference to thallus structure, pigmentation and life cycle. Classification of algae (Bold and Wynne, 1978) - Criteria used in algal classification - Ecology of algae - Economic Importance of algae.

UNIT - II **(15Hours)**

Structure and reproduction of the following genera of algae: *Lyngbya*, *Nostoc*, *Cladophora*, *Codium*, *Padina*, *Batrachospermum* and *Gracilaria*.

UNIT – III **(15Hours)**

Fungi: General characteristics of fungi with reference to their occurrence, thallus structure and reproduction - Classification of fungi by Alexopoulos and Mims (1979). Nutrition in fungi -

Heterothallism- Parasexuality - Phylogeny and affinities of fungi –Economic importance of fungi.

UNIT - IV **(15Hours)**

Detailed study of the occurrence, thallus structure and reproduction of the following genera of fungi: *Peronospora, Aspergillus, Polyporus* and *Fusarium.*

UNTI - V **(15Hours)**

A general account of lichens with special reference to their structure and reproduction - Life history and classification of Bryophytes (Watson, 1963) - Ecology and evolution of Bryophytes - Fossil Bryophytes - A detailed study of *Targionia, Dumortiera* and *Lunularia* . 5%

Text Books:

1. Sharma, P. D. 2003. The Fungi. ELBS Publication, London
2. Alexopoulos, C. J and Mims, C. W. 1979. Introductory Mycology. Wiley Eastern Publication, New Delhi.
3. Chopra, R. N. & Kumar, P. K. 1988. Biology of Bryophytes. John Wiley, New York.
4. Smith, A. J. E. 1982. Bryophyte ecology. Chapman and Hall, London.
5. Dubey, H. C. 1990. An introduction to Fungi. Vikas publishing House, New Delhi.

Reference Books:

1. Sohan Sharma, 2012. Advances In Mycology, Random Publications Publishers and Distributors, New Delhi.

2. Fritsch, F.E.1945, 1955. The structure and reproduction of Algae, (Volume -I and II). Cambridge University Press, London.

3. Lewin, R.A.1972. Physiology and Biochemistry of Algae. Academic Press, New York.

4. Burnett, J.H. 1971. The fundamentals of Mycology. ELBS Publications, London

5. Hale Jr.M.E.1983. Biology of Lichens. Edward Arnold, Mary land.

6. Watson, E.V.1970. Structure and Life of Bryophytes. Hutchinson and Co., London.

7. Watson, E. V. 1968. British Mosses and Liverworts. Hutchinson and Co., London.

Dr. M. KANNAN, M.Sc.,B.Ed.,Ph.D.
HEAD
PG and Research Department of Botany,
Vivekanandha College of Arts and Sciences for Women
(Autonomous)
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Deletion

M.Sc., Botany – CBCS Pattern

For Students Admitted from the academic year 2017 – 2018

Semester I – Core Course II (Paper code: 17P1BO02)

DIVERSITY OF PLANTS - II

(PTERIDOPHYTES, GYMNOSPERMS AND PALAEOBOTANY)

Max. Marks : 75
Credits : 5
Total hours : 75

Aim:

- To enable the students to study the higher group of non flowering plants

Objectives:

- To study the classification, structure of sporophytes and gametophytes of Pteridophytes
- To understand the structure, reproduction and affinities of the sporophyte and gametophytes of selected genera of Pteridophytes
- To understand the general characters, classification of orders in Gymnosperms
- To study the morphology and anatomy of the vegetative and reproductive structure of selected genera of Gymnosperms
- To study important fossils of both Pteridophytes and Gymnosperms

UNIT-I **(15 hrs)**

Classification of Pteridophytes (Sporne, 1976). Evolution of Sorus in ferns. Range in morphology, structure of gametophytes and sporophytes of the following orders - Psilotales, Isoetales, Equisetales, Filicales and Salviniales. Stelar evolution in Pteridophytes. Heterosporyand Seed habit.

UNIT-II **(15 hrs)**

Detailed study of range in structure, reproduction and affinities of the gametophytes and sporophytes with special reference to *Psilotum, Isoetes, Equisetum, Angiopteris, Pteris, Osmunda* and *Salvinia.*

UNIT-III **(15 hrs)**

Classification of Gymnosperms (Sporne, 1967). General account of Pteridospermales and Bennettitales. Comparative morphology and phylogeny of Cycadales, Coniferales and Gnetales. Evolution of male and female gametophyte.

UNTI -IV **(15 hrs)**

Study of morphology and anatomy of the vegetative and reproductive structures of *Araucaria, Podocarpus* and *Cupressus.*

UNTI-V **(15 hrs)**

Fossils and fossilization- methods, types of fossils. Study of morphology and anatomy of the vegetative and reproductive structure in the following fossil forms: *Sphenophyllum, Lyginopteris* and *Cordaites.*

Learning outcome:

- Importance and conservation of plant diversity.

Text Book:

1. Sharma, O.P. 2012. Pteridophyta, Tata McGraw Hill Publishing Company, New Delhi.

Reference books:

1. Foster and Gifford, Jr., 1962. Comparative Morphology of Vascular Plants. Allied Pacific Private Limited, Mumbai.

2. Beek, G. E., 1988. Origin and Evolution of Gymnosperms. Colombia University Press.

Dr. M. KANNAN, M.Sc.,B.Ed.,Ph.D.
HEAD
PG and Research Department of Botany,
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(Autonomous)
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Addition

SEMESTER I

Programme Code	M. Sc.	Programme Title	Master of Science (Botany)	
Course Code	18P1BO02	Title	Batch	2018 -2020
Hours/Week	5	Diversity of Plants - II	Semester	I
			Credits	05

Course Objective

To study the general characters, classification, reproduction and life cycle of Pteridophytes, Gymnosperms and fossils.

