

# **Ph.D. BOTANY**

# **COURSE WORK**

**(With effect from the Academic Year 2017-18)**

**Department of Biology**  
**The Gandhigram Rural Institute Deemed University**  
**(MHRD, Govt. of India)**  
**Accredited by NAAC with 'A' Grade (3<sup>rd</sup> Cycle)**  
**Gandhigram- 624 302**  
**Dindigul District, Tamil Nadu**

**Ph.D. BOTANY  
SCHEME**

<b>FIRST SEMESTER</b>							
	<b>Course code</b>	<b>Course Title</b>	<b>C</b>	<b>L</b>	<b>E</b>	<b>ESE</b>	<b>Total</b>
<b>Core Courses</b>	17BOTR0101	General Botany	4	4	3	100	100
	17BOTR0102	Advances in Botany	4	4	3	100	100
	17BOTR0103	Plant Systematics	4	4	3	100	100
<b>Supportive Courses</b>	17BOTR0104	Research Methodology	4	4	3	100	100
		<b>Total Credits</b>	16				

<b>SECOND SEMESTER</b>							
	<b>Course code</b>	<b>Course Title</b>	<b>C</b>	<b>L</b>	<b>E</b>	<b>ESE</b>	<b>Total</b>
<b>Supportive Courses</b>	17BOTR0205	Quantitative Techniques – Advanced Biostatistics	4	4	3	100	100
<b>Core Courses</b>	17BOTR0SX	Area of Specialization on thrust areas	4	4	3	100	100
<b>Seminar</b>		Seminar-1	1	2		-	-
		Seminar-2	1	2		-	-
		Seminar-3	1	2		-	-
		Term paper on Topical Research	1	2		-	-
		<b>Total Credits</b>	12	-	-	-	-

<b>RESEARCH CREDITS</b>			
	<b>Course code</b>	<b>Course title</b>	<b>C</b>
		a) Project Planning including literature collection, finalization of objectives and methodology	4
		b) Field/ Lab Studies, Data Collection, compilation of results, statistical analysis, results and final conclusion	32
		c) Synopsis and thesis submission, final viva	6
		<b>Total Credits</b>	42
<b>OVERALL CREDITS</b>			<b>70</b>

	<b>Area of Specialization on thrust areas*</b>
17BOTR0S-1	1. Phytochemistry and Pharmacology
17BOTR0S-2	2. Fungal Biotechnology
17BOTR0S-3	3. Plant Reproductive Biology
17BOTR0S-4	4. Plant Taxonomy and Ethnobotany

C- Credits
L- Lecture Hours
E- Exam Hours
ESE- End semester Exam marks

**\*Detailed Syllabus for the area of Specialization may be prepared by the respective doctoral committee**

**Objectives:**

To enable the students

- To have comprehensive knowledge on diversity of plants.
- To understand the physiology and mechanisms of plants
- To understand the various aspects of plant development and reproduction
- To understand the economic importance of plants
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**Learning outcomes:**

The course will provide a comprehensive knowledge on diversity, physiological mechanism, development and reproductive aspects of plants on satisfying the requirements of this course, students will have knowledge and skills on

- Identification of diversity of different life forms
- The physiological, developmental and reproductive aspects of plants
- Identification of different economical important plant species.

**UNIT I :**

Diversity of different plant forms: Algae, Fungi, Bryophytes, Pteridophytes and Gymnosperms: Classification, General characteristics different classes, Phylogeny and Economic Importance of algae, Fungi, bryophytes, Pteridophytes and Gymnosperms.

**UNIT II:**

Plant Physiology: Photosynthesis – Photophosphorylation, Electron transport, Electrochemical gradient and energy transduction, photoprotective mechanisms; CO<sub>2</sub> fixation-C<sub>3</sub>, C<sub>4</sub>, CAM pathways and modern concepts. Respiration & photorespiration – TCA cycle, plant mitochondrial ET & ATP synthesis; alternate oxidase and Modern concepts. Plant growth regulators – Physiological effects and mechanisms of action of plant growth hormones.

**UNIT III:**

Cytology: Architecture of prokaryotic and eukaryotic cells and tissues. Biomembranes and the subcellular organization of eukaryotic cells. Detailed structure, morphology and functions of mitochondria, chloroplasts, endoplasmic reticulum, golgi complex, ribosomes. Nucleus, Ultra structure of nuclear membrane, chemical composition, function. Chromosomes and nucleolus.

**UNIT IV:**

Embryology: Microsporogenesis: male gametophyte pollen fertility and sterility, storage germination. Megasporogenesis: embryo sac – types and development. Pollination, fertilization, incompatibility, breeding systems(geiteno and xenogamy), embryo and seed development, seed viability and germination, polyembryony and parthenocarpy.

