Department of Biochemistry
Mahatma Phule Krishi Vidyapeeth
Rahuri-413 722, Dist. Ahmednagar (MS)

Doctoral Programme in Biochemistry

Course Layout

Minimum Credit Requirements

Sr. No.	Subject	Minimum credit(s)
1.	Major	16
2.	Minor	08
3.	Supporting	05
4.	Seminar	02
5.	Research	45
	Total Credits	75
	Compulsory Non Credit Courses*	06

* exempted, if completed in Master's degree

Sr. No.	Course Number	Course Title	Credits
A) Major subjects (Min. 16 credits)			
1	BIOCHEM 601	ADVANCED ENZYMOLOGY	2+0=2
2	BIOCHEM 602	ADVANCE.0D MOLECULAR BIOLOGY	3+0=3
3	BIOCHEM 603	BIOCHEMISTRY OF BIOTIC AND ABIOTIC STRESSES	3+0=3
4	BIOCHEM 605	GENOMICS, PROTEOMICS AND METABOLOMICS	3+0=3
5	BIOCHEM 607	ADVANCED TECHNIQUES IN BIOCHEMISTRY	0+2=2
6	BIOCHEM 608	BIOCHEMISTRY OF PLANT HORMONES AND PLANT PIGMENTS	2+1=3
		TOTAL	**13+3=16**
B) Minor Subjects (Min. 8 credits)			
1	FST 611	ADVANCES IN FOOD BIOTECHNOLOGY	2+1=3
2	MICRO 602	ADVANCED MICROBIAL PHYSIOLOGY	2+0=2
3	FST 624	PROTEIN CHEMISTRY AND TECHNOLOGY	2+1=3
		TOTAL	**6+2=8**

C) Supporting Subjects (Min. 5 credits)			
1	BIOCHEM 606	BIOMEMBRANES	2+0=2
2	PP 605	CLIMATE CHANGE AND CROP GROWTH	2+0=2
3	BIOCHEM 604	CURRENT TOPICS IN BIOCHEMISTRY	1+0=1
		Total	**5+0=5**
D) Seminar (2 credits)			
1	BIOCHEM 691	DOCTORAL SEMINAR-I	1+0=1
2	BIOCHEM 692	DOCTORAL SEMINAR-II	1+0=1
		TOTAL	**2+0=2**
E) Doctoral Research (45 credits)			
1	BIOCHEM 699	DOCTORAL RESEARCH	0+45=45
F) Non Credit Compulsory Courses			
1	PGS 501	LIBRARY AND INFORMATION SERVICES	0+1=1
2	PGS 502	TECHNICAL WRITING AND COMMUNICATION SKILLS	0+1=1
3	PGS 503	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0=1
4	PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1=1
5	PGS 505	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0=1
6	PGS 506	DISASTER MANAGEMENT	1+0=1
		TOTAL	**3+3=6**

Course Contents

BIOCHEM 601 ADVANCED ENZYMOLOGY 2+0

Theory:

UNIT I

Theory of enzymatic catalysis, specificity, concept of active site and enzyme substrate complex, active site mapping, acid-base and covalent catalysis, factors associated with catalytic efficiency, proximity and orientation, distortion and strain, induced fit hypothesis, Mechanism of enzyme reactions.

UNIT II

Effect of different factors affecting enzyme activity, transition state theory, Arrhenius equation, Determination of energy of activation, kinetics of pH and temperature and determination of pKa and ΔH of active site amino acids.

UNIT III

Kinetics of bisubstrate reactions, mechanism determination by radioisotope exchange, kinetics of mixed inhibitions, substrate and product inhibition.

UNIT IV

Role of enzymes in regulation of metabolism, allosteric enzymes and their kinetics, enzyme engineering, Bifunctional enzymes, enzyme engineering,

Suggested Readings:

Dixon M & Web EC. 1979. *Enzymes*. 3rd Ed. Longmans Green.

Seigel IH. 1975. *Enzyme Kinetics*. John Wiley.

Selected reviews and articles from journals.