Course Outcomes (CO)

K1	CO1	To bridge the gap between fossils and present day living forms
K2	CO2	To acquire knowledge on phylogenetic trends occur in Plant.
K3	CO3	To understand the structure and reproduction of Pteridophytes and Gymnosperms.
K4	CO4	To acquire knowledge on plants existing in the past.

UNIT - I (15Hours)

Classification of Pteridophytes (Sporne, 1976) - Evolution of sorus in ferns – General characters of the following orders - Psilotales, Isoetales, Equisetales, Filicales and Salviniales - Stelar evolution in Pteridophytes – Heterospory and seed habit. **4%**

UNIT - II (15Hours)

Detailed study of range in structure, reproduction and affinities of the gametophytes and sporophytes with special reference to *Psilotum, Isoetes, Equisetum, Angiopteris, Pteris, Osmunda* and *Salvinia.*

UNIT - III (15Hours)

Classification of Gymnosperms (Sporne, 1967). General account of Pteridospermales and Bennettitales. Comparative morphology and phylogeny of Cycadales, Coniferales and Gnetales. Evolution of male and female gametophyte.

UNTI - IV **(15Hours)**

Study of morphology and anatomy of the vegetative and reproductive structures of *Araucaria, Podocarpus* and *Cupressus.*

UNTI - V **(15Hours)**

Fossils and fossilization- methods, types of fossils. Study of morphology and anatomy of the vegetative and reproductive structure in the following fossil forms: *Sphenophyllum*, *Lyginopteris* and *Cordaites.*

Text Books:

1. Sharma, O.P. 2012. Pteridophyta, Tata McGraw Hill Publishing Company, New Delhi.
2. Biswas, C. and Johri, B. M. 2004. The Gymnosperms. Narosa Publishing House, New Delhi.
3. Sporne, K. R. 1965. The Morphology of Gymnosperms. Hutchinson University Press, London.
4. Sporne, K. R. 1965. The Morphology of Pteridophytes. Hutchinson University Press, London.
5. Shukla, A. C. and Sharma, M. 1992. Plant fossils - A link with the past, Birbal Sahni Institute of Palaeobotany, Lucknow, India.
6. Vashishta, B. R. 1987. Pteridophyta. S. Chand and Company, New Delhi.
7. Smith, G. M. 1935. Cryptogamic Botany. Vol. 11. Tata McGraw Hill Publishing Company, New Delhi.
8. Parihar, N. S. 1965. The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
9. Rashid, A. 1979. An Introduction to Pteridophyta. Vikas Publishing House, New Delhi.

Reference books:

1. Foster and Gifford, Jr., 1962. Comparative Morphology of Vascular Plants. Allied Pacific Private Limited, Mumbai.
2. Beek, G. E., 1988. Origin and Evolution of Gymnosperms. Colombia University Press.
3. Bhatnagar and Moitra, 1996. Gymnosperms. New age International Publishers, New Delhi.

4. Chamberlain. J. 1934. Gymnosperms: Structure and Evolution. Chicago Publisher. (Reprinted 1950), New York.
5. Arnolds, C. A., 1947. An Introduction to Paleobotany, McGraw Hill Book Company, New York.
6. Surange, K. R., 1966. Indian Fossil Pteridophytes. CSIR, New Delhi.

M.Sc., Botany – CBCS Pattern **Deletion**

For Students Admitted from the academic year 2017 – 2018

Semester I – Core Course III (Paper code: 17P1BO03)

Taxonomy of Angiosperms and Economic Botany

Max. Marks : 75

Credits : 5

Total hours : 75

Objectives:

- To study the important systems of classifications of Angiosperms
- To understand the modern trends in classification
- To study the plant identification methods and ICBN
- To study the vegetative and reproductive characters of selected families of Angiosperms

Unit I **(15 hrs)**

History and principles of classification. Detailed account of the system of classification proposed by Bentham and Hooker, Bessey, Hutchinson and Cronquist (Including merits and demerits). Herbarium techniques.

Unit II **(15 hrs)**

Modern trends in classification. Taximetrics, Chemotaxonomy and Biosystematics. BSI-Organization, function and contribution. Taxonomic literature – Taxonomic index, Monographs and Revisions.

Unit III **(15 hrs)**

Plant identification – Methods of identification. Keys: Types of keys, rules for construction of keys, advantages and disadvantages. Nomenclature, ICBN, Typification, Priority, Publication, Author citation and retention, Choice and rejection of names.

Unit-IV **(15 hrs)**

A detailed account of the following families and their economic importance- Menispermaceae, Magnoliaceae, Caryophyllaceae, Oxalidaceae, Meliaceae, Sapindaceae, Polygalaceae, Lythraceae, Aizoaceae and Moringaceae.

Unit-V **(15 hrs)**

Boraginaceae, Bignoniaceae, Rhizophoraceae, Oleaceae, Moraceae, Orchidaceae, Dioscoriaceae, Loranthaceae, Aristolochiaceae, Cactaceae, Cypraceae and Poaceae.

Text Book:

1. T.Pullaiah ,2007 Text Book of Angiosperms , Regency Publications
2. Annie Roland, 2005. Taxonomy of Angiosperms, Saras Publication, Nagercoil.
3. Lawrence, G.H.M.1955. The taxonomy of vascular plants (Vol.I-IV).Central Book Depot. Allahabad.
4. Singh,V and Jain,V.K.1989.Taxonomy of Angiosperms. Rastogi Publication, Meerut.
5. Sivarajan, V. V. 1989. Introduction to principles of plant Taxonomy.Oxford and IBH, New Delhi.
6. Subramaniyam, N.S.1995. Modern plant taxonomy.Vikas publishing house,New Delhi.

