

## **DEPARTMENT OF BOTANY : INTRODUCTION AND OBJECTIVES OF THE COURSE**

The study of Botany, dealing with the structure, function, classification and evolution of plants, has inspired many great minds. Plants are unique as solar energy converters and providers of energy for all heterotrophic organisms. It is fascinating to study the wide spectrum of reproductive processes in algae, fungi, lichens, bryophytes, gymnosperms, and flowering plants. A student of Botany has been learning these aspects together with taxonomy, anatomy, plant pathology, plant breeding, microbiology, plant physiology, plant biochemistry, ecology, cytology, genetics, cytogenetics, molecular biology and plant biotechnology.

Renewing and updating of the curriculum is the essential ingredient of any vibrant academic system. Curriculum with necessary additions and changes are introduced in it from time to time, with a prime objective to maintain updated curriculum and also providing therein inputs to take care of paced development in the knowledge of the subject. Revising the curriculum should be a continuous process to provide an updated education to the students by and large. The last few decades have ushered in new advances, not only in general biology, but also in Botany, which now need to be incorporated in the Botany curricula.

The objectives of curriculum development are listed below:

1. To update course contents by introducing (in good measure) recent developments in plant sciences.
2. To prepare the curriculum as such that it can attract, enthuse, sustain and promote the interest of learners for selecting Botany and allied disciplines as their career and make them realize that their choice is intellectually rewarding.
3. To ensure that the curricula are not overloaded .Minimizing the descriptive aspects and eliminating repetition of contents between under graduate and post graduate syllabi is the major objective.
4. To provide the students of Bachelor's programme in Botany, an opportunity to opt one or more courses in allied disciplines to help them pursue specialization / research in interdisciplinary areas.
5. To make provision for improvement in the quality of laboratory and field work in the lack of which the students are not able to appreciate the beauty and variety of form, structure, function and ecological significance of plants and their biological services.
6. To increase the awareness of young learners about the abuse to which plants have been subjected by human greed, and to expertise in exploration, identification and evaluation of plants, conservation of nature and natural resources and in the protection of endangered plant species and other biota dependent on them.

7. To provide for the mobility of students among institutions and different disciplines so as to acquaint with the latest trends and techniques adopted in the field of applied botany.
8. Each course shall be assigned credits depending on the quantum of work required to be done in each semester. The formula for assigning credits to a course is based on the number of contact hours per week.
9. Evaluation for semester based programmes shall be done through Continuous Assessment (C.A) and Semester End Examinations (S.E.E). The weightage for the two types of evaluations: C.A: 30%, S.E.E: 70%, Total: 100%. The evaluation for Continuous Assessment (C.A.) shall be on an internal basis and external for Semester End Examinations (S.E.E.).

# **INTERNATIONAL COLLEGE FOR GIRLS (AUTONOMOUS)**

## **DEPARTMENT OF BOTANY**

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**SCHEME OF EXAMINATION  
AND  
COURSES OF STUDY  
BACHELOR OF SCIENCE (B.SC.)  
BOTANY  
First Semester – Sixth Semester  
(3-year programme)**

**I Semester Examination November 2009  
II Semester Examination April 2010  
III Semester Examination November 2010  
IV Semester Examination April 2011  
V Semester Examination November 2011  
VI Semester Examination April 2012**

**Syllabus applicable for the students seeking admission to B.Sc. (Botany)  
in the academic year 2009-10**

**INTERNATIONAL COLLEGE FOR GIRLS, JAIPUR**  
**DEPARTMENT OF BOTANY**  
**Bachelor of Science**  
**Syllabus based on the Semester System**  
**(Theory and Practical)**

**First Semester:**

**Bot. 101: Diversity of Microbes, Algae and Bryophytes**

**Bot. 102: Lichens, Fungi and Plant Pathology**

**Bot. 103: Practicals based on Bot.101 and 102**

**Second Semester:**

**Bot. 201: Cell and Molecular Biology**

**Bot. 202: Pteridophytes, Gymnosperms and Palaeobotany**

**Bot. 203: Practicals based on Bot. 201 and 202**

**Third Semester:**

**Bot. 301: Genetics and Plant Breeding**

**Bot. 302: Environmental Studies and Plant Conservation**

**Bot. 303: Practicals based on Bot. 301 and 302**

**Fourth Semester:**

**Bot. 401: Plant Anatomy and Embryology**

**Bot. 402: Plant Systematics and Economic Botany**

**Bot. 403: Practicals based on Bot. 401 and 402**

**Fifth Semester:**

**Bot. 501: Plant Physiology and Metabolism**

**Bot. 502: Plant Biochemistry**

**Bot. 503: Practicals based on 501 and 502**

**Sixth Semester:**

**Bot. 601: Plant Biotechnology**

**Bot. 602: Applied Botany**

**Bot. 603: Practicals based on 601 and 602**

### Semester I

<b>Paper Code</b>	<b>Title</b>	<b>Paper</b>	<b>Contact Hrs.</b>		<b>Credit</b>	<b>Max. marks</b>	<b>Min. marks</b>
			<b>Per semester</b>	<b>Per week</b>			
BOT 101	Diversity of Microbes, Algae and Bryophytes	Theory	45	3	3	100	36
BOT 102	Lichens, Fungi and Plant Pathology	Theory	45	3	3	100	36
BOT 103	Practical	Practical	60	4	2	100	36
<b>Total Credits for I Semester</b>					<b>8</b>		

### Semester II

<b>Paper Code</b>	<b>Title</b>	<b>Paper</b>	<b>Contact Hrs.</b>		<b>Credit</b>	<b>Max. marks</b>	<b>Min. marks</b>
			<b>Per semester</b>	<b>Per week</b>			
BOT 201	Cell and Molecular Biology	Theory	45	3	3	100	36
BOT 202	Genetics and Plant Breeding	Theory	45	3	3	100	36
BOT 203	Practical	Practical	60	4	2	100	36
<b>Total Credits for II Semester</b>					<b>8</b>		

### Semester III

<b>Paper Code</b>	<b>Title</b>	<b>Paper</b>	<b>Contact Hrs.</b>		<b>Credit</b>	<b>Max. marks</b>	<b>Min. marks</b>
			<b>Per semester</b>	<b>Per week</b>			
BOT 301	Pteridophytes, Gymnosperms and Paleobotany	Theory	45	3	3	100	36
BOT 302	Environmental studies and Plant Conservation	Theory	45	3	3	100	36
BOT 303	Practical	Practical	60	4	2	100	36
<b>Total Credits for III Semester</b>					<b>8</b>		

## Semester IV

<b>Paper Code</b>	<b>Title</b>	<b>Paper</b>	<b>Contact Hrs.</b>		<b>Credit</b>	<b>Max. marks</b>	<b>Min. marks</b>
			<b>Per semester</b>	<b>Per week</b>			
BOT 401	Plant Anatomy and Embryology	Theory	45	3	3	100	36
BOT 402	Plant Systematics and Economic Botany	Theory	45	3	3	100	36
BOT 403	Practical	Practical	60	4	2	100	36
<b>Total Credits for IV Semester</b>					<b>8</b>		

## Semester V

<b>Paper Code</b>	<b>Title</b>	<b>Paper</b>	<b>Contact Hrs.</b>		<b>Credit</b>	<b>Max. marks</b>	<b>Min. marks</b>
			<b>Per semester</b>	<b>Per week</b>			
BOT 501	Plant Physiology and Metabolism	Theory	45	3	3	100	36
BOT 502	Plant Biochemistry	Theory	45	3	3	100	36
BOT 503	Practical	Practical	60	4	2	100	36
<b>Total Credits for V Semester</b>					<b>8</b>		

## Semester VI

<b>Paper Code</b>	<b>Title</b>	<b>Paper</b>	<b>Contact Hrs.</b>		<b>Credit</b>	<b>Max. marks</b>	<b>Min. marks</b>
			<b>Per semester</b>	<b>Per week</b>			
BOT 601	Plant Biotechnology	Theory	45	3	3	100	36
BOT 602	Applied Botany	Theory	45	3	3	100	36
BOT 603	Practical	Practical	60	4	2	100	36
<b>Total Credits for VI Semester</b>					<b>8</b>		
<b>Total Credits</b>					<b>48</b>		

**B.Sc. Botany**  
**Scheme of Examination**

Semester	Paper code	Credits	Contact Hrs/ week	Maximum Marks	Minimum Marks	Continuous Assessment 30 %	Semester End Exam (70 %)
<b>I</b>	BOT- 101	3	3	100	36	30	70
	BOT- 102	3	3	100	36	30	70
	BOT- 103	2	4	100	36	30	70
<b>II</b>	BOT- 201	3	3	100	36	30	70
	BOT- 202	3	3	100	36	30	70
	BOT- 203	2	4	100	36	30	70
<b>III</b>	BOT- 301	3	3	100	36	30	70
	BOT- 302	3	3	100	36	30	70
	BOT- 303	2	4	100	36	30	70
<b>IV</b>	BOT- 401	3	3	100	36	30	70
	BOT- 402	3	3	100	36	30	70
	BOT- 403	2	4	100	36	30	70
<b>V</b>	BOT- 501	3	3	100	36	30	70
	BOT- 502	3	3	100	36	30	70
	BOT- 503	2	4	100	36	30	70
<b>VI</b>	BOT- 601	3	3	100	36	30	70
	BOT- 602	3	3	100	36	30	70
	BOT- 603	2	4	100	36	30	70