BIOCHEM 601 ADVANCED ENZYMOLOGY 2+0

Teaching Schedule

Sr. No.	Name of the topics	No of Lecture	Weightage (%)
1	Theory of enzymatic catalysis, specificity, concept of active site and enzyme substrate complex	3	7
2	Active site mapping	2	8
3	Acid-base and covalent catalysis	2	6
4	Factors associated with catalytic efficiency, proximity and orientation, distortion and strain, induced fit hypothesis	3	9
5	Mechanism of enzyme reactions	3	9
6	Effect of different factors affecting enzyme activity, transition state theory, Arrhenius equation,	3	10

	Determination of energy of activation		
7	Kinetics of pH and temperature and determination of pKa and ΔH of active site amino acids	3	9
8	Kinetics of bisubstrate reactions	3	9
9	Mechanism determination by radioisotope exchange	2	6
10	Kinetics of mixed inhibitions, substrate and product inhibition	3	9
11	Role of enzymes in regulation of metabolism	2	6
12	Allosteric enzymes and their kinetics	2	6
13	Bifunctional enzymes, Multi enzymes complexes, Enzyme immobilization	2	6
	Total	**32**	**100**

BIOCHEM 601 ADVANCED ENZYMOLOGY 2+0

Lesson Plan

Lecture No.	Name of the topic
1	History of enzyme research
2	Enzyme specificity, concept of active site and enzyme substrate complex
3	Enzyme catalysis
4	Methods of active site mapping using pH, affinity labels and enzyme substrate complex
5	Confirmation of active site amino acid at active site of enzyme
6,7	Acid-base and covalent catalysis
8.	Factors associated with catalytic efficiency
9,10	proximity and orientation, distortion and strain, induced fit hypothesis
11.	Mechanism of enzyme reactions : Chymotrypsin
12	Mechanism of enzyme reactions of lysozyme
13	Mechanism of enzyme reactions of ribonuclease
14	Effect of different factors affecting enzyme activity
15.	Transition state theory, Arrhenius equation
16.	Determination of energy of activation
17	Kinetics of pH and temperature
18	Determination of pKa and ΔH of active site amino acids
19.	Kinetics of single substrate reaction
20.	Mechanism of bisubstrate reactions
21.	Kinetics of bisubstrate reactions : Order, random and ping pong
21.	Kinetics of inhibition of bisubstrate reactions

22.	Use of radioisotope exchange in enzyme research
23.	Determination of mechanism by radioisotope exchange
23.	Enzyme inhibition mechanism
24.	Substrate and product inhibition
25.	Kinetics of mixed inhibitions
26.	Role of enzymes in regulation of metabolism
27.	Enzyme regulation by covalent modification, noncovalent modification, limited proteolysis
28.	Allosteric enzymes : ATCase and hemoglobin mechanism
29.	Kinetics of allosteric enzymes
30.	Bifunctional enzymes
31.	Multi enzymes complexes
32.	Enzyme immobilization

BIOCHEM 602 ADVANCED MOLECULAR BIOLOGY 3+0

Theory:

UNIT I

Organization of prokaryotic genome, nuclear and organelle genes, concept of genome mapping, molecular evolution, cell development and differentiation.

UNIT II

Prokaryotic and eukaryotic gene regulation, RNA editing, molecular biology of viruses.

UNIT III

Methods of gene isolation and transfer in plants and animals, molecular basis of male sterility, Application of genetic engineering in different fields.

UNIT IV

Site directed mutagenesis, gene targeting and gene therapy, bioethics and biosafety guidelines and IPR in recombinant DNA research.

Suggested Readings:

Alberts B, Bray D, Lewis J, Raff M, Roberts K & Watson JD. 2006. *Molecular Biology of the Cell*. 6th Ed. Garland Publ.
Lewin B. 2008. *Gene IX*. 9th Ed. Pearson Publ.
Selected articles from journals.

BIOCHEM 602 ADVANCED MOLECULAR BIOLOGY 3+0

Teaching Schedule

Sr. No.	Name of the topics	No of Lecture	Weightage (%)
1	Organization of prokaryotic genome	3	6
2	Nuclear and organelle genes- genes in chloroplasts and mitochondria in plants	3	6
3	Concept of genome mapping	2	3
3	Molecular evolution, cell development and differentiation	4	8
4	Prokaryotic and eukaryotic gene expression,	5	10
5	RNA editing, molecular biology of viruses	4	8
6	Methods of gene isolation and transfer in plants and animals	5	10
7	Molecular basis of male sterility	3	8
8	Application of genetic engineering in different fields.	3	8
9	Site directed mutagenesis	4	9
10	Gene targeting and gene therapy	5	8
11	Bioethics and biosafety guidelines	4	8
12	IPR in recombinant DNA research	3	8
	Total	**48**	**100**

BIOCHEM 603 BIOCHEMISTRY OF BIOTIC AND ABIOTIC STRESSE 3+0

Theory:

UNIT I

Plant-pathogen interaction and disease development; molecular mechanisms of fungal and bacterial infection in plants; changes in metabolism, cell wall composition and vascular transport in diseased plants.