References:

1. Davis, P.H. and Heywood, V.M. 1965. Principles of Angiosperm Taxonomy. Oliver and Boyd Edinburgh.
2. Gamble, J.S. and Fisher, L.E.F. 1967. The flora of the Presidency of madras (volume I. III). BSI, Calcutta.
3. Grant, E.F. 1984. Plant Biosystematics. Academic Press Inc., Canda.
4. Heywood, V.H. 1967. Plant taxonomy. Edward Arnold, Great Britain.
5. Hutchinson, J. 1973. The families of flowering plants. Oxford University Press, London.
6. Mathew, K.M. 1983. The flora of Tamil Nadu Carnatic. The Rapinet Herbarium, Trichy.
7. Santapau,H and Henry, H.D.1994. A dictionary of flowering plants of India. C.S.N., New Delhi.

SEMESTER I **Addition**

Programme Code	M. Sc.	Programme Title	Master of Science (Botany)	
Course Code	18P1BO03	Title	Batch	2018 -2019
Hours/Week	5	Taxonomy of Angiosperms	Semester	I
			Credits	05

Course Objective

To study the general characters, identification, classification of angiosperms.

Course Outcomes (CO)

K1	CO1	To develop knowledge on identification of plants.
K2	CO2	To develop the skills on cultivation techniques of economically useful plants.
K3	CO3	To understand the different system of classification.
K4	CO4	To apply the knowledge of the herbarium techniques in the preservation, conservation and identification of plants.

Unit - I **(15 Hours)**

History and principles of classification - Detailed account of the system of classification proposed by Taktajan, Bessey, Hutchinson and Cronquist (Including merits and demerits) - Herbarium techniques.

Unit - II **(15 Hours)**

Modern trends in classification - Taximetrics, Chemotaxonomy and Biosystematics. BSI- Organization, function and contribution - Taxonomic literature – Taxonomic index, Monographs and Revisions.

Unit - III **(15 Hours)**

Plant identification – Methods of identification - Keys: Types of keys, rules for construction of keys, advantages and disadvantages - Nomenclature, ICBN, Typification, Priority, Publication, Author citation and retention, Choice and rejection of names.

Unit - IV **(15 Hours)**

A detailed account of the following families and their economic importance- Menispermaceae, Magnoliaceae, Caryophyllaceae, Oxalidaceae, Meliaceae, Sapindaceae, Polygalaceae, Lythraceae, Aizoaceae and Moringaceae.

Unit - V **(15 Hours)**

Boraginaceae, Bignoniaceae, Rhizophoraceae, Oleaceae, Moraceae, Orchidaceae, Nyctaginaceae, Loranthaceae, Aristolochiaceae, Cactaceae, Cyperaceae and Poaceae. **2%**

Text Books:

7. T. Pullaiah, 2007 Text Book of Angiosperms, Regency Publications.
8. Annie Roland, 2005. Taxonomy of Angiosperms, Saras Publication, Nagercoil.
9. Lawrence, G.H.M.1955. The taxonomy of vascular plants (Vol. I - IV). Central Book Depot. Allahabad.
10. Singh, V and Jain, V. K. 1989. Taxonomy of Angiosperms. Rastogi Publication, Meerut.
11. Sivarajan, V. V. 1989. Introduction to principles of plant Taxonomy. Oxford and IBH, New Delhi.
12. Subramaniyam, N.S.1995. Modern Plant Taxonomy. Vikas Publishing House, New Delhi.

Reference Books:

8. Davis, P.H. and Heywood, V.M. 1965. Principles of Angiosperm Taxonomy. Oliver and Boyd Edinburgh.
9. Gamble J.S. and Fisher, L.E.F. 1967. The flora of the Presidency of madras (volume I. III). BSI, Calcutta.

10. Grant, E.F. 1984. Plant Biosystematics. Academic Press Inc., Canada.
11. Heywood, V.H. 1967. Plant taxonomy. Edward Arnold, Great Britain.
12. Hutchinson, J. 1973. The families of flowering plants. Oxford University Press, London.
13. Mathew, K.M. 1983. The flora of Tamil Nadu Carnatic. The Rapinet Herbarium, Trichy.
14. Santapau, H and Henry, H.D.1994. A dictionary of flowering plants of India. C.S.N., New Delhi.

M.Sc., Botany – CBCS Pattern

For Students Admitted from the academic year 2017 – 2018

Deletion

Elective –I Herbal Botany (Paper code: 17P1BOE01A)

Max. Marks: 75
Credits : 5
Total hours : 75

Objectives:

- To understand the traditional medicinal systems and classification of natural drugs
- To study the drug adulteration, drug evaluation and phytochemical investigations
- To study the cultivation, collection and preparation of natural drugs from selected medicinal plants
- To understand the cultivation and utilization of selected medicinal plants
- To understand the drugs containing primary and secondary metaboites

UNIT-I

Traditional Medicinal system: Ayurvedha, Siddha, Unani and Naturopathy. Definition of Drug- Classification of natural drugs (Alphabetical, Morphological, Pharmacological, Chemical and Chemotaxonomical classifications). Traditional and Folklore medicines – Native medicines.

UNIT-II

Pharmcognosy – Definition and Scope. Drug adulteration. Drug evaluation - Chemical evaluation, Physical evaluation and Biological evaluation. Phytochemical investigations.

UNIT-III

Cultivation, collection and preparation of natural drugs- Macroscopic characters (Physical and Organoleptic characters), therapeutical and pharmaceutical uses of the following medicinal plants: *Adadhoda vasica, Centella asiatica, Datura metal, Piper nigrum, Azadiracta indica, Ocimum sanctum* and *Catharanthus roseus*

UNIT-IV

Cultivation and utilization of selected medicinal plants – *Bacopa monnieri, Cassia senna, Gloriosa superba, Phyllanthus amarus* and *Rauwolfia serpentina.*

UNIT-V

A Brief account of the following drugs

Drugs containing carbohydrates- *Isapgo*l.

Drugs containing tannins- *Myrobalan*.