**INTERNAL ASSESSMENT**

C.A. Test	III comp.			Total
15 mks	Class Room Interaction (5mks)	Home Assignment (5 mks)	Attendance (5 mks )	30 mks

Scheme of Evaluation for Continuous Assessment (Practical)				
Test	Practical Record	III comp.		Total
10 mks	10 mks	Viva Voce (5 mks)	Attendance (5 mks )	30 mks

**Note:**

- Time duration of Internal tests will be 45 minutes
- Time duration of SEE will be three hours

**Passing percentage in continuous assessment and semester end exam is 36 %.**

**B.Sc. Semester I**  
**PAPER I**  
**BOT 101: Diversity of Microbes, Algae and Bryophytes**

**Objectives- Exploration, identification of microbes and lower plants.**

**Credits: 3**

**Contact Hours/ Semester: 45**

**Marks: 100**  
**(C.A30%; S.E.E 70%)**

**Unit I**

**Viruses and Bacteria:** General characters, structure, nutrition, reproduction and economic importance, viroids, virions, general account of Cyanobacteria (*Oscillatoria*, *Nostoc*). Scope and application of microbes in agriculture, industry, food, pollution and biological control of pests. (8 Hours)

**Unit II**

**Algae I:** General characters, classification, thallus organization, pigments and reserve food material, reproduction, algal biofertilizers, algae used in industry, eutrophication . (5 Hours)

**Unit III**

**Algae II:** General characters, classification, economic importance, important features and life history of:  
Chlorophyceae: *Volvox*  
Xanthophyceae: *Vaucheria*  
Phaeophyceae: *Ectocarpus*  
Rhodophyceae: *Polysiphonia* (12 Hours)

**Unit IV**

**Bryophytes I:** General characters, classification, distribution of bryophytes in India, alternation of generation, evolutionary trends in thallus and sporogonium organization, economic importance of bryophytes. (7 Hours)

**Unit V**

**Bryophytes II:** Morphology, distribution, structure, reproduction, classification, life history and economic importance of  
Hepaticopsida :*Marchantia*  
Anthocerotopsida: *Anthoceros*  
Bryopsida: *Funaria* (13 Hours)

**Essential Books for BOT 101:**



- Chattopadhyay, SB. Principles and Procedures of Plant Protection (3<sup>rd</sup> edition). Oxford & IBH Publishing Co. Pvt. Ltd.
- Clifton, A. 1958. Introduction to the Bacteria. McGraw Hill & Co., New York
- Jayaraman, Jaishree. Fundamentals of Plant Bacteriology. Kalyani Publishers.
- Kumar, HD. 1958. Introductory Phycology. Affiliated East-West Press Ltd., New Delhi.
- Morris, I. 1986. An Introduction to Algae. Cambridge University Press. Cambridge, UK.
- Pandey, B.P. and Trivedi, P.S. A text book of Bryophytes. Vikas Publication House.

### **Suggested Readings**

- Pandey, BP and Trivedi, P.S. 1998. A Text Book of Algae. Vikas Publishing House.
- Parihar, NS. 1991. Bryophyta. Central Book Depot, Allahabad.
- Puri, P. 1980. Bryophyta. Atma Ram & Sons, Delhi.
- Round, FE. 1986. The Biology of Algae. Cambridge University Press, Cambridge.
- Smith, GM. 1971. Cryptogamic Botany. Vol. I. Algae and Fungi. Tata McGraw Hill Publishing Co., New Delhi.
- Smith, GM. 1971. Cryptogamic Botany. Vol. II. Bryophytes and Pteridophytes. Tata McGraw Hill Publishing Co., New Delhi
- Sharma, OP. 1992. Text Book of Thallophytes. McGraw Hill Publishing Co., New Delhi.
- Trivedi, PC; Sharma, N; Dhankher, RS and Gupta, S. 2003. Diversity of Microbes and Cryptogams. Ramesh Book Depot, Jaipur.
- Vasishtha, PC. Algae Rev. 9<sup>th</sup>. S. Chand & Co., Delhi.
- Verma, HN. 2003. Basics of Plant Virology. Oxford & IBH Publishing House

### **Laboratory Readings**

- Pandey, BP and Trivedi, P.S. 1997. Botany Vol. I (10<sup>th</sup> edition). Vikas Publishing House.
- Pandey, BP; Misra; Trivedi, P.S. 1997. Botany Vol. II. Vikas Publishing House.
- Pandey, BP and Chadha. 1997. Botany Vol. III. Vikas Publishing House.
- Santra, SC and Chatterjee. 2005. College Botany Practical Vol. I. New Central Book Agency (P) Ltd.
- Kumar, S and Kashyap. 2003. Manual of Practical Algae. Campus Books International, New Delhi
- Kanika Sharma. Manual of Microbiology. Ane Books, New Delhi.
- A text book of Practical Botany. Vol I. Bendre and Kumar, Rastogi Pub. Meerut.
- Manual of Practical Algae. Suresh Kumar, Amar Singh Kashyap. Campus Books Internet, New Delhi.

**B.Sc. Semester I**  
**Paper II**  
**BOT 102: Lichens, Fungi and Plant Pathology**

**Objectives-** To facilitate study of a wide spectrum of plant disease, cause, symptom and control measures.

**Credits: 3**

**Contact Hours/ Semester: 45**

**Marks: 100**  
**(C.A30%; S.E.70%)**

**Unit I**

**Lichens:** General characters, structure, reproduction and economic importance.

**Mycoplasma:** General characters, structure, reproduction and economic importance.

**Phytoplasma:** General characters, structure, reproduction and economic importance.  
(5 Hours)

**Unit II**

**Fungi I:** General characters, classification and economic importance, parasexual cycle, heterothallism, mushroom cultivation, poisonous fungi, fungi in medicine.  
(5 Hours)

**Unit III**

**Fungi II:** General characters, classification and economic importance, life history of –  
Mastigomycotina- *Sclerospora*  
Zygomycotina-*Rhizopus*  
Ascomycotina- *Saccharomyces, Aspergillus,*  
Basidiomycotina- *Puccinia, Ustilago*  
Deuteromycotina- *Alternaria*  
(15 Hours)

**Unit IV**

**Plant Pathology I :** History and scope of plant pathology, general account of diseases caused by plant pathogens, significance of plant diseases, pathogen attack and defence mechanisms.  
(5 Hours)

**Unit V**

**Plant Pathology II :** Symptomatology, causal organism, disease cycle and control of the following plant diseases: Tobacco mosaic virus, bhindi yellow mosaic, little leaf of brinjal, citrus canker, white rust of crucifers, green ear disease of bajra, late blight of potato, rust and smut of wheat .  
(15 Hours)

## Essential Books for BOT.102

- Agrios, GN. 1997. Plant Pathology. Academic Press, London.
- Albajes, R; Gullino, ML; Van Lanteren, JC and Elad, Y. 2000. Integrated Pest and Disease Management in Greenhouse Crops. Kluwer Academic Publishers.
- Alexopoulous, CJ; Mims,CW and Blackwel, M. 1996. Introductory Mycology. John Wiley & Sons Inc.

## Suggested Readings

- Bilgrami and Verma. Physiology of Fungi..Vikas Publishing House Pvt. Ltd., New Delhi.
- Bridge, P; Moore, DR and Scott, PR. 1998. Information Technology, Plant Pathology and Biodiversity. CAB International, U.K.
- Chupp., Manual of Vegetable Plant Diseases. Discovery Publishing House, New Delhi.
- Dube, HC. 1990. An Introduction to Fungi. Vikas Publishing House Pvt. Ltd., Delhi.
- Horsfall, JC and Diamond, AE. Plant Pathology Vol. 1, 2&3. Academic Press, New York; London.
- Mehrotra, RS. Plant Pathology. Tata McGraw Hill, New Delhi
- Narayanswamy, P. Microbial Plant Pathogens and Crop Disease Management. Oxford & IBH Publishing Co. Pvt. Ltd.
- Pathak, Khatri, Pathak. Fundamentals of Plant Pathology. Agrobios. Jodhpur.
- Rangaswamy, G and Mahadevan, A. 1999. Diseases of crop plants in India (4<sup>th</sup> edition). Prentice Hall of India Pvt., New Delhi.
- Sharma, PD. 1991. The Fungi. Rastogi & Co., Meerut.
- Singh, RS. An Introduction to Principles of Plant Pathology. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Trivedi, PC. 1998. Nematode diseases in Plants. CBS Publisher and Distributor, New Delhi.
- Vasishtha, PC. Fungi. S.Chand and Company, New Delhi.
- Webster, J. 1985. Introduction to Fungi. Cambridge University Press.

