



PERIYAR UNIVERSITY
Salem -636 011, Tamil Nadu
NAAC A Grade – State University – NIRF Rank 83, ARIIA-4
Department of Botany

M.Phil - Course work details

Title of the Paper: RESEARCH METHODOLOGY						
Course Paper						
Subject code : 13QBOTC01						
Revised syllabus Year of Revision 2018	Revised syllabus Year of Revision 2018 and Modified for OBE in 2019				Unit wise Percentag e of Revision	Over all Percentag e of Revision
Nil	Objectives:					
	Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1,K2,K3,K4,K5,K6)			
Selection of research topics and data retrieval: Using library, internet, compiling of working bibliography. Principles of experimental designs. Principles of thesis writing - Research Report: Types of reports – contents – styles of reporting – Steps in drafting reports – Editing the final draft – Evaluating the final draft.	I	Selection of Research topic	Selection of research topics and data retrieval: Using library, internet, compiling of working bibliography. Principles of experimental designs. Principles of thesis writing - Research Report: Types of reports – contents – styles of reporting – Steps in drafting reports – Editing the final draft – Evaluating the final draft.	-		

Basics of common phytochemical techniques including their modern trends for qualitative and quantitative analysis of listed compounds: chromatography, spectrophotometry, electrophoresis, centrifugation and tracer techniques.	II	Techniques	Basics of common phytochemical techniques including their modern trends for qualitative and quantitative analysis of listed compounds: chromatography, spectrophotometry, electrophoresis, centrifugation and tracer techniques.	-	-
Sample collection for microbial analysis: surface and subsurface soils, rhizospheric soils, water, air. Handling of samples, preparation for microscopy (liquid cultures, soil samples); confocal laser scanning microscopy, SEM, TEM, STEM, AFM, Flow cytometry, imaging. Estimation of microbial biomass (methods based on C content, DNA content, fumigation). Cultural methods, MPN method.	III	Sample collection and analysis methods	Sample collection for microbial analysis: surface and subsurface soils, rhizospheric soils, water, air. Handling of samples, preparation for microscopy (liquid cultures, soil samples); confocal laser scanning microscopy, SEM, TEM, STEM, AFM, Flow cytometry, imaging. Estimation of microbial biomass (methods based on C content, DNA content, fumigation). Cultural methods, MPN method.	-	
Plant Tissue Culture and Plant Micro techniques: Principles and applications of plant tissue culture, fixatives, methods of fixation, methods of dehydration, embedding, sectioning and staining. Herbarium Methodology: Collection, poisoning, drying and preservation of herbarium specimens, Important National and International herbaria.	IV	Plant Tissue Culture and Plant Micro techniques	Plant Tissue Culture and Plant Micro techniques: Principles and applications of plant tissue culture, fixatives, methods of fixation, methods of dehydration, embedding, sectioning and staining. Herbarium Methodology: Collection, poisoning, drying and preservation of herbarium specimens, Important National and International herbaria.	-	
Collection of data: Steps, modes and precautions in the collection of data, primary Vs secondary data, editing of secondary data; sampling theories. Condensation of data: Measures of central tendency (Mean, Median and Mode) and measure of dispersion (range, mean deviation, standard deviation). Representation of data: graph and diagrams. Analysis of data: Correlation, regression, test of significance (F-test, T- test, Z- test and ± 2 test).	V	Data analysis	Collection of data: Steps, modes and precautions in the collection of data, primary Vs secondary data, editing of secondary data; sampling theories. Condensation of data: Measures of central tendency (Mean, Median and Mode) and measure of dispersion (range, mean deviation, standard deviation). Representation of data: graph and diagrams. Analysis of data: Correlation, regression, test of significance (F- test, T- test, Z- test and ± 2 test).	-	
Reference • Jeyaraman, J. 1981. Laboratory Manual			Reference • Jeyaraman, J. 1981. Laboratory Manual in Biochemistry.		