UNIT II

Plant defense response, antimicrobial molecules; genes for resistance, hypersensitive response and cell death; systemic and acquired resistance.

UNIT III

Plant viruses, host-virus interactions, disease induction, virus movement, and host range determination; viroids, pathogen-derived resistance.

UNIT IV

Biochemical basis of abiotic stresses namely osmotic (drought, salinity), temperature, heavy metals, air and water pollutants, synthesis and functions of proline and glycine betaine in stress tolerance interaction between biotic and abiotic stresses; stress adaptation.

UNIT V

Reactive oxygen species and biotic and abiotic stress, antioxidants, enzymes defense system. Role of calcium, nitric oxide and salicylic acid in plant development. Molecular strategies for imparting tolerance against biotic and abiotic stress.

Suggested Readings:

Basra AS. 1997. *Stress Induced Gene Expression in Plants*. Harwood Academic Publ.

Chessin M, DeBorde D & Zipf A. 1995. *Antiviral Proteins in Higher Plants.* CRC Press.

Crute IR, Burdon JJ & Holub EB. (Eds.). 1997. *Gene-for-Gene Relationship in Host-Parasite Interactions.* CABI. 40

BIOCHEM 603 BIOCHEMISTRY OF BIOTIC AND ABIOTIC STRESSES 3+0

Teaching Schedule

Sr. No.	Name of the topics	No of Lectures	Weightage (%)
1	Plant-pathogen interaction and disease development	2	5
2	Molecular, mechanisms of fungal and bacterial infection in plants changes in metabolism, cell wall composition and vascular transport in diseased plants	6	9
3	Plant defense response, antimicrobial molecules	3	6
3	Genes for resistance	2	5
4	Hypersensitive response and cell death	2	5
5	Systemic and acquired resistance	2	5
6	Plant viruses, host-virus interactions, disease induction, virus movement, and host range determination; viroids, pathogen-derived resistance	4	7
7	Biochemical basis of abiotic stresses namely drought and salinity	4	7
8	Biochemical basis of abiotic stresses namely temperature	2	5
9	Biochemical basis of abiotic stresses namely heavy metals	2	6
10	Biochemical basis of abiotic stresses namely air and water pollutants	2	6
11	Synthesis and functions of proline and glycine betaine in stress tolerance interaction between biotic and abiotic stresses; stress adaptation.	5	10
12	Reactive oxygen species and biotic and abiotic stress	3	6
13	Antioxidants in enzymes defense system	4	7
14	Role of calcium, nitric oxide and salicylic acid in plant development	3	6
15	Molecular strategies for imparting tolerance against biotic and abiotic stress	2	5
	Total	**48**	**100**

BIOCHEM 604 CURRENT TOPICS IN BIOCHEMISTRY 1+0

Theory:

UNIT I

Advanced topics related to nutrition and metabolism.

UNIT II

Advanced topics related to enzymology and industrial biochemistry.

UNIT III

Advanced topics related to molecular biochemistry and immunology.

UNIT IV

Advanced topics related to metabolic engineering and bioprospecting.

Suggested Readings:

Selected articles from journals.

BIOCHEM 605 GENOMICS, PROTEOMICS AND METABOLOMICS 3+0

Theory:

UNIT I

Protein and nucleic acid sequencing: Various methods of sequencing including automated sequencing and microarrays, whole genome sequence analysis.

UNIT II

Comparative genomics, functional genomics, transcriptomics, gene identification, gene annotation, pairwise and multiple alignments, application of genomics, Quantitative PCR, SAGE, MPSS, microarray.

UNIT III

Proteome technology- 2D-PAGE, MSMS, MALDI-TOF, protein microarray, comparative proteomics and structural proteomics.

UNIT IV

Metabolic pathway engineering, vitamin A engineering in cereals, microarray analysis, role of bioinformatics in functional genomics.

Suggested Readings:

Baxevanis AD & Ouellette BFF. 2004. *Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins.* 3rd Ed. Wiley InterScience.

Dale JW & Schantz MV. 2002. *From Genes to Genomes*. John Wiley.

Lieber DC. 2002. *Introduction to Proteomics - Tools for the New Biology*. Humana Press.