## Suggested Laboratory Readings

- Santra, SC and Chatterjee. 2005. College Botany Practical Vol. I. New Central Book Agency (P) Ltd.,Calcutta.
- Santra, SC. 2005. College Botany Practical Vol. II. New Central Book Agency (P) Ltd.
- A text book of Practical Botany. Vol.I.Bendre .and Kumar ,Rastogi Publication,Meerut

**B.Sc. Semester I**  
**PAPER III**  
**BOT103: Practical syllabus based on BOT. 101 and 102**

**Credits: 3**

**Contact Hours/ Semester: 45**

**Marks: 100**  
**(C.A30%; S.E.E70%)**

**Suggested exercises:**

- Major contributors in the field of microbiology- Pasteur, Leuwenhock, Koch, Metchinkoff, Paul Ehrlich, Flemming.
- Staining of different types of bacteria.
- Electron micrograph of bacteriophages.
- Study of *Spirulina*
- Field study of eutrophication by algae.
- Microscopic preparation and study of the following algal members: *Nostoc*, *Oscillatoria*, *Volvox*, *Chara*, *Vaucheria*, *Ectocarpus*, *Polysiphonia*.
- Study of external morphology and microscopic preparation of the following Bryophytes: *Marchantia*, *Porella*, *Anthoceros*, *Funaria* .
- Study of mushroom cultivation.
- Microscopic preparation and study of *Albugo*, *Sclerospora*, *Rhizopus*, *Saccharomyces*, *Aspergillus*, *Puccinia*, *Ustilago*.
- Study of specimens of different types of lichens.
- Study of some locally available plant diseases caused by viruses, mycoplasma, bacteria and fungi in field and laboratory viz. Yellow Vein Mosaic of Bhindi, Tobacco Mosaic Virus, Little Leaf of Brinjal, Citrus Canker, White Rust of Crucifers, Green Ear Disease of Bajra, Late Blight of Potato, Rust and Smut of Wheat.
- Study of permanent specimens and slides of the all the above mentioned course material.

**B.Sc. Semester II**  
**PAPER I**  
**BOT 201: Cell and Molecular Biology**

**Objectives:** To study the molecular aspects of cell structure and functions in plant cell.

**Credit: 3**

**Contact Hours/Semester: 45**

**Marks 100**  
**(C.A.30% : S.E.E70%)**

**UNIT I**

**Cell envelopes and organelles :** Cell wall : structure, plasma membrane: structure, models and functions, ion carriers, channels and pumps, structure and function of chloroplast ,mitochondria, golgi bodies, endoplasmic reticulum, lysosomes, plasmodesmata, vacuoles, ribosomes, biogenesis of chloroplast and mitochondria. Ultrastructure of nucleus, nuclear membrane, nucleolus, nuclear pores.

(10 Hours)

**UNIT II**

**Chromosome Organization:** Chromosome structure and packaging of DNA, molecular organization of centromere and telomere, specialized type of chromosome: Polytene and lampbrush chromosome, B chromosomes, karyotype analysis, Heterochromatin and Euchromatin, Barr bodies.

(10 Hours)

**UNIT III**

**Cell Division:** Amitosis, Mitosis, Meiosis, Cell cycle .

(8 Hours)

**UNIT IV**

**DNA-The Genetic Material:** DNA structure, A, B and Z forms , replication, DNA damage and repair, DNA methylation, transposons , satellite and repetitive DNA, transcription of DNA, transcription factors, RNA processing, translation. .

(10 Hours)

**UNIT V**

**RNA-The Genetic Material:** RNA structure and its types- r RNA , mRNA , and tRNA , Biogenesis and structure of different types of RNA, RNA editing, nucleolus and ribosomal RNA genes.

(7 Hours)

### **Essential Books for BOT 201**

- Alberts, B; Bray, D; Lewis, J; Raff, M; Roberts, K and Watson, JD. 1999. Molecular Biology of the Cell. Garland Publishing Inc., New York.
- Buchanan, BB; Gruissem, W and Jones, RL. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists. Maryland, USA.
- Powar, C.B. Cell Biology. Himalaya Publishing House, Mumbai.
- Introductory Cell Biology. Veer Bala Rastogi.

### **Suggested Readings**

- De Robertis. Cell and Molecular Biology. Waverly International.
- Karp and Gerald. Cell and Molecular Biology: Concepts and Experiments (3<sup>rd</sup> edition). John Wiley & Sons.
- Kleinsmith, LJ and Kish, VM. 1995. Principles of Cell and Molecular Biology (2<sup>nd</sup> edition). Harper Collins College Publishers. New York, USA.
- Krishnamurthy, KV. 2000. Methods in Cell Wall Cytochemistry. CRC Press, Boca Raton; Florida.
- Lewin, B 2000. Genes VII. Oxford University Press, New York.
- Lodish, H; Berk, A; Zipursky, SL; Matsudaira, P; Baltimore, D and Darnell, J. 2000. Molecular Cell Biology (4<sup>th</sup> edition). WH Freeman & Co., New York.
- Rost, T et al. 1998. Plant Biology. Wordsworth Publishing Co. California, USA.
- Wolfe, SL. 1993. Molecular and Cellular Biology. Wordsworth Publishing Co. California, USA.
- Weil, JH. 2003. Molecular Insight in Plant Biology. Oxford & IBH Publishing Co. Pvt. Ltd.

### **Suggested Laboratory Readings**

- Khasim, SM. 2002. Botanical Microtechnique: Principles and Practice. Capital Publishing Co., New Delhi.
- Protein Expression: A Practical Approach. Ed. Higgins, SJ and Hames, BD. Oxford University Press
- Malacinski, GM and Freifelder, D. Essentials of Molecular Biology III Ed. Jones & Barlett Publishers.
- A text book of Practical Botany. Vol I. Bendre and Kumar. Rastogi Publication.

**B.Sc. Semester II**  
**Paper II**  
**BOT 202: Pteridophytes, Gymnosperms and Palaeobotany**

**Objectives:** To study the structural, developmental and economic aspects of Pteridophytes and Gymnosperms.

**Credits: 3**

**Contact Hours/ Semester: 45**

**Marks: 100**  
**(C.A30% ; S.E.E70%)**

**Unit I**

**Pteridophytes I:** General characters, classification, telome theory, stelar system, apogamy, apospory, origin of seed habit and heterospory, leptosporangiate and eusporangiate type of development

(9 Hours)

**Unit II**

**Pteridophytes II:** Important characters, classification, structure, economic importance and life history of:

Psilopsida: *Psilotum*

Lycopsida- *Selaginella*

Sphenopsida: *Equisetum*

Pteropsida: *Marsilea*

(9 Hours)

**Unit III**

**Gymnosperm I:** General characters, classification, evolution of Gymnosperms, Distribution in India, Affinities of gymnosperms with Angiosperms and Pteridophytes, Economic importance.

(9 Hours)

**Unit IV**

**Gymnosperm II:** Important characters, classification, structure, economic importance and life history of:

Cycadopsida: *Cycas*

Coniferopsida: *Pinus*

Gnetopsida: *Ephedra*

(9 Hours)

## **Unit V**

Palaeobotany: Fossilization, geological time scale, fossil pteridophytes: *Rhynia*, *Lepidodendron*, fossil gymnosperms: *Glossopteris*, *Williamsonia*

(9 Hours)



## **Essential Books for BOT 202**

- Bhatnagar, SP and Moitra, A. 1996. Gymnosperms. New Age International( Pvt.) Ltd., New Delhi.
- Chamberlain, C.J. Gymnosperms: Structure and Evolution .CBS Publishers and Distributors, New Delhi.
- Moitra, A. 2003. Gymnosperms. New Age International (Pvt.) Ltd.New Delhi.
- Parihar, NS. 1996. Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
- Purohit and Vyas. 1997. A Text Book of Gymnosperms. Ramesh Book Depot, Jaipur.
- Sharma, OP. 1990. Text Book of Pteridophyta. McMillan India Ltd., New Delhi.
- Sporne, KR. 1965. The Morphology of Gymnosperms. Hutchinson and Co. Ltd., London.
- Vasishtha, PC. 2004. Gymnosperms Vol.V. S. Chand & Co., Delhi.

## **Suggested Readings**

- Singh, H. 1978. Embryology of Gymnosperms. Encyclopaedia of Plant Anatomy X. Gebruder Borntraeger, Berlin.
- Smith, GM. 1971. Cryptogamic Botany, Vol. II Bryophytes and Pteridophytes. Tata McGraw Hill Publishing Co., New Delhi.
- Sporne, KK. 1991. The Morphology of Pteridophytes. BI Publishing Pvt. Ltd., Bombay.
- Stewart, WN and Rathwell, GW. 1993. Paleobotany and the Evolution of plants. Cambridge University Press, Cambridge.
- Trivedi, PC; Sharma, N; Dhanker, RS and Gupta, S. 2003. Diversity of Microbes and Cryptogams. Ramesh Book Depot, Jaipur.
- Vasishtha, PC. 2004. Gymnosperms Vol.V. S. Chand & Co., New Delhi.

## **Suggested Laboratory Readings**

- Bendre. 1995. A Text Book of Practical Botany.Vol.II Rastogi Publications, Meerut.
- Santra, SC. 2005. College Botany Practical Vol.II. New Central Book Agency (P) Ltd., Calcutta.
- Pandey, BP and Chadha. 1997. Botany Vol. III. Vikas Publishing House.
- Santra, SC; Chatterjee, TP and Das, AP. College Botany Practical Vol. 1. New Central Book Agency (P) Ltd., Kolkata
- Pandey B.P.and Trivedi P.S.1997.Vol.II Vikas Publishing House.