Drugs containing lipids- *Arachis oil*.

Drugs containing resin and resin combination-*Cannabis*

Drugs containing alkaloids- *Cinchona.*

Text book:

1. Agarwal, 1985. Drug plants in India. Kalyani Publishers, Ludhiyana.
2. Agarwal, S.S. and Paridhave, M, 2007. Herbal Drug Technology. University Press, New Delhi.
3. Bhattacharjee, S.K. 2004. Hand Book of Medicinal plants. Pointer Publishers, Jaipur
4. Biswas, P.K. 2006. Encyclopedia of Medicinal plants (vol. I-VII).Dominant Publishers, New Delhi.
5. Chopra,R.N. 1980. Glossary of Indian Medicinal plants. CSIR, New Delhi.

References:

1. Anonymous, 1999. Pharmacognosy of Indigenous Drug (Vol. I-III). Cental Council for Research in Ayurvedha and siddha, New Delhi.
2. Anonymous, 2004. Cultivation of selected Medicinal Plants. National Medicinal Plants Board, Govt. of India, New Delhi.
3. Jaibala,S. and Balakrishnan, G. 1975. Ahand book of common remedies based on Siddha system of Indian medicines. St. Louis institute press, Chennai.
4. John Jothi Prakash, E. 2003. Medicinal Botany and Pharmacognosy. JPR Publication, Valliyur, Tirunelveli.
5. Dhavan, B.N. Ayurvedic Research on Medicinal plants in India. INSA, New Delhi.
6. Gokhale, S.B., Kokate, C.K. and Purohit, A.P. 2003. Pharrmacognosy. Nirali Prakashan, Pune.
7. Hanada, S.S. and V.K. Kapoor,1993. Pharmacognosy. Vallabh Prakashan. New Delhi.
8. Harbourne, J.B. 1998. Phytochemical methods: A Guide to Morden Techniques of Plant Analysis (3rd edition). Chapman and Hill Co., New York.

Addition

SEMESTER I

Programme Code	**M. Sc.**	**Programme Title**	**Master of Science (Botany)**	
Course Code	**18P1BOE01A**	**Title**	**Batch**	**2018 -2020**
Hours/Week	**3**	**Herbal Botany**	**Semester**	**I**
			Credits	**03**

Course Objective

To study the cultivation techniques, phytochemical screening, drug adulteration and application of medicinal plants to the society.

Course Outcomes (CO)

K1	CO1	To develop the skill of cultivation, collection and preparation of herbal drugs.
K2	CO2	To understand the various phytochemical present in the plants which are pointers for drug adulteration and evaluation.
K3	CO3	To acquire knowledge on traditional and indigenous system of medicine.
K4	CO4	To develop the skill of applying the therapeutic and pharmaceutical uses of medicinal plants to the society.

UNIT - I **(15Hours)**

Traditional Medicinal system - Ayurvedha, Siddha, Unani and Naturopathy. Definition of Drug - Classification of natural drugs (Alphabetical, Morphological, Pharmacological, Chemical and Chemotaxonomical classifications) - Traditional and Folklore medicines – Native medicines.

UNIT - II **(15Hours)**

Pharmacognosy – Definition and Scope - Drug adulteration - Drug evaluation - Chemical evaluation, Physical evaluation and Biological evaluation - Phytochemical investigations.

UNIT - III **(15Hours)**

Cultivation, collection and preparation of natural drugs- Macroscopic characters (Physical and Organoleptic characters), therapeutical and pharmaceutical uses of the following medicinal plants: *Adathoda vasica, Centella asiatica, Papaver somniferum, Piper nigrum, Azadirachta indica, Ocimum sanctum* and *Catharanthus roseus.* **3%**

UNIT - IV **(15Hours)**

Cultivation and utilization of selected medicinal plants – *Bacopa monnieri, Cassia senna, Gloriosa superba, Phyllanthus amarus* and *Rauwolfia serpentina.*

UNIT – V **(15Hours)**

A Brief account of the following drugs

Drugs containing carbohydrates- *Isapgol*.

Drugs containing tannins- *Myrobalan*.

Drugs containing lipids- *Arachis oil*.

Drugs containing resin and resin combination-*Cannabis*

Drugs containing alkaloids- *Cinchona*.

Text books:

1. Agarwal, 1985. Drug plants in India. Kalyani Publishers, Ludhiyana.
2. Agarwal, S.S. and Paridhave, M, 2007. Herbal Drug Technology. University Press, New Delhi.
3. Bhattacharjee, S.K. 2004. Hand Book of Medicinal plants. Pointer Publishers, Jaipur
4. Biswas, P.K. 2006. Encyclopedia of Medicinal plants (vol. I-VII).Dominant Publishers, New Delhi.
5. Chopra, R. N. 1980. Glossary of Indian Medicinal plants. CSIR, New Delhi.

Reference Books:

1. Anonymous, 1999. Pharmacognosy of Indigenous Drug (Vol. I-III). Cental Council for Research in Ayurvedha and siddha, New Delhi.
2. Anonymous, 2004. Cultivation of selected Medicinal Plants. National Medicinal Plants Board, Govt. of India, New Delhi.
3. Jaibala, S. and Balakrishnan, G. 1975. A Hand Book of Common Remedies Based on Siddha System of Indian Medicines. St. Louis Institute Press, Chennai.
4. John Jothi Prakash, E. 2003. Medicinal Botany and Pharmacognosy. JPR Publication, Valliyur, Tirunelveli.
5. Dhavan, B.N. Ayurvedic Research on Medicinal plants in India. INSA, New Delhi.
6. Gokhale, S.B., Kokate, C.K. and Purohit, A.P. 2003. Pharrmacognosy. Nirali Prakashan, Pune.
7. Hanada, S.S. and V.K. Kapoor, 1993. Pharmacognosy. Vallabh Prakashan. New Delhi.
8. Harbourne, J.B. 1998. Phytochemical methods: A Guide to Morden Techniques of Plant Analysis (3rd edition). Chapman and Hill Co., New York.