Suhai S. 2002. *Genomics and Proteomics - Functional and Computationa Aspects*. Kluwer.

BIOCHEM 605 GENOMICS, PROTEOMICS AND METABOLOMICS 3+0

Teaching Schedule

Sr. No.	Name of the topics	No of Lectures	Weightage (%)
1	Importance and significance of genomics and proteomics	2	5
2	Protein and nucleic acid sequencing methods	4	8
3	Automated sequencing and microarrays	3	7
4	Whole genome sequence analysis Human genome and rice genome	4	10
5	Comparative genomics	2	4
6	Functional genomics and transcriptomics	3	7
7	Application of genomics	2	5
8	Gene identification and annotation	3	7
9	Qualitative PCR	2	5
10	SAGE and MPSS	3	5
11	Proteome technology 2D – PAGE MSMS, MALDI-TOP	4	10
12	Protein microarray	3	5
13	Comparative and structural proteomics	3	5
14	Engineering of metabolic pathways, case studies	3	7
15	Microarray analysis	3	5
16	Role of bioinformatics in functional genomics	3	5
	Total	**48**	**100**

BIOCHEM 605 GENOMICS, PROTEOMICS AND METABOLOMICS 3+0

Lesson Plan

Lecture No.	Name of the topic
1	Importance and significance of genomics
2	Importance and significance of proteomics
3	Methods of protein sequencing N-terminal and C- terminal
4	Amino-acid sequencing from overlapping peptide fragments
5	Chemical method of nucleic acid a sequencing
6	Enzymatic method of nucleic acid a sequencing
7	Automation in sequence analysis of proteins
8	Automation in sequence analysis of nucleic acid
9	Technique of microarrays
10	Whole gene sequence analysis : concept and prospects
11	Significance of human genome sequence analysis in human disease

12	Rice genome sequencing and implication in rice improvement
13	Comparative genomics
14	Functional genomics
15	Transcriptomics
16	Application of genomics pharmacy
17	Application of genomics Industry and Agricultural
18	Methods used for gene identification and gene annotation

BIOCHEM 606 BIOMEMBRANES 2+0

Theory:

UNIT I

Concept of biomembranes and their classification based on cellular organelles; physico-chemical properties of different biological and artificial membranes, cell surface receptors and antigen.

UNIT II

Membrane biogenesis and differentiation; membrane components-lipids, their distribution and organization; proteins, intrinsic and extrinsic, their arrangement; carbohydrates in membranes and their function.

UNIT III

Various membrane movements; transport across membrane and energy transduction.

UNIT IV

Role of membrane in cellular metabolism, cell recognition and cell –to – cell interaction; signal transduction, recent trends and tools in membrane research.

Suggested Readings:

Lodish H, Berk A, Zipursky SA, Matsudaira P, Baltimore D & Darnel J. 1999. *Molecular Cell Biology*. WH Freeman.

Nelson DL & Cox MM. 2000. *Lehninger Principles of Biochemistry*. 3rd Ed. Printed in India by Replika Press Pvt. Ltd., New Delhi for Worth Publ., New York.

Smallwood M, Knox JP & Bowls BJ. 1996. *Membranes: Specialized Functions in Plants*. Bros. Scientific Publ.

BIOCHEM 606 BIOMEMBRANES 2+0

Teaching Schedule

Sr. No.	Name of the topics	No of Lectures	Weightage (%)
1	Concept of biomembranes and their classification based on cellular organelles	2	6
2	Physico-chemical properties of different biological and artificial membranes	2	6
3	Cell surface receptors and antigen	2	7
4	Membrane biogenesis and differentiation	2	6
5	Membrane components-lipids, their distribution and organization	3	10
6	Membrane components proteins, intrinsic and extrinsic, their arrangement	3	10
7	Membrane components carbohydrates in membranes and their function	2	7
8	Various membrane movements	2	6
9	Transport across membrane	2	6
10	Energy transduction	2	6
11	Role of membrane in cellular metabolism	3	10
12	Role of membrane in cell recognition and cell –to – cell interaction	2	7
13	Signal transduction	3	8
14	Recent trends and tools in membrane research	2	5
	Total	**32**	**100**

BIOCHEM 607 ADVANCED TECHNIQUES IN BIOCHEMISTRY 0+2

Theory:

UNIT I

Isolation and purification of protein from microbial/plant/animal source. Electrophoretic separation of protein. Determination of molecular weight of protein using PAGE/ gel filtration method.