**B.Sc. Semester II**  
**PAPER III**  
**BOT 203: Practical syllabus based on BOT 201 and 202**

**Credits: 3**

**Contact Hours/ Semester: 45**

**Marks: 100**  
**(C.A30%; S.E.E70%)**

**Suggested Exercises**

- Study of electron micrographs of various cell organelles- cell ultrastructure, specialized chromosomes, nucleus, golgi body, endoplasmic reticulum.
- Study of Mitosis and Meiosis.
- Study of Permanent slides and specimens in the above mentioned course material.
- Microscopic preparation and study of different types of steles.
- Microscopic double stained preparation and anatomical study of the following pteridophytes- *Psilotum*, *Lycopodium*, *Selaginella*, *Equisetum* and *Marsilea*.
- Microscopic preparation and study of single stained temporary slides of the cones of *Lycopodium*, *Selaginella*, *Equisetum* and sporocarp of *Marsilea*.
- Microscopic double stained preparation of stem of *Pinus*, *Ephedra*, T.S. leaf of *Cycas* and needle of *Pinus*, T.S. of normal and coralloid root of *Cycas*.
- Microscopic preparation male cone of *Pinus*, male and female cone of *Ephedra*, male cone and megasporophyll of *Cycas*.
- Microscopic examination of fossil slides/ specimen/ photographs of *Rhynia*, *Lepidodendron*, *Glossopteris*, *Williamsonia*.

**B.Sc. Semester III**  
**PAPER I**  
**BOT 301: Genetics and Plant Breeding**

**Objectives:** To study the mendelian as well as modern aspects of genetics with Plant Breeding.

**Credits: 3**

**Contact Hours/ Semester: 45**

**Marks: 100**  
**(C.A30%; S.E.E70%)**

**UNIT I**

**Genetic Inheritance :** Mendelism, laws of inheritance, gene interactions, linkage and crossing over, multiple alleles, sex determination, sex linked, sex influenced, sex limited traits.

(8 Hours)

**UNIT II**

**Chromosomal variations:** Chromosomal aberrations, duplication, deficiency, inversion and translocation, origin, occurrence and application of haploids, aneuploids and polyploids, autopolyploids and allopolyploids, monosomics and trisomics. Mutations- spontaneous and induced, physical and chemical mutagens , related genetic disorders- Turner's syndrome, Down's syndrome, Klinefelter's syndrome, Cri-du –chat syndrome, Triple X syndrome.

(10 Hours)

**UNIT III**

**Gene expression:** Gene fine structure, introns and their role in genetics, regulation of gene expression in prokaryotes and eukaryotes, lac operon and tryptophan operon, lytic and lysogenic cycle in bacteriophages.

(10 Hours)

**UNIT IV**

**Extra nuclear genome:** Genetics of mitochondrial and chloroplast DNA- structure, functions and inheritance, plasmids and episomes; maternal effects and cytoplasmic inheritance, cytoplasmic male sterility.

(8 Hours)

**UNIT V**

**Plant Breeding:** Methods of plant breeding, selection (mass, pureline and clonal), pedigree analysis, acclimatization, hybridization, heterosis and inbreeding depression

(8 Hours)

## **Essential Books for BOT 301**

- Athertl, AG; Girton, JR and McDonald, JF. 1999. The Science of Genetics. Saunders College Publishing. Fort Worth, USA
- Chaudhary, HK. 1998. Elementary Principles of Plant Breeding. Oxford & IBH Publishing Co. Pvt. Ltd.
- Chopra, VL. 2003. Plant Breeding. Oxford & IBH Publishing Co. Pvt. Ltd.
- Devi and Pratibha. 2003. Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios, Jodhpur.
- Gupta, PK. 1993. Genetics and Plant Breeding. Rastogi Publications, Meerut.
- Mohan P. Arora and Gurdarshan S. Sandhu. Genetics, 5<sup>th</sup> revised edition. Himalaya Publishing House, Mumbai

## **Suggested Readings**

- Hartt, DL and Jones, EW. 1998. Genetics: Principles and Analysis (4<sup>th</sup> edition). Jones and Bartlett Publishers. Massachusetts, USA.
- Hawkins. Gene Structure and Expression. Cambridge University Press, Cambridge, UK
- Russel, PJ. 1998. Genetics. The Benjamin/ Cummings Publishing Co. Inc.,USA.
- Sharma. 1997. Plant Breeding. Tata McGraw Hill Publishing Co. Pvt. Ltd.
- Singh, BD. 2003. Plant Breeding. Kalyani Publishers.
- Sinha. 1995. Cytogenetics, Plant Breeding and Evolution. Tata McGraw Hill Publishing Co. Pvt. Ltd., New Delhi.
- Snustad, DP and Simmons, MJ. 2000. Principles of Genetics. John Wiley & Sons Inc., USA.
- Stent, GS 1986. Molecular Genetics. CBS Publications, New Delhi.
- Tyagi. 1996. Fundamentals of Cytogenetics, Plant Breeding and Evolution. Ramesh Book Depot, Jaipur.
- Gardner.2000 Genetics. John Wiley and Sones Inc.,USA.

## **Suggested Laboratory Readings**

- Pandey, BP and Trivedi, P.S. 1997. Botany Vol. I(10<sup>th</sup> edition). Vikas Publishing House.
- Pandey, BP; Misra; Trivedi, P.S. 1997. Botany Vol. II. Vikas Publishing House.
- Pandey, BP and Chadha. 1997. Botany Vol. III. Vikas Publishing House
- Lab. Manual of Plant Breeding and Genetics.

**B.Sc. Semester III**  
**Paper II**  
**BOT. 302: Environmental Studies and Plant Conservation**

**Objectives: The course aims studying environment and to aware the students about conservation.**

**Credits: 3**

**Contact Hours/ Semester: 45**

**Marks: 100**  
**(C.A30%; S.E.E70%)**

**Unit I**

**Ecology:** Definition and scope, interaction of climatic, topographic, edaphic and biotic factors, constituting the environment components, Ecosystem: Introduction, types of ecosystem, structure and function of ecosystem, biotic and abiotic components, food chain, food web, ecological pyramids, energy flow, productivity

(10 Hours)

**Unit II**

**Community ecology:** Definition and brief history, characteristics of a community, ecological succession, composition, structure, origin and development of a community

(9 Hours)

**Unit III**

**Plant adaptation:** Soil-Plant Atmosphere Continuum (SPAC), ecological groups of plants:

Hydrophytes- *Eichhornia, Hydrilla*

Xerophytes: *Casuarina, Nerium*

Halophytes: *Rhizophora*

(8 Hours)

**Unit IV**

**Pollution and climate change:** Air, Water and Soil Pollution: sources, effects on plants and ecosystems, control measures, greenhouse effect, ozone depletion, global warming, public awareness, chipko movement.

(9 Hours)

**Unit V**

**Conservation:** *Ex-situ* and *in-situ* conservation, endangered plants, Red data book, botanical gardens, afforestation, elementary knowledge of institutions related to plant conservation: Botanical Survey of India (BSI), National Bureau of Plant Genetic

Resources (NBPGR), Council of Scientific and Industrial Research(CSIR), Department of Biotechnology(DBT), Indian Council of Agricultural Research(ICAR)

(9 Hours)

## Essential Books recommended for BOT 302

- Anonymous . 1997. National Gene Bank: Indian Heritage on Plant Genetic Resources (Booklet). National Bureau of Plant Genetic Resources, New York.
- Arora, RK and Nayar., ER. 1984. Wild Relatives of Crop Plants in India. NBPGR Science Monograph No. 7.
- Baker, HG. 1978. Plants and Civilization (3<sup>rd</sup> edition).. CA Wadsworth, Belmont.
- Bole, PV and Vaghani, Y. 1986. Field Guide to Common Indian Trees. Oxford University Press, Mumbai.
- P.D.Sharma. Ecology and Environment. Rastogi Publication.
- H.S. Mann , Arid Zone Research and Development. Scientific Publishers, Jodhpur.
- Odum, EP. 1971. Fundamentals of Ecology. Saunders, Philadelphia. New York.

## Suggested Readings

- Barbour, MG; Burk, JH and Pitts, WD. 1987. Terrestrial Plant Ecology. Benjamin/ Cummings Publication Co., New York.
- Begon, M; Harper, JL and Townsend, CR. 1996. Ecology. Blackwell Science. Cambridge, USA.
- Brady, NC. 1990. The Nature and Properties of Soils. McMillan.
- Chandel, KPS; Shukla, G and Sharma, N. 1996. Biodiversity in Medical and Aromatic Plants in India: Conservation and Utilization. NBPGR, New Delhi.
- Chapman, JL and Reiss, MJ. 1988. Ecology: Principles and Applications. Cambridge University Press. Cambridge, UK.
- Desert Ecology. I. Prakash. Scientific Publishers, Jodhpur.

## Suggested Laboratory Readings

- Pandey, BP and Trivedi, P.S. 1997. Botany Vol. I (10<sup>th</sup> edition). Vikas Publishing House.
- Pandey, BP; Misra; Trivedi, P.S. 1997. Botany Vol. II. Vikas Publishing House.
- Pandey, BP and Chadha. 1997. Botany Vol. III. Vikas Publishing House
- Sharma P.D. Text Book of Practical Botany. Rastogi Publications.

**B.Sc. Semester III**  
**PAPER III**  
**BOT 303: Practical Syllabus Based on BOT 301 and 302**

**Credits: 3**

**Contact Hours/ Semester: 45**

**Marks: 100**

**(C.A30%; S.E.E70%)**

**Suggested exercises**

- Study of Barr bodies.
- Study of B chromosomes
- Study of mitosis in onion root tips.
- Calculation of mitotic index.
- Study of meiosis in onion flower buds.
- Study of monohybrid and dihybrid crosses in the field and working on the numerical problems related to them.
- To find the frequency of herbaceous species by quadrat method.
- To find the density of herbaceous species by quadrat method.
- To find the minimum size of quadrat.
- Study of adaptive modifications in plants by specimens/ slide preparation /photographs in  
Hydrophytes- *Eichhornia, Hydrilla*  
Xerophytes- *Casuarina, Nerium*  
Halophytes- *Rhizophora*
- Soil analysis:
  - a) Study of soil texture.
  - b) Study of soil pH.
  - c) Study of soil water holding capacity.
  - d) Study of soil moisture percentage
  - e) Testing of soil for the presence of carbonate, nitrate, inorganic salts and replaceable bases.