## **UNIT V:**

**Economic Botany:** Economic importance of cereals and millets, legume and nuts, vegetables and fruits, spices and condiments, gums and resins, fibre wood, tannin, dye, oil, sugar and starch, beverage yielding plants and medicinal plants.

### **References:**

1. Davis, PH. and Y.H. Heywood. 1965. Principles of Angiosperm Taxonomy. Oliver & Boyd.
2. Grant, W.F. 1984. Plant Biosystematics. Acad. Press. New York
3. Judd, W.S. et al. 2002. Plant systematics– A Phylogenetic approach 2<sup>nd</sup>. Edn. Sinauer associates Inc. Publishers. Sunderland, Massachusetts, USA.
4. Kumar,A and Purohit S.S. 2007. Plant Physiology Fundamentals and Applications. Agrobios India.
5. Melvile, T.C. 2008. Applied Economic Botany. Read Books Publishers Publishing Co. Pvt. Ltd. New Delhi.
6. Sambamurty A.V.S.S. and Subramanyam N.S. 2000. Economic Botany of Crop Plants. Asiatech Publishers Inc. India.
7. Simpson, M.G. 2006. Plant systematics. Elsevier Academic Press, U.S.A
8. Singh, G. 2004. Plant systematics – Theory and Practice. Oxford and IBH
9. Sivarajan, V.V. 1991 Introduction to the Principles of Taxonomy, Oxford and IBH Pub. Co., New Delhi.
10. Verma V. 2007. Text book of plant physiology Ane Books, Kolkata India.

### **Journals and Web-resources:**

1. <http://www.publish.csiro.au/bt>
2. <http://www.amjbot.org/>
3. <http://www.nrcresearchpress.com/loi/cjb1>
4. <https://www.cliffsnotes.com/study-guides/biology/microbiology/the-unicellular-algae/general-characteristics-of-algae>
5. <http://www.ivyroses.com/Biology/Fungi/fungi-characteristics.php>
6. [cms.gcgl11.ac.in/attachments/article/115/Gen%20Chr,classificatn\\_Bryo.pdf](http://cms.gcgl11.ac.in/attachments/article/115/Gen%20Chr,classificatn_Bryo.pdf)

## LECTURE SCHEDULE: GENERAL BOTANY

Unit	Lecture Number	Topic	Lecture delivery Mechanism
<b>I</b>	<b>1</b>	Diversity of different plant forms: Algae, Fungi, Bryophytes, Pteridophytes and Gymnosperms	Lecture+ PPT
	<b>2</b>	Classification, General characteristics different classes, Phylogeny	Lecture
	<b>3</b>	Economic Importance of algae, Fungi, bryophytes, Pteridophytes and Gymnosperms.	Lecture
<b>II</b>	<b>4</b>	Plant Physiology: Photosynthesis – Photophosphorylation, Electron transport, Electrochemical gradient and energy transduction, photoprotective mechanisms;	Lecture+ Video
	<b>5</b>	CO <sub>2</sub> fixation-C <sub>3</sub> , C <sub>4</sub> , CAM pathways and modern concepts.	Lecture+ Video
	<b>6</b>	Respiration & photorespiration – TCA cycle, plant mitochondrial ET & ATP synthesis; alternate oxidase and Modern concepts.	Lecture+ Video
	<b>7</b>	Plant growth regulators – Physiological effects and mechanisms of action of plant growth hormones,	Lecture+ PPT+ Video
<b>III</b>	<b>9</b>	Cytology: Architecture of prokaryotic and eukaryotic cells and tissues. Biomembranes and the subcellular organization of eukaryotic cells.	Lecture+ PPT
	<b>10</b>	Detailed structure, morphology and functions of mitochondria, chloroplasts, endoplasmic reticulum, golgi complex, ribosomes.	Lecture + Video
	<b>11</b>	Nucleus, Ultra structure of nuclear membrane, chemical composition, function. Chromosomes and nucleolus.	Lecture+ PPT
<b>IV</b>	<b>12</b>	Embryology: Microsporogenesis: male gametophyte pollen fertility and sterility, storage germination.	Lecture+ PPT
	<b>13</b>	Megasporogenesis: embryo sac – types and development. Pollination, fertilization, incompatibility, breeding systems(geiteno and xenogamy), embryo and seed development, seed viability and germination, polyembryony and parthenocarpy.	Lecture+ PPT
<b>V</b>	<b>14</b>	Economic Botany: History, varieties and economic importance of cereals and millets, legumes, nuts, vegetables and fruits.	Self study
	<b>15</b>	History, varieties and economic importance of spices, condiments, gums, resins, fibre, wood.	Self study
	<b>16</b>	History, varieties and economic importance of tannin, dye, oil, sugar, starch, beverages and medicinal plants.	Self study