Deletion

SUBJECT CODE: 17P2BO04		
SEMESTER - II	**CREDITS: 5**	**HOURS: 75**

Anatomy of Angiosperms, Embryology of Angiosperms and Plant Micro technique

Objectives:

- To study the meristems types, theories on meristems, anomalous secondary growth and nodal anatomy.
- To study the microsporogenesis, megasporogenesis, polyembryony, apomixsis, agamospory, apospory and parthenocarpy.
- To understand the light and electron microscopy and microtechnique steps.

Learning Outcome:

- Acquiring knowledge on the anatomy and embryology of angiosperms, light and electron microscopy and microtechnique.

Unit - I **(15 Hours)**

Cell wall- pits, plasmodesmata and functions. Meristems – types - theories on shoot and root apical meristems. Procambium - cambium, vascular cambium - structure and function – Seasonal activity, role in wound healing and grafting.

Unit - II **(15 Hours)**

Complex tissues - secondary xylem and secondary phloem - structure and functions. Tyloses, heart wood and sap wood and growth rings. Leaf - structure – types. Secondary thickening in stem and root and periderm formation - lenticels. Anomalous secondary growth in dicot and monocot stems. Nodal anatomy- uni, tri and multilacunar nodes.

Unit – III **(15 Hours)**

Microsporogenesis and Megasporogenesis. Sexual incompatibility - genetic basis, barriers to fertilization, physiology and biochemistry of incompatibility. Endosperm and

embryo- structure, types and development. Polyembryony – causes – types. Apomixis, Agamospermy, Apospory and Parthenocarpy.

Unit – IV **(15 Hours)**

Light microcopy - optical principles, resolution, magnification and aberrations. Phase contrast microscopy - Dark field illumination. Electron microscope Transmission Electron Microscope and Scanning Electron Microscope - Principle and operation techniques. Maceration, Squashes, Smears and Clearing techniques.

Unit – V **(15 Hours)**

Microtechnique steps - fixation and fixatives, dehydration, clearing, infiltration, embedding block making and sectioning. Microtomes types and operating mechanism – Rotary and Sledge microtome. Stains and staining techniques. Camera lucida – types – principle and use. Micrometry

Text Books:

1. Bhojwani, S. S. and Bhatnagar, S. P. 2013. The Embryology of Angiosperms. Vikas Publishing House Private Limited, New Delhi.
2. Dwivedi, J. N. 1988. Embryology of Angiosperms. Rastogi and Company, Meerut.
3. Pandey, B. P. 2010. Plant anatomy, S. Chand and Company Private Limited, New Delhi.
4. Pandey, B. P. 2012. A Textbook of Botany: Angiosperms - Taxonomy, Anatomy, Embryology and Economic Botany, S. Chand and Company Private Limited, New Delhi.
5. Singh, V. 2010. Plant Anatomy and Embryology of Angiosperms, Global Media Publications, Delhi.

Reference Books:

1. Cutter, E. G. 1978. Plant Anatomy: Experimental and Interpretation. Edward Arnold Publishing Limited, London.
2. Esau, K. 1972. Plant anatomy, Wiley Eastern Private Limited, New Delhi.
3. Esau, K. 1977. Anatomy of Seed plants. Wiley Publications, New Delhi

4. Fahn, A. 1989. Plant anatomy. Macmillan Publication Private Limited, Singapore.

5. Fatin, A. 1982. Plant Anatomy (3rd Edition). Pergoman Press, Oxford.

6. Maheswari, P. 1976. An introduction to the Embryology of angiosperms, Tata Mc Graw Hill Publishing Company Limited, New Delhi.

Addition

SEMESTER – II

Programme Code	M. Sc.	Programme Title	Master of Science (Botany)	
Course Code	18P2BO04	Title	Batch	2018 -2020
Hours/Week	6	Anatomy of Angiosperms, Embryology of Angiosperms and Plant Micro technique	Semester	II
			Credits	05

Course Objective

- To study the anatomy and embryology of angiosperms, microscopy and plant microtechnique steps.

Course Outcomes (CO)

K1	CO1	To develop the skill of sectioning.
K2	CO2	To understand the internal tissue system of plants.
K3	CO3	To apply the skill of microtechnique for the preparation and identification of slides for industries.
K4	CO4	To acquire anatomical knowledge which are pointers for identification.

Unit - I **(15 Hours)**

Cell wall- pits, plasmodesmata and functions. Meristems – types - theories on shoot and root apical meristems. Procambium - cambium, vascular cambium - structure and function – Seasonal activity, role in wound healing and grafting.

Unit - II **(15 Hours)**

Complex tissues - secondary xylem and secondary phloem - structure and functions. Tyloses, heart wood and sap wood and growth rings. Leaf - structure – types. Secondary thickening in stem and root and periderm formation - lenticels. Anomalous secondary growth in dicot and monocot stems. Nodal anatomy- uni, tri and multilacunar nodes.

Unit – III **(15 Hours)**

Microsporogenesis and Megasporogenesis. Sexual incompatibility - genetic basis, barriers to fertilization, physiology and biochemistry of incompatibility. Endosperm and

embryo- structure, types and development. Polyembryony – causes – types. Apomixis, Agamospermy, Apogamy and Parthenocarpy. **1%**

Unit – IV **(15 Hours)**

Light microcopy - optical principles, resolution, magnification and aberrations. Phase contrast microscopy - Dark field illumination. Electron microscope Transmission Electron Microscope and Scanning Electron Microscope - Principle and operation techniques. Maceration, Squashes, Smears and Clearing techniques.