**B.Sc. Semester IV**  
**PAPER I**  
**BOT 401: Plant Anatomy and Embryology**

**Objectives:** The course aims studying not only morphology, structure and development of flowering plants but their practical and experimental aspects also.

**Credits: 3**

**Contact Hours/ Semester: 45**

**Marks: 100**

**(C.A30% ; S.E.E70%)**

**UNIT I**

**Plant anatomy:** Simple and complex permanent tissues; Internal structure of primary root, primary stem and leaf, differentiation of secondary tissues in roots and stem, general account of their structure and their roles, anomalous secondary growth, cambium, periderm, lenticels, secretory ducts and laticifers.

(10 Hours)

**UNIT II**

**Plant Development:** Histological organization of shoot apical meristem and root apical meristem, origin and development of leaf, types of root system, origin of lateral roots, root hair; branching and its patterns.

(8 Hours)

**UNIT III**

**Embryology I:** Structure of anthers, microsporogenesis, role of tapetum, pollination, pollen germination, pollen tube growth . Megasporogenesis, ovule development, types of ovules, development and types of embryo sacs, embryo sac cells, and double fertilization, *in vitro* fertilization.

(8 Hours)

**UNIT IV**

**Embryology II:** Endosperm: structure, types and development, Embryogenesis: the zygote, laws of embryogenesis, embryo development in dicotyledons and monocotyledons, nutrition of embryo, polyembryony, apomixis.

(11 Hours)

**UNIT V**

**Seed:** Development and structure of seed in monocotyledons and dicotyledons, suspended animation, seed dormancy (primary and secondary, causes of seed dormancy, seed as a unit of replenishment.

(8 Hours)

### **Essential Books for 401**

- Bhatnagar. 2002. The Embryology of Angiosperms. Vikas Publishing House.
- Bhojwani, SS and Bhatnagar, SP 2000. The Embryology of Angiosperms, 4<sup>th</sup> revised and enlarged edition, Vikas Publication House, New Delhi.
- Cutter, EG 1969, Part I Cells and Tissues, Edward Arnold, London
- Cutter, EG 1971, Plant Anatomy: Experiment and Interpretation PartII, Organs, Edward Arnold, London
- Eames. 1997. An Introduction to Plant Anatomy (2<sup>nd</sup> edition). Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- Fahn, A. 1982. Plant Anatomy (3<sup>rd</sup> edition). Pergamon Press, Oxford.
- Vasishtha, BR. 1997. Plant Anatomy. S. Nagin & Co.

### **Suggested Readings**

- Esau, K 1977, Anatomy of Seed Plants, 2<sup>nd</sup> edition, John Wiley & Sons, New York.
- Grewal, RC. 2000. Plant Anatomy. Campus Books International, New Delhi.
- Hartmann, HT and Kestler, DE 1976. Plant propagation: Principles and Practices, 3<sup>rd</sup> edition Prentice-Hall of India Pvt. Ltd, New Delhi.
- Leins, P; Tucker, SC and Endress, PK. 1988. Aspects of Floral Development. J. Cramer, Germany.
- Maheshwari. An Introduction to Embryology of Angiosperms. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- Pandey, BP. 2002. Plant Anatomy. 6<sup>th</sup> Rev. S. Chand & Co., Delhi.
- Raghavan, V. 1997. Molecular Embryology of Flowering plants. Cambridge University press. Cambridge, UK.
- Proctor, M and Yeo, P. 1973. The Pollination of Flowers. Witham Collins Sons, London.
- Raghavan, V. 1999. Developmental Biology of Flowering Plants. Springer-Verlag, New York.
- Raven, PH; Evert, RF and Eichhom, S. 1992. Biology of Plants (5<sup>th</sup> edition). Worth, New York.

### **Laboratory Readings**

- Pandey, BP and Trivedi, P.S. 1997. Botany Vol. I (10<sup>th</sup> edition). Vikas Publishing House.
- Pandey, BP; Misra; Trivedi, P.S. 1997. Botany Vol. II. Vikas Publishing House.
- Pandey, BP and Chadha. 1997. Botany Vol. III. Vikas Publishing House
- A Text Book of Practical Botany. Vol II. Bendre and Kumar. Rastogi Publication, Meerut.

**B.Sc. Semester IV**  
**PAPER II**  
**BOT 402: Plant Systematics and Economic Botany**

**Objectives:** The objective of this course is to identify thrust areas of modern taxonomy without shifting focus from the traditional ones. With biodiversity and its conservation being areas of prime concern, the identification of plants becomes all the more important.

**Credits: 3**

**Contact Hours/ Semester: 45**

**Marks: 100**  
**(C.A30% ; S.E.E70%)**

**UNIT I**

**Classification:** Systems of classification- artificial systems, natural system, phylogenetic system; salient features of the system proposed by Linnaeus, Bentham and Hooker, Engler and Prantl.

(10 Hours)

**UNIT II**

**Botanical Nomenclature:** Historical account of nomenclature, ICBN, Principles, rules and recommendations; Principle of priority, type concept, nomenclature of taxa according to their categories, valid and effective publication, author citation, change of rank, nomenclature of hybrids and cultivated plants.

(10 Hours)

**UNIT III**

**Angiosperm Taxonomy-I:** Aims and fundamental components (alpha and omega taxonomy) of identification, taxonomic literature, herbaria and botanical gardens. Keys for identification. Study of the following families: Ranunculaceae, Brassicaceae, Malvaceae, Rutaceae, Papilionaceae, Ceasalpiniaceae, Mimosaceae, Apiaceae,

(8 Hours)

**UNIT IV**

**Angiosperm Taxonomy-II:** Study of the following families:  
Asteraceae, Apocyanaceae, Asclepiadaceae, Solanaceae, , Acanthaceae, Lamiaceae, Euphorbiaceae, Liliaceae and Poaceae.

(8 Hours)

## **UNIT V**

**Economic Botany:** Origin, cultivation and uses of wheat, rice and maize, General account of medicinal plants: *Rauwolfia*, *Commiphora*, *Cinchona*, *Ashwagandha*, *spices* and condiments, oil and timber yielding plants; commercial crops like tea, rubber and sugarcane.

(9 Hours)

## Essential Books for BOT 402

- Bendre and Kumar, A. 1998. Economic Botany. Rastogi Publications, Meerut.
- PH and Heywood, VH. 1973. Principles of Angiosperms Taxonomy. Robert E. Krieger Publishing Co., New York.
- Grant, V. 1971. Plant Speciation. Columbia Davis, University Press, New York.
- Grant, WF. 1984. Plant Biosystematics. Academic Press, London.
- Harrison, HJ. 1971. New Concepts in Flowering Plant Taxonomy. Hieman & Co. Educational Book Ltd., London.
- Kocchar, SL. 1998. Economic Botany in Tropics, 2<sup>nd</sup> edition. McMillan India Ltd., New Delhi.
- Pandey. 1993. Economic Botany. S. Chand & Co., New Delhi.
- Sharma, OP. 1996. Hill's Economic Botany (Late Dr. AF Hill, adopted by OP Sharma). Tata McGraw Hill Co. Ltd., New Delhi.

## Suggested Readings

- Jones, AD and Wilbins, AD. 1971. Variations and Adaptations in Plant Species. Hieman & Co. Educational Books Ltd., London.
- Jones, SB Jr. and Luchsinger, AE. 1986. Plant Systematics (2<sup>nd</sup> edition). McGraw Hill Book Co., New York.
- Kumar and Suresh. 2002. Economic Botany. Campus books International, New Delhi.
- Nordemstam, B; El Gazaly, G and Kassas, M. 2000. Plant Systematics for 21<sup>st</sup> Century. Portland Press Ltd., London.
- Radford, AE. 1986. Fundamentals of Plant Systematics. Harper & Row Publications, USA.
- Rendel. 1979. The Classification of Flowering Plants Vol. I & II. Vikas Publishing House.
- Sambhamurthy, AVSS and Subramanayam, NS. 1989. A Text Book of Economic Botany. Wiley Eastern Ltd., New Delhi.
- Simpson, BB and Conner- Ogorzaly, M. 1986. Economic Botany- Plants in Our World. McGraw Hill, New York.
- Sivrajan, VV. 1999. Introduction to Principles of Plant Taxonomy (2<sup>nd</sup> edition). Oxford & IBH Publishing Co. Pvt. Ltd.
- Stace, TA. 1989. Plant Taxonomy and Biosystematics (2<sup>nd</sup> edition). Edward Arnold Ltd., London.
- Takhtajan, AL. 1997. Diversity and Classification of Flowering Plants. Columbia University Press.
- Tyagi. 1996. An Introduction to Taxonomy of Angiosperms. Himalaya Publishing House.
- Woodland, DW. 1991. Contemporary Plant Systematics. Prentice Hall, New Jersey.