UNIT II

Experiments on DNA: Isolation, agarose gel electrophoresis and restriction analysis of DNA.

UNIT III

Isolation of chloroplast and mitochondria by differential centrifugation and their purification by density gradient centrifugation.

UNIT IV

Isolation and purification of enzymes, isozymic analysis and enzyme immobilization

Suggested Readings:

Kolowick NP & Kaplan NP. *Methods in Enzymology*. Academic Press (Series).

Plummer DT. 1998. *An Introduction to Practical Biochemistry*. 3rd Ed. Tata McGraw Hill.

Rickwood D. (Ed.). 1984. *Practical Approaches in Biochemistry*. 2nd Ed. IRL Press, Washington DC.

Wilson K & Goulding KH. 1992. *A Biologist's Guide to Principles and Techniques of Practical Biochemistry.* 3rd Ed. Cambridge Univ. Press.

Wilson K & Walker J. 2000. *Principles and Techniques of Practical Biochemistry.* 5th Ed. Cambridge Univ. Press.

BIOCHEM 607 ADVANCED TECHNIQUES IN BIOCHEMISTRY 0+2

Teaching Schedule

Sr. No.	Name of the topics	No of Practicals	Weightage (%)
1	Isolation and purification of protein (δ-endotoxin) from *Bacillus thuringenesis*	2	5
2	Isolation and purification of Bt. Toxin from Bt-transgenic	2	5
3	Isolation and purification of protein from animal source	2	5
4	Electrophoresis : Technique for separation of proteins	2	7
5	Electrophoretic separation of soluble proteins extracted from germinating seeds.	1	5
6	Determination of molecular weight of protein using SDS- PAGE	1	5
7	Determination of molecular wt. of protein by using gel filtration chromatography	2	5
8	Isolation and purification of genomic DNA From plant tissue	2	7
9	Isolation and purification of genomic DNA From plasmid DNA from bacterial culture.	2	5
10	Amplification of DNA using PCR	2	7
11	Agarose gel electrophoreses of amplified DNA	2	5
12	Restriction analysis of DNA	2	7
13	Isolation of chloroplasts by differential centrifugation	1	5
14	Isolation of mitochondria by differential centrifugation	2	6
15	Isolation of organelle DNA from mitochondria/chloroplasts	2	7
16	Isolation and Purification of peroxidase from wheat seedlings.	2	6
17	Isolation of purification of nitrate reductase from spinach leaves	2	6
18	Isozyme analysis using native PAGE	1	5
	Total	**32**	**100**

BIOCHEM 608 BIOCHEMISTRY OF PLANT HORMONES AND PLANT PIGEMETS 2+1

Theory:

UNIT I

To impart knowledge of the structure, mechanism of action of plant hormones and growth regulators,their bioassays and to acquaintance with distribution, functions, chemistry, significance, biosynthesis and degradation of plant pigments.

UNIT II

Brief history of discoversy, biochemistry, isolation, biosynthesis, metabolism, mechanism of action and physiological effects of auxins, gibberellins, cytokinins, abscisic acid, ethylene and other naturally occurring plant growth promoters and inhibitors. Plant growth and development parttems and knetics of growth and mechanisms of cellular differentions.

UNIT III

Nature, distribution, functions, chemistry and significance of plant pigments, biosynthesis and degradation of plant pigments - chlorophylls, carotenoids, anthocyanins. xanthophylls, phycobilins, phytochromes, flavonoids and quinines,alkaloids,glucosinolates and saponints. Interactions of pigments/secondary plant metabolites with other biomolecules

Practical:

Determination of chlorophyll, lycopene,flavonoids. Isolations and estimatin of endogenous plant hormones such as auxins, gibberellins, cytokinins, abscisic acid and ethylene.

Suggested Readings:

Moore, T.C. 1980. *Biochemistry and physiology of Plant Hormones,* Narosa Publishing House, New Delhi.

Takahashi N. 1986. *Chemistry of Plant Hormones,* CRC, Press, USA

Leoppold, A.C. and Krideman 1975. *Plant Growth and Development.*
Tata Mc-Graw Hills Publ. Co., New Delhi.

Chichester, CoO. 1972. *Chemistry of Plant Pigments.* Academic Press, New York.

Goodwin T.W. and Mercer, E.I. 1983. *Introduction to Plant Biochemistry.* II Edn. Pergamon Press, Oxford.

Goodwin, T.W. 1980. *Biochhemistry of the Carotenolds Vol I* Chapman and Hall.