Unit – V **(15 Hours)**

Microtechnique steps - fixation and fixatives, dehydration, clearing, infiltration, embedding block making and sectioning. Microtomes types and operating mechanism – Rotary and Sledge microtome. Stains and staining techniques. Camera lucida – types – principle and use. Micrometry

Text Books:

1) Bhojwani, S. S. and Bhatnagar, S. P. 2013. The Embryology of Angiosperms. Vikas Publishing House Private Limited, New Delhi.
2) Dwivedi, J. N. 1988. Embryology of Angiosperms. Rastogi and Company, Meerut.
3) Pandey, B. P. 2010. Plant anatomy, S. Chand and Company Private Limited, New Delhi.
4) Pandey, B. P. 2012. A Textbook of Botany: Angiosperms - Taxonomy, Anatomy, Embryology and Economic Botany, S. Chand and Company Private Limited, New Delhi.
5) Singh, V. 2010. Plant Anatomy and Embryology of Angiosperms, Global Media Publications, Delhi.

Reference Books:

1) Cutter, E. G. 1978. Plant Anatomy: Experimental and Interpretation. Edward Arnold Publishing Limited, London.
2) Esau, K. 1972. Plant anatomy, Wiley Eastern Private Limited, New Delhi.
3) Esau, K. 1977. Anatomy of Seed plants. Wiley Publications, New Delhi
4) Fahn, A. 1989. Plant anatomy. Macmillan Publication Private Limited, Singapore.

5) Fatin, A. 1982. Plant Anatomy (3rd Edition). Pergoman Press, Oxford.
6) Maheswari, P. 1976. An introduction to the Embryology of angiosperms, Tata Mc Graw Hill Publishing Company Limited, New Delhi.

Deletion

SUBJECT CODE: 17P2BO05		
SEMESTER - II	**CREDITS: 5**	**HOURS: 75**

Cell and Molecular Biology and Genetics

Objectives:

- To study the structure and functions of cell organelles.
- To understand the DNA structure and RNA and protein synthesis.
- To study understand the linkage, chromosome mapping, mutation and Hardy-Weinberg law.

Learning Outcome:

- Acquiring knowledge on structure and functions of cell organelles, DNA structure, RNA and protein synthesis, linkage, chromosome mapping, mutation and Hardy-Weinberg law.

Unit - I **(15 Hours)**

Plasma membrane- structure models and functions. Cell wall, Chloroplast, Mitochondria, Golgi apparatus, Lysosomes, Endoplasmic Reticulum, Nucleolus and Nucleus - structure and functions. Apoptosis and programmed cell death.

Unit - II **(15 Hours)**

DNA structure – A, B, C and Z forms – replication, damage and repair. Chromosomes – morphology, ultra structure, types – lamp brush, polytene, isochromosome and B-chromosome. Structural and numerical variations in chromosomes. Modern concept of gene – introns, extrons and their significance.

Unit III **(15 Hours)**

RNA types and biosynthesis of mRNA - Eukaryotic transcription – RNA polymerase - General and specific transcription factors - regulatory elements and mechanism of transcription

regulation- transcriptional and post transcriptional gene splicing. Translation- initiation, elongation and termination.

Unit IV **(15 Hours)**

Gene interaction and modified Mendel's F_2 ratio. Multiple alleles and pseudo alleles. Polygenic inheritance. Linkage and recombination. Chromosome mapping. Sex determination- sex linked inheritance – cytoplasmic inheritance.

Unit V **(15 Hours)**

Mutation- types and its role in evolution. Molecular basis of mutation. Mutagens- physical and chemical mutagens. Population genetics. Hardy – Weinberg law and its applications. Cis-trans effects. Regulation of gene expression in prokaryotes. Signal transduction – signaling molecules – signal receptors – signaling pathways.

Text Books:

1. Gupta, P. K. 2008. Cytology, Genetics and Genetic Engineering,. Rastogi Publication, Meerut.
2. Mohan, P. Arora. 1992. Evolutionary Biology, Himalaya Publishing House, New Delhi.
3. Sambamurthy, A. V. S. S. 1999. Genetics. Narosa Publishing House, New Delhi.
4. Sen, S., Kar, D. K. and Johri, B. M. 2005. Cytology and Genetics, Narosa Publishing House, New Delhi.
5. Sharma, A. K. and Sharma, 1965. Chromosome Technique. Theory and Practice Oliver and Boyd, London.

Reference Books:

1. Ayala and Kiegr, 1980. Modem Genetics. Benjamin Publishing Company, Amsterdam.
2. Bodmer, W. F., Cavalli – Sforza, L. L. 1976. Genetics, Evolution and Man. W. H. Freeman and Company, New York.
3. De Robertis. 1975. Cell Biology. W.C. Sander's Company, Philadelphia.
4. Dobzhansky, T. H. 1970. Genetics of the evolutionary process. Columbia University Press, New York.
5. Dupraw, E. J. 1969. Cell and Molecular Biology. Academic Press, New York.
6. Freifelder, 2008. Molecular Biology. Narosa Publishing House, New Delhi.

SEMESTER – II

Addition

Programme Code	M. Sc.	Programme Title	Master of Science (Botany)	
Course Code	18P2BO05	Title	Batch	2018 -2020
Hours/Week	6	Cell and Molecular Biology and Genetics	Semester	II
			Credits	05

Course Objective

- To study the structure and functions of cell organelles, DNA structure, RNA, protein synthesis, linkage, chromosome mapping, mutation and Hardy-Weinberg law.

Course Outcomes (CO)

K1	CO1	To acquire knowledge on various organelles present in the plant cell.
K2	CO2	To acquire knowledge on inheritance of characters and structure of genetic material.
K3	CO3	To understand the process of central dogma of molecular biology.
K4	CO4	To enhance the knowledge on cytogenetic research.