### **Laboratory Readings**

- Bendre. 1995. A Text Book of Practical Botany. Rastogi Publications, Meerut.
- Pandey, BP; Misra; Trivedi, P.S. 1997. Botany Vol. II. Vikas Publishing House.  
Pandey, BP and Chadha. 1997. Botany Vol. III. Vikas Publishing House

**B.Sc. Semester IV**  
**Paper III**  
**BOT 403: Practical based on BOT 401 and 402**

***Suggested exercises:***

- To study the body plan of a dicotyledonous plant.
- Study of primary and secondary growth in root and stem of monocots and dicots by section cutting and permanent slides.
- Study of internal structure of dicot and monocot leaves. Study of structure and development of stomata.
- Field study of various life forms exhibited by flowering plants and study of diversity in leaf shape, size and other foliar features.
- To study monopodial and sympodial branching.
- L.S. shoot tip to study cytohistological zonation and origin of leaf buttresses.
- L.S. root tip to study different primordial and structure of root cap and root hair.
- Study of anomalous secondary growth in *Boerhaavia*, *Bignonia*, *Bougainvillea*, *Leptadenia*, *Salvadora*, *Nyctanthes* and *Dracaena*.
- Structure of anther, microsporogenesis and pollen grains. Calculation of pollen viability percentage using *in vitro* pollen germination techniques.
- Structure of ovule and embryo sac development (through slides).
- Study of embryo development in monocots and dicots.
- Vegetative propagation by means of cutting, budding and grafting exercises.
- Study of seed germination.
- Field study for identification, collection and preservation of plant material.
- Preparation of herbarium.
- Study of flora, monographs, icons, manuals and indexes.
- Study of the following plants (any one from each family)
  - Ranunculaceae: *Ranunculus*, *Delphinium*.
  - Brassicaceae: *Brassica*, *Iberis*
  - Malvaceae: *Hibiscus*, *Althea*, *Abutilon*.
  - Rutaceae: *Murraya*, *Citrus*
  - Papilionaceae: *Pisum*, *Lathyrus*.
  - Cesalpiniaceae: *Bauhinia*, *Cassia*.
  - Mimosaceae: *Acacia*, *Mimosa*.
  - Apiaceae: *Coriandrum*, *Foeniculum*,
  - Asteraceae: *Helianthus*, *Tridax*, *Sonchus*.
  - Apocyanaceae: *Nerium*, *Catharanthus*, *Tabernaemontana*, *Thevetia*.
  - Asclepiadaceae: *Calotropis*
  - Solanaceae: *Solanum*, *Cestrum*, *Datura*, *Petunia*.
  - Acanthaceae: *Adhatoda*, *Peristrophe*.
  - Lamiaceae: *Ocimum*, *Salvia*.
  - Euphorbiaceae: *Euphorbia*, *Phyllanthus*, *Ricinus*.
  - Liliaceae: *Asphodelus*, *Asparagus*.
  - Poaceae: *Avena*, *Hordeum*, *Triticum*, *Zea*, *Sorghum*
- Economic Botany

**B.Sc. Semester V**  
**PAPER I**  
**BOT 501: Plant Physiology and Metabolism**

**Objectives:** The course aims to study the vital and the various metabolic activities in plants.

**Credits: 3**

**Contact Hours/ Semester: 45**

**Marks: 100**

**(C.A30%; S.E.E 70%)**

**Unit-I**

**Plant-Water relations:** Plants and water, diffusion and osmosis, ascent of sap, apoplast and symplast concept, transpiration, guttation , significance of transpiration , stomatal structure water stress and ABA.

**Mineral nutrition:** Role of micro and macro elements, mineral uptake, deficiency and toxicity symptoms, hydroponics.

(10 Hours)

**Unit-II**

**Transport of Organic substances:** Mechanism of phloem transport, source-sink relationship, factors affecting translocation.

**Nitrogen metabolism:** N<sub>2</sub> cycle, mechanism, biology and chemistry of nitrogen fixation, Importance of nitrate reductase and its regulation, Root nodulation, Nod factor, nif and nod genes, asymbiotic N<sub>2</sub> fixation, ammonia assimilation

(10 Hours)

**Unit-III**

**Photosynthesis:** Chloroplast structure, Photosynthetic pigments, action spectra and enhancement effects, concepts of two photosystems , photophosphorylation, Calvin cycle, C<sub>4</sub> pathway ,CAM plants, photorespiration .

(10 Hours)

**Unit-IV**

**Respiration:** RQ, ATP-the biological energy currency, fermentation, glycolysis , Kreb's cycle, Electron transport mechanism, oxidative phosphorylation, pentose phosphate pathway,

(5 Hours)

**Unit-V**



**Growth and Development:** Plant growth regulators- Auxins, Gibberellins, Cytokinins, Abscisic acid, Ethylene : biosynthesis, chemistry , mechanism of action and their physiological roles, physiology of flowering: photoperiodism and vernalization, growth movements

(10 Hours)

## Essential Books for BOT 501

- Dennis, DT; Turpin, DH; Lefebvre, DD and Layzell (eds.). 1997. Plant Physiology
- Devlin. 1997. Plant Physiology. East-West Press Pvt. Ltd.
- Gosh, AK. 2005. Plant Physiology. New Central Book Agency (P) Ltd., Calcutta.
- Hopkins, WG. 1995. Introduction to Plant Physiology. John Wiley & Sons Inc., New York, USA.
- Taiz, L and Zieger, E. 1998. Plant Physiology (2<sup>nd</sup> edition). Sinauer Associates, Inc. Publishers Massachusetts, USA.
- Salisbury, FB and Ross, CW. 1992. Plant Physiology (4<sup>th</sup> edition). Wadsworth Publishing Co., California, USA.

## Suggested Readings

- Lawlor and David, W. 2001. Photosynthesis. Viva Books Pvt. Ltd.
- Lea, PJ and Leegood, RC. 1999. Plant Biochemistry and Molecular Biology. John Wiley & Sons, New York.
- Mohr, H and Schopfer, P. 1995. Plant Physiology. Springer- Verlag, Berlin, Germany.
- Pandey, BP. 1998. Plant Physiology. Vikas Publishing House.
- Sands. 1995. Problems in Plant Physiology. John Murray, London.
- Srivastava, HN. 2006. Pradeep's Botany Vol. V. Pradeep Publications, Jalandhar.
- Verma, SK. Plant Physiology and Biochemistry. S. Chand & Sons, New Delhi.

## Laboratory Readings

- Bajracharya, D. 2003. Experiments in Plant Physiology: A Laboratory Manual.
- Bendre. 1995. A Text Book of Practical Botany. Vol. II Rastogi Publications, Meerut.
- Santra, SC. 2005. College Botany Practical Vol.II. New Central Book Agency (P) Ltd., Calcutta.
- Pandey, BP and Chadha. 1997. Botany Vol. III. Vikas Publishing House.

**B.Sc. Semester V**  
**Paper II**  
**BOT 502: Plant Biochemistry**

**Objectives:** To study the various biochemical pathways in plants and the structure of various biomolecules .

**Credits: 3**

**Contact Hours/ Semester: 45**

**Marks: 100**

**(C.A30%; S.E.E70%)**

**Unit-I**

**Carbohydrates:** Classification, structure and functions of monosaccharides, disaccharides, polysaccharides and glycoproteins including starch, cellulose and pectins.

(9 Hours)

**Unit-II**

**Proteins:** Structure of proteins: Primary, Secondary ,Tertiary, Quaternary ; Simple and conjugated proteins , Synthesis of amino acids by reductive amination , GS-GOGAT system and transamination, stereo-isomeric and amphoteric properties of amino acids

(9 Hours)

**Unit-III**

**Fat metabolism:** Saturated and Unsaturated fatty acids, Synthesis of long chain fatty acids; Structure, functions and biosynthesis of lipids,  $\alpha$ -oxidation,  $\beta$ -oxidation

(9 Hours)

**Unit-IV**

**Enzymes:** Structure and properties, concept of holoenzyme, apoenzyme, coenzyme and cofactors, regulation of enzyme activity, mechanism of action , Factors affecting enzyme activity ,enzyme kinetics, Michaelis-Menten equation.

(9 Hours)

**Unit-V**

**Secondary metabolites:** Biosynthesis and functions of secondary metabolites with special reference to antioxidants, tannins, coumarins

(9 Hours)

## Essential Books for BOT 502

- Buchanan, BB; Grissem, W and Jones, RL. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists. Maryland, USA
- Srivastava, HN. 2006. Pradeep's Botany Vol. V. Pradeep Publications, Jalandhar
- Voet, D and Voet, J. 1995. Biochemistry (2<sup>nd</sup> edition). John Wiley & Sons Inc.. New York.
- Mohr, H and Schopfer, P. 1995. Plant Physiology. Springer- Verlag, Berlin, Germany.
- Lehninger.2000. Principles of Biochemistry. Wadsworth Publishing Co. California, USA.
- J.L. Jain. Fundamentals of Biochemistry. S.Chand and Co., New Delhi.