**Objectives:**

To enable the students

- To have comprehensive knowledge on transgenics in plants.
- To understand the mechanism of secondary metabolites production
- To understand the various aspects of gene transfer methods
- To understand the mechanism of genetic recombination

**Learning outcomes:**

The course will provide a comprehensive knowledge on advance aspects botanical research. On satisfying the requirements of this course, students will have knowledge and skills on

- Transgenics in plants, secondary metabolites production from plant cells
- gene transfer methods
- Industrial botany and genetic recombination in plant cells

**UNIT I:**

Transgenesis in plants: Somaclones; plant cell - bacterium hybrids; biociders; biological control; pathogen resistance; herbicide resistance; stress resistance; homozygous cultivars; enrichment of storage proteins; improvement of photosynthesis; post harvest preservation; selection of auxotrophs & secondary metabolite production.

**UNIT II:**

Tissue Culture: Biotechnological applications of plant cell, tissue and organ culture, Media types, preparation; callus formation, organogenesis. Somatic embryogenesis, somaclonal variation, embryo culture, artificial seeds .Production of secondary metabolites from plant cell cultures - Processes for enhancing the production of secondary metabolites- Technology of plant cell culture for production of chemicals.

**UNIT III:**

Direct gene transfer methods- chemical methods, electroporation, microinjection, particle bombardment. Application of Plant biotechnology for the production of quality oil, Industrial enzymes, paper, biodegradable plastics,antigens (edible vaccine) and antibodies

**UNIT IV:**

Molecular mechanism of genetic recombination in prokaryotes & eukaryotes: models of recombination, recombination activating genes & hotspots, Holliday & double Holliday junction, cruciform DNA, recombination by replication, site-specific recombination, gene conversion, heteroduplexes & recombinational probes; V(D)J/somatic, Cre-Lox & FLP-FRT recombination

## **UNIT V:**

Genetic Engineering, SCP; Protein engineering, fusion proteins & designer enzymes, Production of biopharmaceuticals, commodity & industrial chemicals, food & beverages; Metabolite engineering & nif-engineering; Anti-sense technology; Biosafety & biohazards, physical & biological containment; Genetic screening & privacy; Ethical, economic & legal issues.

### **References:**

1. Torr, J. D. 2006. Genetic Engineering-Current Controversies. Greenhaven Press.
2. Magnien, E. & De Nettancourt, D. 1985. Genetic Engineering of Plants and Micro-Organisms Important for Agriculture. Springer Verlag.
3. Gerald Karp 2013. Cell and Molecular Biology: Concepts and Experiments. 7<sup>th</sup> Edition, Wiley, NJ, USA.
4. Geoffrey M. Cooper & Robert E. Hausman 2013. The Cell: A Molecular Approach, 6<sup>th</sup> Edition, Sinauer Associates, Inc., Sunderland, USA.
5. Harvey Lodish, Arnold Berk, Chris A. Kaiser & Monty Krieger 2012 Molecular Cell Biology. 7<sup>th</sup> Edition, W. H. Freeman, NY, USA.
6. Stephen R. Bolsover, Elizabeth A. Shephard, Hugh A. White & Jeremy S. Hyams 2011. Cell Biology: A Short Course Wiley-Blackwell, NJ, USA.
7. Doods, J. H. and Roberts, L. W. 1985. Experiments in Plant Tissue culture, Cambridge University Press.
8. George, E. F. 1993-96. Plant propagation by Tissue culture-2 vols. Exegetics Ltd.

### **Journals and Web-resources:**

1. <https://link.springer.com/journal/11240>
2. <https://www.journals.elsevier.com/journal-of-molecular-biology/>
3. <http://www.springer.com/life+sciences/journal/11008>
4. <http://www.sciencedirect.com/science/journal/00222836?sdc=1>
5. <http://www.scirp.org/journal/ajmb/>
6. <https://www.nature.com/nsmb/>
7. <https://www.gmb.org.br/>