Unit - I **(15 Hours)**

Plasma membrane- structure models and functions. Cell wall, Chloroplast, Mitochondria, Golgi apparatus, Lysosomes, Endoplasmic Reticulum, Nucleolus and Nucleus - structure and functions. Apoptosis and programmed cell death.

Unit - II **(15 Hours)**

DNA structure – A, B, C and Z forms – replication, damage and repair. Chromosomes – morphology, ultra structure, types – lamp brush, polytene, isochromosome and B-chromosome. Structural and numerical variations in chromosomes. Modern concept of gene – introns, extrons and their significance.

Unit - III **(15 Hours)**

RNA types and biosynthesis of mRNA - Eukaryotic transcription – RNA polymerase - General and specific transcription factors - regulatory elements and mechanism of transcription

regulation- transcriptional and post transcriptional gene splicing. Translation- initiation, elongation and termination.

Unit - IV **(15 Hours)**

Gene interaction and modified Mendel's F_2 ratio. Multiple alleles and pseudo alleles. Polygenic inheritance. Chromosome mapping. Sex determination- sex linked inheritance – cytoplasmic inheritance. **3%**

Unit - V **(15 Hours)**

Mutation- types and its role in evolution. Molecular basis of mutation. Mutagens- physical and chemical mutagens. Population genetics. Hardy – Weinberg law and its applications. Cis-trans effects. Regulation of gene expression in prokaryotes. Signal transduction – signaling molecules – signal receptors – signaling pathways.

Text Books:

6. Gupta, P. K. 2008. Cytology, Genetics and Genetic Engineering,. Rastogi Publication, Meerut.
7. Mohan, P. Arora. 1992. Evolutionary Biology, Himalaya Publishing House, New Delhi.
8. Sambamurthy, A. V. S. S. 1999. Genetics. Narosa Publishing House, New Delhi.
9. Sen, S., Kar, D. K. and Johri, B. M. 2005. Cytology and Genetics, Narosa Publishing House, New Delhi.
10. Sharma, A. K. and Sharma, 1965. Chromosome Technique. Theory and Practice Oliver and Boyd, London.

Reference Books:

7. Ayala and Kiegr, 1980. Modem Genetics. Benjamin Publishing Company, Amsterdam.
8. Bodmer, W. F., Cavalli – Sforza, L. L. 1976. Genetics, Evolution and Man. W. H. Freeman and Company, New York.
9. De Robertis. 1975. Cell Biology. W.C. Sander's Company, Philadelphia.
10. Dobzhansky, T. H. 1970. Genetics of the evolutionary process. Columbia University Press, New York.
11. Dupraw, E. J. 1969. Cell and Molecular Biology. Academic Press, New York.

12. Freifelder, 2008. Molecular Biology. Narosa Publishing House, New Delhi.
13. Harvey Lodish. 2008. Molecular Cell Biology. W. H. Freeman Publication, New York.
14. Lewin. 1994. Genes: (Vol. VII). Oxford University Press, London.

Deletion

SUBJECT CODE: 17P2BOE03A		
SEMESTER - II	**CREDITS: 4**	**HOURS: 60**

Plant Bio-technology and Bio-informatics

Objectives:

- To study the scope, potentialities and application of biotechnology.
- To understand the DNA recombinant technology, genetic engineering, enzymes and cloning.
- To understand the basic knowledge of bio-informatics.

Learning Outcome:

- Acquiring knowledge on application of biotechnology, DNA recombinant technology, genetic engineering, enzymes, cloning and bio-informatics.

UNIT I (12 Hours)

Biotechnology - scope and potentialities. Plant tissue culture – concept of totipotency – organization of tissue culture laboratory. Sterilization methods – Plant tissue culture media (MS) and plant hormones, Surface sterilization, callus culture, Micro-propagation, Organogenesis – Application of plant tissue culture in agriculture and crop improvement.

UNIT II (12 Hours)

Somatic embryogenesis –encapsulated seeds. Production of haploids plants through anther culture –Protoplast isolation, culture and regeneration, methods of fusing protoplasts, somatic hybridization. Introduction to plant secondary metabolites. DNA transfer by particle bombardment, micro and macro injection methods – lipofection and electroporation.

UNIT III (12 Hours)

Recombinant DNA technology – gene transfer in plants – aims, strategies for development of transgenic plants — organization of Ti plasmid, *Agrobacterium tumifaciens*

mediated gene transfer. Transgenic plants with stress tolerance for drought and salinity, crop improvement, herbicide resistance, insect resistance, virus resistance, plants as bioreactors.

UNTI IV **(12Hours)**

Genetic engineering – enzymes – nucleases, polymerases, ligases, alkaline phosphatase, reverse transcriptase – SI nucleases – vectors – use of plasmids, cosmids, phage and transposans as vectors – gene cloning – cloning in eukaryotes. Amplification of genes by PCR. cDNA and construction of cDNA libraries. Germplasm storage – Cryopreservation.

UNTI V **(12 Hours)**

Introduction to bio-informatics, Classification of biological databases, Biological data formats, application of bioinformatics in various fields. Sequence alignment, Substitution matrices, Scoring matrices-PAM and BLOSUM. Local and Global alignment concepts, dot plot, dynamic programming methodology, multiple sequence alignment- progressive alignment. Database searches for homologous sequences- Fasta and Blast Version.

Text books:

1. Dubey, R.C. 2001. A text book of biotechnology. S. Chand and Company Private Limited, New Delhi.
2. Gupta, P.K. 1994. Elements of Biotechnology. Rastogi Publications, Meerut.
3. Ignacimuthu, S. J. 2003. Plant Biotechnology. Oxford and IBH Publishing, New Delhi.
4. Kalyankumar, 1992. Plant tissue culture. New Central Book Agency, Calcutta.
5. Kumar, H. D. 1998. A Text book of Biotechnology. EWP, New Delhi.
6. Kumaresan, P. 2007. Biotechnology. Saras Publications, Nagercoil.
7. Shanmugavel, P. 2005. Principles of Bioinformatics, Pointer Publishers, Jaipur, India.