## Suggested Readings

- Hegde, PH. 2005. Text Book of Biochemistry. Mohit Publications, New Delhi.
- Lea, P.J. and Leegood, R.C.1999.Plant Biochemistry and Molecular Biology. John Wiley & Sons, New York.
- Lesk, AM. 2001. Introduction to Protein Architecture. Oxford University Press, UK
- Mathews, CK; van Holde, KE and Ahern, KG. 2003. Biochemistry. Pearson Education Pvt. Ltd., New Delhi.
- Montgomery, R; Conway, TW and Spector, AA. 1990. Biochemistry: A Case Oriented Approach (5<sup>th</sup> edition). The CV Mosby Co., Toronto.
- Murphy and Terence, M. 1998. Plant Biology. Wadsworth Publishing Co., California.
- Principles and Techniques of Biochemistry and Molecular Biology (6<sup>th</sup> edition). Wilson, K and Walker, J (eds.). Cambridge University Press
- Rawn, DJ. Biochemistry. Panima Publishing Co., New Delhi.
- Sands. 1995. Problems in Plant Physiology. John Murray, London.
- Thimmaiah, SR. 2004. Standard Methods of Biochemical Analysis. Kalyani Publishers.
- Trehan, K. 1990. Biochemistry (2<sup>nd</sup> edition.). New Age International (P) Ltd., Publishers, New Delhi.
- West, ES; Todd, WR; Mason, HS and Bruggen, JTV. 1974. Textbook of Biochemistry (4<sup>th</sup> edition). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Zubay, G.L.; Parson,W.W. and Vance, D.E. Principles of Biochemistry.

## Suggested Laboratory Readings

- Ramakrishnan, S; Prasannan, KG and Rajan, R. Textbook of Medical Biochemistry (2<sup>nd</sup> edition). Orient Longman.
- Methods in Plant Biochemistry and Molecular Biology. 1997. Dashek, WV (ed.). CRC Press.
- Wilson and Walker .Practical Biochemistry: Principles and Techniques. Cambridge University Press.U.K.

- Thimmaiah, SR. 2004. Standard Methods of Biochemical Analysis. Kalyani Publishers.

**B.Sc. Semester V**  
**PAPER III**  
**BOT 503: Practical syllabus based on BOT 501 and 502**

**Credits: 3**

**Contact Hours/ Semester: 45**

**Marks: 100**

**(C.A30%; S.E.E70%)**

**Suggested exercises:**

- Demonstration of phenomenon of plasmolysis using Rheo discolor leaves.
- Demonstration of phenomenon of osmosis by potato osmoscope.
- Demonstration of phenomenon of imbibition.
- Demonstration of phenomenon of root pressure.
- Demonstration of phenomenon of unequal transpiration in dorsiventral leaves using cobalt chloride paper.
- Measurement of the rate of transpiration using potometers.
- Anatomical study of root nodule depicting symbiotic relationship between nitrogen fixing bacteria and roots of leguminous plants.
- To demonstrate that light, CO<sub>2</sub> and chlorophyll are necessary for photosynthesis.
- To demonstrate that O<sub>2</sub> is evolved during photosynthesis.
- To determine the value of RQ of different respiratory substrates by Ganong's respiroscope.
- To demonstrate that CO<sub>2</sub> is given out during respiration
- Measurement of growth by arc auxanometer.
- Phytochemical tests for the following- glucose, starch, proteins, fats, tannins, ascorbic acid and anthocyanins.
- Demonstration of respiratory enzymes- peroxidase, catalase and dehydrogenase in plant tissue samples and measurement of their activities.

**B.Sc. Semester VI**  
**PAPER I**  
**BOT 601: Plant Biotechnology**

**Objectives:** To study the tools and techniques of plant biotechnology .

**Credit: 3**

**Marks: 100**

**Contact Hours/ Semester: 45**

**(C.A30%; S.E.E70%)**

**UNIT-I**

**Plant tissue culture-I:** Basic aspects of plant tissue culture, Cellular totipotency, cytodifferentiation and organogenesis, micropropagation, somatic embryogenesis, artificial seeds.

(9 Hours)

**UNIT-2**

**Plant tissue culture - II:** Isolation and culture of protoplast, anther culture, cybrids, somatic hybridization, somaclonal variations, applications of plant tissue culture, biotransformation, intellectual property rights (IPR)

(9 Hours)

**UNIT-3**

**Genetic engineering:** Tools and techniques of recombinant DNA technology, genomic and cDNA library, Marker genes, gene transfer by *Agrobacterium*, chromosome walking, techniques for gene mapping, transgenesis

(9 Hours)

**UNIT-4**

**Tools and techniques-I :** Gel electrophoresis: Sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS PAGE), High performance liquid chromatography (HPLC), Polymerase chain reaction (PCR), Enzyme linked immunosorbent assay (ELISA)

(9 Hours)

**UNIT-5**

**Tools and technique -II :** Flow cytometry, confocal microscopy, ultracentrifugation, FISH (Fluorescent in situ hybridization), GISH (Genomic in situ hybridization), SEM (Scanning electron microscopy), TEM (Transmission electron microscopy), mass spectrometry.

(9 Hours)

## Essential Books for BOT 601

- Bhojwani, SS and Razdan, MK. 1996. Plant Tissue Culture: Theory and Practice (a revised edition). Elsevier Science Publishers. New York, USA.
- Brown, TA. 1999. Genomes. John Wiley & Sons (Asia) Pvt. Ltd., Singapore.
- Callow, JA; Ford-Lloyd, BV and Newbury, HJ. 1997. Biotechnology and Plant Genetic Resources: Conservation and Use. CAB International, Oxon, UK.
- Chawla, HS. 2002. Introduction to Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd.
- Primrose, SB. 1995. Principles of Genome Analysis. Blackwell Science Ltd. Oxford, UK.

## Suggested Readings

- Chrispeels, MJ and Sadava, DE. 1994. Plants, Genes and Agriculture. Jones and Barlett Publishers. Boston, USA.
- Collins, HA and Edwards, S. 1998. Plant Cell Culture. Bios Scientific Publishers. Oxford, UK.
- Gustafson, JP. 2000. Genomes. Kluwer Academic Plenum Publishers. New York.
- Jolles, O and Jomvall, H(eds.) .2000. Proteomics in Functional Genomics. Birkhauser Verlag, Basel, Switzerland.
- Kartha, KK. 1985. Cryopreservation of Plant Cells and Organs.
- Edwards and Sue. 1998. Plant Cell Culture. Bios Scientific Publishers, London.
- Ignacimuthu, S. 2001. Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd.
- Murphy and Terence, M. 1998. Plant Biology. Wadsworth Publishing Co., California.
- Narayanswamy. 1994. Plant Cell and Tissue Culture. Tata McGraw Hill , New Delhi.
- Shantharam, S and Montgomery, JF. 1999. Biotechnology, Biosafety and Biodiversity. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
- Singh and Rita. 2004. Plant Biotechnology. Global Vision Publishing House.
- Vasil, IK and Thorpe, TA. 1994. Plant Cell and Tissue Culture. Kluwer Academic Publishers, The Netherlands

## Suggested Laboratory Readings

- Pandey, BP and Chadha. 1997. Botany Vol. III. Vikas Publishing House
- Henry, RJ. 1997. Practical Application of Plant Molecular Biology. Chapman & Hall, London
- Philips, GC. 1995. Plant Cell, Tissue and Organ Culture: Fundamental Methods. Narosa Publishing House.
- Botanical Microtechniques: Principles and Practice-Khasim S.M.



**B.Sc. Semester VI**  
**Paper II**  
**BOT 602: Applied Botany**

**Objectives: To develop an understanding of basic fundamental aspects of Botany.**

**Credits: 3**

**Contact Hours/ Semester: 45**

**Marks: 100**

**(C.A30% ; S.E.E70%)**

**Unit I**

**Horticulture:** History of horticulture, fundamentals of horticulture, techniques of plant propagation, a brief account of pomology, olericulture, floriculture and ornamental horticulture, viticulture, Applications of tissue culture in horticulture.

( 9 Hours )

**Unit II**

**Gardening and Landscaping:** Fundamentals of landscape design, principles and styles of landscape design, analysis of garden designs, selection of plants, environmental factors important for plant culture, flower beds, topiary, plant protection- pests, disease and weeds, miscellaneous growing techniques- bonsai, terrariums, pot culture, hydroponics etc.

( 9 Hours )

**Unit III**

**Garden Management:** Steps of plant culture- planting, pruning, irrigation and machinery, preparation of soil, cost and quality of different materials, surfacing materials and their effects, garden tools and their accessories, compost pit, vermicomposting and organic farming.

( 9 Hours )

**Unit IV**

**Forestry:** Sustainable forestry management, socio- economic initiatives in forest management, forests as centers of biodiversity, social forestry.

( 9 Hours )

**Unit V**

**Botany in Industry:** Brief description of biofuels and biodiesel, plants in cosmetic industry, aroma therapy and flower essence therapy, pharmaceutical industry, phytoremediation, plant indicators.