## LECTURE SCHEDULE: ADVANCES IN BOTANY

Unit	Lecture Number	Topic	Lecture delivery Mechanism
<b>I</b>	<b>1</b>	Transgenesis in plants: Somaclones; plant cell - bacterium hybrids; biociders; biological control	Lecture
	<b>2</b>	Pathogen resistance; herbicide resistance; stress resistance	Lecture
	<b>3</b>	Homozygous cultivars; enrichment of storage proteins; improvement of photosynthesis; post harvest preservation	Lecture+ PPT
	<b>4</b>	Selection of auxotrophs & secondary metabolite production.	Lecture+ PPT
<b>II</b>	<b>5</b>	Tissue Culture: Biotechnological applications of plant cell, tissue and organ culture, Media types, preparation; callus formation, organogenesis.	Lecture
	<b>6</b>	Somatic embryogenesis, somaclonal variation, embryo culture, artificial seeds Production of secondary metabolites from plant cell cultures -	Lecture
	<b>7</b>	Processes for enhancing the production of secondary metabolites. Technology of plant cell culture for production of chemicals-	Lecture + Video
<b>III</b>	<b>8</b>	Direct gene transfer methods- chemical methods, electroporation, microinjection, particle bombardment.	Lecture+ Video
	<b>9</b>	Application of Plant biotechnology for the production of quality oil- Industrial enzymes paper	Lecture
	<b>10</b>	Biodegradable plastics-antigens (edible vaccine) and plantibodies	Lecture
<b>IV</b>	<b>11</b>	Molecular mechanism of genetic recombination in prokaryotes & eukaryotes:	Lecture+ PPT
	<b>12</b>	Models of recombination, recombination activating genes & hotspots	Lecture+PPT
	<b>13</b>	Holliday & double Holliday junction, cruciform DNA, recombination by replication, site-specific recombination.	Lecture+PPT
	<b>14</b>	Gene conversion, heteroduplexes & recombinational probes	Lecture+PPT
	<b>15</b>	V(D)J/somatic, Cre-Lox & FLP-FRT recombination	
<b>V</b>	<b>16</b>	Genetic Engineering – Merits & Demerits: SCP; Protein engineering, fusion proteins & designer enzymes	Lecture+PPT
	<b>17</b>	Production of biopharmaceuticals, commodity & industrial chemicals, food & beverages	Lecture+PPT
	<b>18</b>	Metabolite engineering & nif-engineering	Lecture+PPT
	<b>19</b>	Anti-sense technology;. Genetic screening & privacy; Ethical, economic& legal issues	Lecture+PPT
	<b>20</b>	Biosafety & biohazards, physical & biological containment	Lecture

**Objectives:**

To enable the students

- To have comprehensive knowledge on history and evolution of plant systematics.
- To understand the classical and modern aspect of plant classification.
- To understand the various aspects of International Code of Nomenclature (ICN).
- To understand the evolutionary tendencies of different orders.

**Learning outcomes:**

The course will provide a comprehensive knowledge on history and evolution of plant systematic, various classification system and ICN. On satisfying the requirements of this course, students will have knowledge and skills on

- Basic and applied aspects of plant systematic
- Various classification systems proposed.
- Various aspects of International Code of Nomenclature (ICN).
- Evolutionary tendencies of different plant groups.

**UNIT I:**

History of developments in taxonomy: Linnaean to post-Linnaean era; Systematics - concepts and components; Evolutionary ecology-concepts and principles; Microevolution - theory and concepts; Species and speciation; Phylogenetic systematics; Macroevolution - inferring phylogenies. Evolutionary tendencies noticed in Ranales, Rosales, Centrospermae, Tubiflorae, Amentiferae, Helobiales, Liliflorae, Glumiflorae.

**UNIT II:**

Systems of angiosperm classification: Phenetic versus phylogenetic system; Cladistics in taxonomy; relative merits and demerits of major systems of classification Takhtajan, Cronquist, Thorne. Systems of Angiosperm Classification: Phenetic versus phylogenetic systems. Cladistics in taxonomy, Angiosperm phylogeny group (APG). Herbarium techniques and significance.

**UNIT III:**

Diversity and classification of flowering plants; Biological diversity-concepts and applications; Diversity- patterns, indices and applications. The species concept: Taxonomic hierarchy, species, genus, family and other categories; Principles used in assessing relationship delimitation of taxa and attribution of rank, BSI and its role.

**Unit IV:**

International code of Nomenclature (ICN); History of Botanical Nomenclature principles of ICBN; Types method; Author citation; Retention and rejection of names; Publication of names, Phylogeny of Angiosperms: Origin and evolution of angiosperms; Important phylogenetic concepts; Taxonomic evidences obtained from Anatomy, Embryology and Palynology, Chemotaxonomy and Molecular taxonomy.

**Unit V:**

Salient features, vegetative and sexual characters of Fabaceae, Sapindaceae, Menispermaceae, Rutaceae, Euphorbiaceae, Myrtaceae, Lamiaceae, Rubiaceae, Orchidaceae, Cyperaceae and Poaceae.