Reference Books:

1. David W. Mount. 2001. Bioinformatics Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press, New York.
2. Levin. 2000. Genes (Vol. I-VII). Oxford University Press, London.

3. Nicholl, D. S. T. 1994. Introduction to Genetic Engineering. Cambridge University Press, London.
4. Old, R. N. and Primrose. 1994. Principles of Gene Manipulation. Blackwell Scientific Publications, Oxford.
5. Pennigton, S. R. and Dunn, M.J. 2002. Proteomics. Viva Books Private Limited, New Delhi.
6. Purohit, S. S. 2003. Biotechnology – Fundamentals and Applications. Agrobios, New Delhi.
7. Satyanarayana, U. 2005. Biotechnology. Books and Allied Private Limited, Kolkata.
8. Singh, B. D. 2003. Biotechnology. Kalyani Publishers, New Delhi.

Addition

SEMESTER – II

Programme Code	M. Sc.	Programme Title	Master of Science (Botany)	
Course Code	18P2BOE03A	Title	Batch	2018 -2020
Hours/Week	5	Plant Bio-technology and Bio-informatics	Semester	II
			Credits	04

Course Objective

- To study the application of biotechnology, DNA recombinant technology, genetic engineering, enzymes, cloning and bio-informatics.

Course Outcomes (CO)

K1	CO1	To apply the skill of invitro regeneration techniques in plants.
K2	CO2	To create awareness on conservation of rare species through the tissue culture technique.
K3	CO3	To apply the skill of amplifying the industrial useful genes through PCR technology.
K4	CO4	To acquire knowledge on biological databases for analyzing and sequencing genomes of plants.

UNIT - I **(12 Hours)**

Biotechnology - scope and potentialities. Plant tissue culture – concept of totipotency – organization of tissue culture laboratory. Sterilization methods – Plant tissue culture media (MS) and plant hormones, Surface sterilization, callus culture, Micro-propagation, Organogenesis – Application of plant tissue culture in agriculture and crop improvement.

UNIT - II **(12 Hours)**

Somatic embryogenesis –encapsulated seeds. Production of haploids plants through anther culture –Protoplast isolation, culture and regeneration, methods of fusing protoplasts, somatic hybridization. Introduction to plant secondary metabolites. DNA transfer by particle bombardment, micro and macro injection methods – lipofection and electroporation.

UNIT - III **(12 Hours)**

Recombinant DNA technology – gene transfer in plants – aims, strategies for development of transgenic plants — organization of Ti plasmid, *Agrobacterium tumifaciens* mediated gene transfer. Transgenic plants with stress tolerance for drought and salinity, crop improvement, herbicide resistance, insect resistance, virus resistance, plants as bioreactors.

UNTI - IV **(12Hours)**

Genetic engineering – enzymes – nucleases, polymerases, ligases, alkaline phosphatase, reverse transcriptase – SI nucleases – vectors – use of plasmids, cosmids, phage and transposans as vectors – gene cloning – cloning in eukaryotes. Amplification of genes by PCR. Germplasm storage – Cryopreservation. Intellectual Properties Right. **4%**

UNTI V **(12 Hours)**

Introduction to bio-informatics, Classification of biological databases, Biological data formats, application of bioinformatics in various fields. Sequence alignment, Substitution matrices, Scoring matrices-PAM and BLOSUM. Local and Global alignment concepts, dot plot, dynamic programming methodology, multiple sequence alignment- progressive alignment. Database searches for homologous sequences- Fasta and Blast Version. Bio-nanotechnology. **3%.**

Text books:

1. Dubey, R.C. 2001. A text book of biotechnology. S. Chand and Company Private Limited, New Delhi.
2. Gupta, P.K. 1994. Elements of Biotechnology. Rastogi Publications, Meerut.
3. Ignacimuthu, S. J. 2003. Plant Biotechnology. Oxford and IBH Publishing, New Delhi.
4. Kalyankumar, 1992. Plant tissue culture. New Central Book Agency, Calcutta.
5. Kumar, H. D. 1998. A Text book of Biotechnology. EWP, New Delhi.
6. Kumaresan, P. 2007. Biotechnology. Saras Publications, Nagercoil.
7. Shanmugavel, P. 2005. Principles of Bioinformatics, Pointer Publishers, Jaipur, India.

Reference Books:

1. David W. Mount. 2001. Bioinformatics Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press, New York.
2. Levin. 2000. Genes (Vol. I-VII). Oxford University Press, London.
3. Nicholl, D. S. T. 1994. Introduction to Genetic Engineering. Cambridge University Press, London.
4. Old, R. N. and Primrose. 1994. Principles of Gene Manipulation. Blackwell Scientific Publications, Oxford.
5. Pennigton, S. R. and Dunn, M.J. 2002. Proteomics. Viva Books Private Limited, New Delhi.
6. Purohit, S. S. 2003. Biotechnology – Fundamentals and Applications. Agrobios, New Delhi.
7. Satyanarayana, U. 2005. Biotechnology. Books and Allied Private Limited, Kolkata.
8. Singh, B. D. 2003. Biotechnology. Kalyani Publishers, New Delhi.

Dr. M. KANNAN, M.Sc.,B.Ed.,Ph.D.
HEAD
PG and Research Department of Botany,
Vivekanandha College of Arts and Sciences for Women
(Autonomous)
Elayampalayam-637 205, Tiruchengode.

PRINCIPAL,
VIVEKANANDHA COLLEGE OF ARTS AND SCIENCES FOR WOMEN (Autonomous)
ELAYAMPALAYAM - 637 205.
TIRUCHENGODE (Tk.) NAMAKKAL (Dt.)
TAMILNADU