( 9 Hours )

### **Essential Books for BOT 602**

- Complete Gardening in India-KS Gopaldaswami Iengar
- Firminger`s Manual of Gardening in India- Firminger
- Groves of beauty and plenty
- Beautiful Climbers of India- BP Pal
- Flowering Trees- MS Randhawa
- Vegetables- B Choudhary
- Fruits- Ranjit Singh
- Orchids of India- TK Bose & SK Bhattacharjee
- The Colour Dictionary of Flowers and Plants for Home and Garden- Roy Hay & Patrick M. Syngé
- Garden Designing- LH Barley
- Ecotourism- David A. Fennell
- Environmental Impact of Ecotourism- Ralf Buckley
- Ecotourism and Sustainable Development- Martha Honey
- Landscape Design- A Practical Approach
- Great Garden Designs- Tim Newbury
- Books of Indian Trees.- Bhattacharya
- An atlas of major flowering trees in India.-Swaminathan
- Text Book of Botany- A.C.Dutta

### **Laboratory Readings**

- Bendre and Kumar Vol.I Rastogi Publication
- Home Gardening-Pratibha Trivedi
- Applied Botany-P.C.Trivedi
- College Botany Practical Vol. I and II - Santia S.C.
- Gardening in India -Lancaster`s Pericy

**B.Sc. Semester VI**  
**PAPER III**  
**BOT 603: Practical based on BOT 601 and 602**

**Credit: 2**

**Contact Hours / Semester: 45**

**Marks:100**

**(C.A30%; S.E.E70%)**

**Suggested Exercises:**

- Study of laboratory requirements and general techniques of biotechnology.
- Principle and application of the following- Laminar Air Flow, Autoclave and Ultracentrifugation.
- Preparation of different types of tissue culture medias and solutions of nutrients and growth regulators
- Demonstration of inoculation technique, aseptic transfer of explant, optimizing the conditions for direct/ indirect differentiation in different explants to study totipotency, cytodifferentiation and organogenesis.
- Germination of pollen of *Catharanthus roseus* in 10 % sucrose solution.
- Demonstration of the technique of protoplast isolation and somatic embryogenesis in *Daucus carota*.
- Demonstration of the technique of anther culture in *Datura*.
- Demonstration of the technique of gel electrophoresis of bacterial DNA.
- Demonstration of the phenomenon of action of Restriction Endonucleases.
- Field study of various plant forms- climbers, trees, shrubs, orchids, ferns and palms.
- Experimental study of the technique of vegetative propagation-cutting, budding, grafting and air layering etc.
- To study propagation by means of bulbs, corms, tubers, rhizome etc.
- To study different styles of garden design.
- Field visit to understand different patterns of landscape design.
- Preparation of record on local biodiversity.

**B.Sc. SEMESTER – V EXAMINATIONS**  
**BOTANY**  
**BOT - 501**  
**(Plant Physiology and Metabolism)**

**TIME ALLOWED: THREE HOURS**  
**Maximum Marks - 70**

Question paper consists of three sections

SECTION A – Consists of 20 compulsory multiple choice questions carrying one mark each.

SECTION B – Consists of 10 compulsory short answers type questions (word limit 50 words) carrying two marks each.

SECTION C – Consists of five questions. Attempt any 3 long essay type questions carrying ten marks each

**SECTION A**

**1. Multiple choice questions.**

**1 X 20 = 20 Marks.**

(i). Who is considered as father of plant physiology:

- |                    |                   |
|--------------------|-------------------|
| (a). Theophrastus  | (b). Strausburger |
| (c). Stephen Hales | (d). Kramer       |

(ii). Cuticle in plants is :

- |                  |                            |
|------------------|----------------------------|
| (a). permeable   | (b). semi permeable        |
| (c). impermeable | (d). selectively permeable |

(iii). The most common effect due to heavy metal is:

- |                          |                              |
|--------------------------|------------------------------|
| (a). DNA Damage          | (b). Chlorophyll destruction |
| (c). Reduction of lipids | (d). Nitrogen metabolism     |

(iv). Which of these is essential for liberation of Oxygen during light reaction:

- |                |                |
|----------------|----------------|
| (a). chlorine  | (b). nitrogen  |
| (c). magnesium | (d). manganese |

(v). Which of these do not have direct effect on phloem translocation :

- |             |                      |
|-------------|----------------------|
| (a). light  | (b). temperature     |
| (c). oxygen | (d). CO <sub>2</sub> |

(vi). The pores in sieve area closes due to deposition of :

- (a). R- protein      (b). callus  
(c). callose      (d). lipids

(vii). Nitrogenfixing organisms are known as:

- (a). phototrophs      (b). diazotrophs  
(c). heterotrophs      (d). autotrophs

(viii). The substance protecting nitrogen fixing enzymes from destruction by O<sub>2</sub> is

- (a). haemoglobin      (b). leghaemoglobin  
(c). globulin      (d). none

(ix). Red Drop Effect was given by:

- (a). Warburg      (b). Emerson  
(c). Hill      (d). Blackman

(x). Which of these is CAM plant:

- (a). cactus      (b).maize  
(c). sugarcane      (d). grass

(xi). Which is called as universal pigment:

- (a). Chlorophyll a      (b). Chlorophyll b  
(c). Chlorophyll c      (d). Chlorophyll d

(xii). Membrane of thylakoid is :

- (a). one layered      (b). two layered  
(c). three layered      (d). four layered

(xiii). How many molecules of pyruvic acid are formed in glycolysis :

- (a). one      (b). two  
(c). four      (d). six

(xiv). What is the product of aerobic respiration:

- (a). CO<sub>2</sub>      (b).water  
(c). energy      (d). all the above

(xv). Out of fat and carbohydrate which gives more energy, on equal weight basis:

- (a). carbohydrate      (b). fat



12. Define OT, TP, WP and DPD. What is their relationship in plant cell?
13. Discuss factors affecting respiration.
14. Write short notes on :
  - (a) Nitrogenase complex
  - (b) Munch Hypothesis.
15. Explain the mechanism of auxin action .
16. Describe calvin cycle.

*The candidate should ensure that this question paper contains \_\_\_\_ printed pages.*

**B.Sc.**

**B.Sc. SEMESTER – V EXAMINATION**

**BOTANY**

**BOT - 502**

**(Plant Biochemistry)**

**TIME ALLOWED: THREE HOURS**

**Maximum Marks - 70**

Question paper consists of three sections

SECTION A – Consists of 20 compulsory multiple choice questions carrying one mark each.

SECTION B – Consists of 10 compulsory short answers type questions (word limit 50 words) carrying two marks each.

SECTION C – Consists of five questions. Attempt any 3 long essay type questions carrying ten marks each

**SECTION A**

**1. Multiple choice questions.**

**1x20 = 20 Marks.**

(i). Who proposed induced fit theory:

- (a). Woods                      (b). Phillips  
(c). Fisher                      (d). Koshland

(ii). What are Apoenzymes:

- (a). Amino acids      (b). Vitamin  
(c). Carbohydrates      (d). Proteins

(iii). The enzymes which was crystallized first :

- (a). Urease      (b). Insulin  
(c). Zymase      (d). Diatas

(iv). Which of the following is a non competitive inhibitor:

- (a). PAB      (b). Malonic Acid  
(c). Cyanide      (d). Sulpha drugs

(v). Lipids without fatty acids are :

- (a). conjugated lipids      (b). derieved lipids  
(c). non saponifiable lipids      (d). simple lipids



(vi). Who discovered oxidation pathway :

- (a). Knop            (b). Koop
- (c). Robert        (d). Smith

(vii). The product of  $\alpha$ -oxidation is:

- (a). CO<sub>2</sub>            (b). Acetyl CoA
- (c). Melonyl Co A   (d). None

(viii). Conjugated lipids have only :

- (a). Saturated Fatty acid                      (b). Unsaturated fatty acid
- (c). Fatty acid and other groups            (d). none

(ix). The organelle in which fat is stored is :

- (a). glyoxisomes        (b). peroxisomes
- (c). oleosomes         (d). lysosomes

(x). Basic unit of cellulose :

- (a). glucose            (b).galactose
- (c). lactose            (d). fructose

(xi). In animals, carbohydrate is stored in form :

- (a). glycogen            (b). starch
- (c). cellulose            (d). chitin

(xii). In furanose form of fructose a bond is formed between :

- (a). C1-C2                                              (b). C5-C2
- (c). C1-C4                                              (d). None

(xiii). Fungal cell wall is made up of polysaccharide :

- (a). Celulose                                              (b).Cellobiose
- (c). Chitin                                                (d). Peptidoglycan

(xiv). Example of non- protein amino acid:

- (a). Histamine            (b).Glycine
- (c). Tryptophan         (d). Glutamine

(xv). Which one of the following is an aromatic amino acid:

- (a). Tryptophan            (b). Serine
- (c). Methionine            (d). Glutamic acid

(xvi). Gliadins is a term used for :

- (a).Albumin                      (b). Globulin  
(c). Prolamin                      (d). Glutamin

(xvii). Example of Scleroprotein is :

- (a). Collagen                      (b). Chitin  
(c). Albumin                      (d). Chromoprotein

(xviii). The secondary metabolite used against fungal pathogen is

- (a).Coumarin                      (b). Lignin  
(c). Tannin                      (d). Alkaloid

(xix). Secondary metabolite obtained from Catharanthus :

- (a). Pyrethrins                      (b). Flavanoids  
(c). Vinblastin                      (d). Ajamalin

(xx). The secondary metabolite with benzopyronic structure is :

- (a). Coumarin                      (b). Lignin  
(c). Alkaloids                      (d). Tannin

## SECTION B

**2 x 10 = 20 Marks**

2. Write a short note on Lock and Key hypothesis.
3. What do you mean by enzyme inhibition.
4. What is the importance of Lipoprotein .
5. Give the chemical nature of lipids.
6. Differentiate between Amylose and Amylopectin.
7. Name five commercial carbohydrate products.
8. Describe briefly Zwitter ion.
9. Write note on conjugated protein.
- 10.What do you mean by secondary metabolite.
11. Name three antioxidants used in pharmaceutical industry.

## SECTION C

**10 x 3 = 30 Marks**

12. Explain enzyme kinetics with special reference to Michelis-menton equation.
13. Discuss briefly about  $\beta$  oxidation of fatty acids.
14. Give classification of carbohydrates.
15. Explain the secondary structure of proteins .
16. Give biosynthesis of coumarins.

*The candidate should ensure that this question paper contains \_\_\_\_ printed pages.*