**References:**

1. Simpson, M.G. 2006. Plant Systematics. Academic Press, London
2. Sivarajan, V. V. 1996. Principles of plant taxonomy. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
3. Sharma, O.P. 2013. Plant Taxonomy. McGraw Hill Education Pvt. Ltd. New Delhi.
4. Mondal, A.K. 2005. Advanced Plant Taxonomy. New Central Book Agency (P) Ltd., New Delhi.
5. Johri, R.M. 2005. Taxonomy. Vols. I-IV, Sonali Publication, New Delhi.
6. Bhattacharyya, B. 2005. Systematic Botany. Narosa Publishing House, New Delhi.
7. Subramanyam, N.S. 1999. Modern Plant Taxonomy. Vikas Publishing House, New Delhi.
8. Singh, V., Pandey, P.C. and Jain, D.K. 1997. A text book of Botany: Angiosperms. Rastogi Publications, Meerat.
9. Singh, V. and Jain, D. K. 1997. Taxonomy of Angiosperms. Rastogi publications. Shivaji Road, Meerat.

**Journals and Web-resources:**

1. <http://www.springer.com/life+sciences/plant+sciences/journal/12225>
2. <https://biotaxa.org/phytotaxa>
3. <http://www.worldcat.org/title/bulletin-of-the-botanical-survey-of-india/oclc/1752752>
4. <http://www.iaat.org.in/journal.html>
5. <http://www.nordicjbotany.org/>
6. <https://www.banglajol.info/index.php/BJPT>
7. <http://www.tandfonline.com/toc/tweb20/current/>
8. <https://www.jstor.org/journal/taxon>

## LECTURE SCHEDULE: PLANT SYSTEMATICS

Unit	Lecture Number	Topic	Lecture delivery Mechanism
<b>I</b>	<b>1</b>	History of developments in taxonomy: Linnaean to post-Linnaean era;	Lecture
	<b>2</b>	Systematics - concepts and components. Evolutionary ecology-concepts and principles;	Lecture
	<b>3</b>	Microevolution - theory and concepts Species and speciation;	Lecture+PPT
	<b>4</b>	Phylogenetic systematics; Macroevolution - inferring phylogenies.	Lecture+PPT
	<b>5</b>	Evolutionary tendencies noticed in Ranales, Rosales, Centrospermae, Tubiflorae, Amentiferae, Helobiales, Liliflorae, Glumiflorae.	Lecture+PPT
<b>II</b>	<b>6</b>	Systems of angiosperm classification: Phenetic versus phylogenetic system	Lecture
	<b>7</b>	Cladistics in taxonomy; relative merits and demerits of major systems of classification Takhtajan, Cronquist, Thorne.	Lecture+PPT
	<b>8</b>	Systems of Angiosperm Classification: Phenetic versus phylogenetic systems. Cladistics in taxonomy, Angiosperm phylogeny group (APG), Herbarium techniques and significance.	Lecture
<b>III</b>	<b>9</b>	Diversity and classification of flowering plants; Biological diversity-concepts and applications. Diversity- patterns, indices and applications.	Lecture
	<b>10</b>	The species concept: Taxonomic hierarchy, species, genus, family and other categories.	Lecture
	<b>11</b>	Principles used in assessing relationship delimitation of taxa and attribution of rank, BSI and its role.	Lecture
<b>VI</b>	<b>12</b>	International code of Botanical Nomenclature; History of Botanical Nomenclature principles of ICBN.	Lecture+PPT
	<b>13</b>	Types method; Author citation; Retention and rejection of names; Publication of names.	Lecture+PPT
	<b>14</b>	Phylogeny of Angiosperms: Origin and evolution of angiosperms; Important phylogenetic concepts.	Lecture
	<b>15</b>	Taxonomic evidences obtained from Anatomy, Embryology and Palynology, Chemotaxonomy and Molecular taxonomy.	Lecture+PPT
<b>V</b>	<b>16</b>	Salient features, vegetative and sexual characters of Fabaceae, Sapindaceae, Menispermaceae.	Lecture+PPT
	<b>17</b>	Salient features, vegetative and sexual characters of Rutaceae, Euphorbiaceae and Myrtaceae,	Lecture+ PPT
	<b>18</b>	Salient features, vegetative and sexual characters of Lamiaceae, Rubiaceae and Orchidaceae	Lecture+ PPT
	<b>19</b>	Salient features, vegetative and sexual characters of Cyperaceae and Poaceae.	Lecture+ PPT

**Objectives:**

To enable the students:

- To understand the working principles, construction and applications of the instruments used in the studies related to various disciplines of biological sciences.
- To expose the students on the basic understanding of research concepts and learn the art of thesis & paper writing, publication and scientific ethics.