Pawar, C.B. and Chatwal, G.R. 1988. *Biochemistry.* Himalaya Publishing House, New Delhi.

BIOCHEM 608 BIOCHEMISTRY OF PLANT HORMONES AND PLANT PIGEMETS 2+1

Teaching Schedule

Sr. No.	Name of the topics	No of Lecture	Weightage (%)
1	Brief history of discovery, biochemistry, isolation, biosynthesis, metabolism, mechanism of action and physiological effects of auxins,	4	10
2	Brief history of discovery, biochemistry, isolation, biosynthesis, metabolism, mechanism of action and physiological effects of auxins, gibberellins	4	10
3	Brief history of discovery, biochemistry, isolation, biosynthesis, metabolism, mechanism of action and physiological effects of auxins,	2	6
4	Brief history of discovery, biochemistry, isolation, biosynthesis, metabolism, mechanism of action and physiological effects of auxins, abscisic acid, ethylene and other plant growth promoters and inhibitiors	3	15
5	Kinetics of growth and mechanisms of cellular differentiations	2	5
6	Nature, distribution, functions, chemistry and significance of plant pigments	2	5
7	Biosynthesis and degradation of pant pigments viz., chlorophylls, carotenoids,	2	6
8	Biosynthesis and degradation of pant pigments viz., chlorophylls, carotenoids,	2	6
9	Biosynthesis and degradation of pant pigments viz., chlorophylls, anthocyanins, xanthophylls,,	2	6
10	Biosynthesis and degradation of pant pigments viz., phycobilins, phyochromes, flavonoids,	2	6
11	Biosynthesis and degradation of pant pigments viz., Xanthophylloes, phycobilins, phytochorones, flavonoids and quinines, alkaloids, glucosinolates and saponins	4	15
12	Interactions, of pigments/secondary plant metabolites with other biomolecules	2	5
	Total	32	100

BIOCHEM 608 BIOCHEMISTRY OF PLANT HORMONES AND PLANT PIGEMETS 2+1

Lesson Plan

Lecture No.	Name of the topic
1	Brief history of discovery, biochemistry, isolation of auxins
2	Brief history of discovery, biochemistry, isolation, biosynthesis, metabolism, mechanism of action
3	Physiological effects of auxins,
4	Brief history of discovery, biochemistry, isolation, biosynthesis
5	Brief history of gibberellins
6,7	Brief history of discovery, biochemistry, isolation, biosynthesis, metabolism, mechanism of action
8.	Brief history of discovery, biochemistry, isolation, biosynthesis, metabolism, mechanism of action and physiological effects of auxins
9,10	Brief history of discovery, biochemistry, isolation, biosynthesis, metabolism, mechanism of action and physiological effects of auxins,
11.	Plant growth promoters and inhibitors
12	Kinetics of growth
13	Mechanisms of cellular differentiations
14	Nature, distribution, functions, chemistry and significance of plant pigments
15.	Biosynthesis and degradation of pant pigments chlorophylls
16.	Biosynthesis and degradation of pant pigments carotenoids
17	Biosynthesis and degradation of pant pigments anthocyanins
18	Biosynthesis and degradation of pant pigments xanthophylls alkaloids,
19.	Biosynthesis and degradation of pant pigments phycobilins
20.	Biosynthesis and degradation of pant pigments glucosinolates
21.	Biosynthesis and degradation of saponins

BIOCHEM 608 BIOCHEMISTRY OF PLANT HORMONES AND PLANT PIGEMETS 2+1

Practical

Practical No.	Name of the Practical
1-2	Estimation of chlorophyll, auxins, gibberellins, cytokinins, abscisic acid and ethylene.
3	Estimation of lycopene
4	Estimation of flavonoids.
5	Estimation of IAA
6	Estimation of IBA
7-8	Estimation,of GA3, From germinating seeds, and ethylene.
9	Estimation,of cytokinins
10	Estimation of ethylene
11	Estimation of abscisic acid
12	Estimation of xanthophylls
13	Estimation of alkaloids
14-15	Estimation of phytochormes
16	Estimation of glucosinolates

Seminar (2 credits)		
BIOCHEM 691	DOCTORAL SEMINAR-I	1+0=1
BIOCHEM 692	DOCTORAL SEMINAR-II	1+0=1
	TOTAL	**2+0=2**
Doctoral Research (45 credits)		
BIOCHEM 699	DOCTORAL RESEARCH	0+45=45