**Learning outcomes:**

- The students are be able to understand the working principle, operation system and importance of pH meter and various Microscopes.
- The students are be able to understand the working principle, operation system and importance of centrifuge, photometers and chromatography.
- The students are be able to understand the working principle, operation system and importance of molecular techniques.
- The students are be able to understand the overall concepts of Research and art of writing Thesis
- The students are be able to understand art of writing research articles, publication and scientific ethics.

**Unit I : pH meter, microscopic and polarimetric techniques:**

pH meter - types, basic principle, operation and application; Buffers-principle, standards and preparation of buffer; pH determination & pH indicators. Microscopy – Principle, operation and application - simple, compound, light-field, dark-field, phase-contrast, fluorescence, confocal and electron microscopy. Micrometry-principle and application. Polarimetry -principle and application. Experiments on buffer preparation and pH determination. Exposure to various microscopes.

**Unit II : Centrifuge, Photometric and Chromatographic techniques:**

Centrifugation-types, principle and application. Photometry - Principle, operation and application-colorimeter, spectrophotometer, flame photometer, bomb calorimeter, UV-Visible spectroscopy, atomic absorption spectroscopy, mass spectroscopy and FTIR spectroscopy. Chromatography– types, principle and application: paper chromatography, thin layer chromatography, column chromatography, Ion Exchange, GC-MS and HPLC. Demonstration on differential and gradient centrifugation Demonstration on verification of Beer-Lamberts law. Demonstration on chromatographic separation of amino acids and sugars. Experiment on ARA.

### **Unit III: Molecular techniques:**

Electrophoresis - Principle and applications, paper electrophoresis, agarose gel-Polyacrylamide gel electrophoresis (PAGE and SDS- PAGE) and immuno electrophoresis. Molecular techniques- Microarray, MALDI-TOF, Amino acid sequencing-DNA sequencing (Enzymatic & Chemical methods) Blotting techniques-southern, northern and western blottings and PCR techniques. RAPD, RFLP and ARDRA techniques. Demonstration/experiments on isolation, separation of DNA and Protein molecules by electrophoresis techniques.

### **Unit IV : Research and Thesis writings:**

Research –definition, objectives, types and importance – Research methods in biological Sciences –Research process – Literature survey – sources – scientific databases – Research report writing – Parts of thesis and Dissertation – Title, certificate, declaration, acknowledgements, contents, list of tables, figures, plates & abbreviations, Introduction, Review of literature, Materials and methods – Results – Presentation of data - Tables, figures, maps, graphs, photographs – Discussion – Summary, bibliography / References and Appendix.

### **Unit V : Research Publication and Project writing:**

Writing scientific paper: Importance of title – abstract – key words, Introduction, Materials and Methods, Results, Discussion, Acknowledgements and References – Publication on research journals – Standards of research journals – peer review – impact factor –citation index. Proof correction – proof correction marks –Method of correction proof. Writing chapters in books. – Preparation of Research proposal and funding agencies – Research fellowships. Ethics in science reporting – Reproduction of published materials – Plagiarism & Anti – Plagiarism check – citation and acknowledgement. Biosafety levels – IBC – Institutional ethical committees – IPR & IPP.

### **References:**

1. David.T Plummer (2009). An Introduction to Practical Biochemistry, Tata Mc Graw Hill Pub.Co.Ltd, New Delhi.
2. N.Gurumani (2006).Research Methodology for Biological Sciences. MJP Publishers, Chennai.
3. K.Kannan (2003). Hand book of Laboratory Culture media, reagents, stains and buffers. Panima Publishing Corporation, New Delhi
4. Glick, B.R and Pasternak.J.J.,(2003). Molecular Biotechnology, ASM Press, Washington.DC.
5. P.Asokan (2002).Analytical biochemistry-Biochemical techniques. First Edn. China Publications, Melvishoram, Vellore.
6. Rajbir Singh (2002).Chromatography 1st Edition Mittal Publications, New Delhi.
7. Keith Wilson and John Walker (2002). Practical Biochemistry-Principles and techniques. 5thEd.Cambridge Univ.Press, London.
8. James.D.Watson, Michael Gilman,JanWit Koeski and Mark Zuller(2001). Recombinant DNA. IInd Ed.Scientific American Book. New York.
9. Rodney Boyes(2001). Modern Equipmental Biochemistry. III Ed Addison Wesley Longman Pvt.Ltd., Indian Branch ,Delhi.
10. S.Palanichamy and M.Shanmugavelu.(1997). Research methods in biological sciences. Palani Paramount Publications, Palani.

**Web resources:**

PubMed search engine for database of references and abstracts on life sciences and biomedical topics: <https://en.wikipedia.org/wiki/PubMed>.

Plagiarism Software: Online plagiarism checker for checking articles: <https://www.plagiarismsoftware.net/> and [www.arkund.com/en/](http://www.arkund.com/en/)

**LECTURE SCHEDULE: RESEARCH METHODOLOGY**

Unit	Lecture No.	Topics	Lecture delivery Mechanism
<b>I</b>	1	pH meter - types, basic principle, operation and application	Lecture +PPT
	2	Buffers-principle, standards and preparation of buffer; pH determination & pH indicators.	Lecture +PPT
	3	Principle, Operation and application of simple, compound, light-field microscopes	Lecture +PPT
	4	Principle, Operation and application of dark-field, phase-contrast, fluorescence microscopes	Lecture Exposure visit
	5	Principle, Operation and application of confocal and electron microscopy.	Lecture Exposure visit
	6	Micrometry-principle and application.	Lecture +PPT
	7	Polarimetry -principle and application	Lecture +PPT
	8	Experiments on buffer preparation and pH determination. Exposure to various microscopes.	Practical Demo
<b>II</b>	9	Centrifugation-types, principle and application	Lecture +PPT
	10	Principle, Operation and application of colorimeter, spectrophotometer, flame photometer, bomb calorimeter,	Lecture +PPT
	11	Principle, Operation and application of UV-Visible spectroscopy, atomic absorption spectroscopy, mass spectroscopy and FTIR spectroscopy.	Lecture Exposure visit
	12	Chromatography– types, principle and application: paper chromatography, thin layer chromatography, column chromatography & Ion Exchange	Lecture +PPT
	13	Principle, Operation and application of GC-MS and HPLC.	Lecture Exposure visit
	14	Demonstration on differential and gradient centrifugation	Practical Demo
	15	Demonstration on verification of Beer-Lamberts law.	Practical Demo
	16	Demonstration on chromatographic separation of amino acids and sugars & Experiment on ARA.	Practical Demo
<b>III</b>	17	Electrophoresis- Principle and applications	Lecture
	18	Paper and agarose gel electrophoresis,	Lecture Exposure visit
	19	Polyacrylamide gel electrophoresis (PAGE and SDS-PAGE) and immuno electrophoresis.	Lecture Exposure visit

	20	Microarray, MALDI-TOF and Amino acid sequencing	Lecture Exposure visit
	21	DNA sequencing (Enzymatic & Chemical methods)	Lecture Exposure visit
	22	Blotting techniques-southern, northern and western blottings and their applications	Lecture Exposure visit
	23	PCR, RAPD, RFLP and ARDRA techniques and their applications	Lecture Exposure visit
	24	Demonstration/experiments on isolation, separation of DNA and Protein molecules by electrophoresis techniques.	Practical Demo
<b>IV</b>	25	Research- Definition, objectives, types and importance	Lecture +PPT
	26	Research methods in Biological Sciences- Research process	Lecture +PPT
	27	Literature survey- sources- scientific databases	Lecture + Library visit
	28	Research report writing – Parts of thesis and Dissertation – Title, certificate, declaration, acknowledgements, and contents – list of tables, figures, plates & abbreviations.	Invited Lecture
	29	Parts of thesis: Introduction, Review of literature, Materials and methods	Invited Lecture
		Parts of thesis: Results – Presentation of data - Tables, figures, maps, graphs, photographs – Discussion – Summary, bibliography / References and Appendix	Invited Lecture
<b>V</b>	30	Writing scientific paper – Importance of title – abstract – key words, Introduction, Materials and Methods, Results, Discussion, Acknowledgements and References	Invited Lecture
	31	Publication on research journals – Standards of research journals – peer review – impact factor –citation index	Invited Lecture
	32	Writing chapters in books	Invited Lecture
	33	Proof correction – proof correction marks –Method of correction proof	Invited Lecture
	34	Preparation of Research proposal and funding agencies – Research fellowships	Invited Lecture
	35	Ethics in science reporting – Reproduction of published materials – Plagiarism & Anti –Plagiarism check – citation and acknowledgement.	Invited Lecture
	36	Biosafety levels – IBC – Institutional ethical committees – IPR & IPP.	Class Room Discussion

## **17BOTR0205 QUANTITATIVE TECHNIQUES- ADVANCED BIOSTATISTICS Credits- 4**

### **Objective:**

To provide students with a basic understanding of the principles of statistical methods and techniques as applied to biological Sciences.

### **Learning Outcomes:**

Upon completion of the course, the students will be able to perform the following:

- Choose appropriate statistical measures to analyze biological data.
- Students may try a few “Bio- Statistics tutorial” available in the internet.
- Select an appropriate measure, test and make interpretation of the results in biological experiments.
- Create and interpret visual representation of quantitative data in biological research.
- Understand different rates, ratios and Odds ratio required to interpret biological data.

### **UNIT- I:**

Descriptive Statistics: Types of data; Measures of central value; Variability Measures, Skewness measures; Computational Tools: SPSS, MATLAB, DMRT; Origin Software; NCBI online Tools on sequence alignment and physiological tree analysis

### **UNIT- II:**

Sampling and sample Designs: Census VS Sample methods- Laws of sampling; Sampling Techniques, Determination of Sample size; Merits and Demerits of Sampling and Non- Sampling errors; Reliability of samples.

### **UNIT- III:**

Probability and Theoretical distributions: Basic concepts in probability, Definition of Probability, Approaches to probability; Theoretical Distributions- Simple problems in Binomial, Poisson and Normal Distributions with biological applications.

### **UNIT- IV:**

Correlation Techniques: Simple Correlation and Regression problems; Multiple Correlation and Regression Analysis; Logistic Regression Analysis, Factor Analysis; Discriminant Analysis; Cluster Analysis; Illustration with SPSS; Bio- assays and odds ratios.

### **UNIT- V:**

Inferential Statistics; Basic concepts; Type- I and Type- II errors; Steps in Hypothesis Testing; Different Test procedures; Analysis of variance and Design of Experiments; Multiple comparisons Least significant difference Test; Analysis of Covariance.

## References:

1. Vijayalakshmi. G and C. Sivapragasam (2009)Research methods; Tips and Techniques, MJP publishers, Chennai
2. Sinha, B.L (2006) Statistics in Psychology and Education. Anmol publications, New Delhi
3. Gurumani, N(2004)An Introduction to Biostatistics, MJP publishers, Chennai
4. Stevens, J.P (2002) Applied Multivariate Statistics for the Social Sciences, 4<sup>th</sup> Edition, New Jersey, Lawrence, Erlbaum Associates
5. Aneshensel, C.S(2002)Theory- Based Data Analysis for the Social Sciences, Thousand Oaks, CA: Sage publications.
6. Sampath Kumar V.S(1997)Bio-Statistics, Manonmaniam Sundaranar University, University publication, Tirunelveli
7. Arora, P.N and P.K. Mathan(1996)Bio- Statistics, Himalaya publishing House, NewDelhi
8. Kline, P(1994)An Easy Guide to Factor Analysis, London: Routledge
9. Gupta, S.P(1992)Statistical methods, Sultan Chand, New Delhi
10. Milton J.S(1992)Statistical methods in Biological and Health Sciences, McGraw Hill, Inc., New York

## Webliography:

1. Data analysis: Online manuals and guides to software packages, SSPS product file: <http://www.spss.com/statistics>.
2. Practical examples for the analysis of Surveys - <http://www2.napier.ac.UK/depts/fhls/peas/index.htm>
3. Research methods and Statistics arena - [http://www.researchmethodsarena.com/resources/resources .asp](http://www.researchmethodsarena.com/resources/resources.asp)
4. Analysis of statistics and quantitative data analysis - website: [www.data-archive.ac.UK](http://www.data-archive.ac.UK)
5. Resource for methods in evaluation in Social research -<http://gsociology.icaap.org/methods/>.

**LECTURE SCHEDULE: QUANTITATIVE TECHNIQUES- ADVANCED BIOSTATISTICS**

Unit	Lecture	Topic	Delivery Mechanism
I	1 to 12	Introduction and Types of data, Central measures, Variability Measures and Skewness Computational Tools	Lecture Practical Practical Lecture + Practical
II	1 to 12	Introduction; Census VS Sample. Laws of Sampling and Sampling Techniques Determination of Sample size Merits and Demerits of sampling Sampling and Non- sampling errors	Lecture Self study Lecture Self study Self study
III	1 to 12	Probability- Basic concepts Approaches in Probability Computation of Probability- Simple problems in Binomial, Poisson and Normal Distributions	Lecture Lecture Lecture and Practical Lecture+ Practical
IV	1 to 14	Correlation and Regression- concepts Simple problems Multiple Correlation and Regression Analysis Logistic Regression Factor Analysis Discriminant Analysis, Cluster Analysis Bio-assays and odds ratios	Self study Lecture+Practical Lecture+Practical Lecture+Practical Lecture+Practical Lecture+Practical Lecture+Practical Lecture+ Practical
V	1 to 14	Basic concepts Type I and Type II errors Steps in Hypothesis Testing Test procedure Design of Experiments, Analysis of Variance Multiple comparisons, Least significance difference Test; Analysis of Covariance	Lecture Lecture Lecture Lecture Lecture+Practical Lecture+Practical Lecture+Practical Lecture+Practical