<p>in Biochemistry. Wiley Eastern Ltd. Mumbai.</p> <ul style="list-style-type: none"> • Plummer, D.T. An Introduction to practical biochemistry. Tata MC Graw Hill Co. New York. • Keith Wilson and John Walker. 1995. Practical biochemistry. Univ. of Cambridge., New York. • Chawla, H.S. 2000. Introduction to biotechnology. Oxford and IBH publishing Co., New Delhi. • Johansen, D.A. 1940. Plant Microtechnique. MC Graw Hill Co., New York. • Nagarajan, P. and Senthilkumar, N. 2001. Molecular biology principles and methods a practical approach, Sree Narmatha Printers, Coimbatore. • Sharma, R.K. and S.P.S. Sangha. 2009. Basic Techniques in Biochemistry and Molecular Biology. I.K. International Pvt. Ltd, New Delhi. • Keith Wilson and John Walker.2010. Principles and Techniques of Biochemistry and Molecular biology. Cambridge University Press, New York. • Palanichamy, S. and M. Shunmugavelu. 1997. Research methods in Biological Sciences. Palani Paramount Publications, Palani. • P.R. Yadav and Rajiv tyagi, 2006. Biological Technicques, Discovery Publishing House, New Delhi. • Susan carson, Heather B. Miller and D. Scottwitherow, 2012. Molecular biology techniques, Elesiver. • Bajpai P.K. 2006. Biological 		<p>Wiley Eastern Ltd. Mumbai.</p> <ul style="list-style-type: none"> • Plummer, D.T. An Introduction to practical biochemistry. Tata MC Graw Hill Co. New York. • Keith Wilson and John Walker. 1995. Practical biochemistry. Univ. of Cambridge., New York. • Chawla, H.S. 2000. Introduction to biotechnology. Oxford and IBH publishing Co., New Delhi. • Johansen, D.A. 1940. Plant Microtechnique. MC Graw Hill Co., New York. • Nagarajan, P. and Senthilkumar, N. 2001. Molecular biology principles and methods a practical approach, Sree Narmatha Printers, Coimbatore. • Sharma, R.K. and S.P.S. Sangha. 2009. Basic Techniques in Biochemistry and Molecular Biology. I.K. International Pvt. Ltd, New Delhi. • Keith Wilson and John Walker.2010. Principles and Techniques of Biochemistry and Molecular biology. Cambridge University Press, New York. • Palanichamy, S. and M. Shunmugavelu. 1997. Research methods in Biological Sciences. Palani Paramount Publications, Palani. • P.R. Yadav and Rajiv tyagi, 2006. Biological Technicques, Discovery Publishing House, New Delhi. • Susan carson, Heather B. Miller and D. Scottwitherow, 2012. Molecular biology techniques, Elesiver. • Bajpai P.K. 2006. Biological instrumentation and Methodology. S Chand Publishers, New Delhi. • Annadurai. B. 2011. A textbook of immunology and immunotechnology. S.Chand Publishers, New Delhi. • Ananta Swargiary. 2017. Biological tools and Techniques. Kalyani Publishers, New Delhi. • Sabari Ghosal and Srivastava A. K. 2009. Fundamentals of Biological Techniques and Instrumentation. PHI Learning 		
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<p>instrumentation and Methodology. S Chand Publishers, New Delhi.</p> <ul style="list-style-type: none"> • Annadurai. B. 2011. A textbook of immunology and immunotechnology. S.Chand Publishers, New Delhi. • Ananta Swargiary. 2017. Biological tools and Techniques. Kalyani Publishers, New Delhi. • Sabari Ghosal and Srivastava A. K. 2009. Fundamentals of Biological Techniques and Instrumentation. PHI Learning Private Ltd. New Delhi. • Gurumani. N. 2006. Research Methodology for biological sciences. MJP Publishers, Chennai. • Skoog, Holler and Crouch.2007. Instrumental Analysis. Cengage Learning Pvt.Ltd. New Delhi. • Barzum, J and Graff Henry, 1977. The Modern researcher. • Edekar, V. H., 1982. How to write assignments, Research papers, dissertations, Kanak publ., New Delhi. • Kothari, C.R. 2006. Research Methodology Methods and Techniques • Mahajan. B.K. 1997. Methods in Biostatistics. Jay Pee Brothers Medical Publishers (P) Ltd. New Delhi. • Bernard Rosner. 2010. Fundamentals of Biostatistics. Brooks/cole, Boston, USA. • Agarwal, B.L. 1988. Basic Statistics. New Age International Publishers. New 		<p>Private Ltd. New Delhi.</p> <ul style="list-style-type: none"> • Gurumani. N. 2006. Research Methodology for biological sciences. MJP Publishers, Chennai. • Skoog, Holler and Crouch.2007. Instrumental Analysis. Cengage Learning Pvt.Ltd. New Delhi. • Barzum, J and Graff Henry, 1977. The Modern researcher. • Edekar, V. H., 1982. How to write assignments, Research papers, dissertations, Kanak publ., New Delhi. • Kothari, C.R. 2006. Research Methodology Methods and Techniques • Mahajan. B.K. 1997. Methods in Biostatistics. Jay Pee Brothers Medical Publishers (P) Ltd. New Delhi. • Bernard Rosner. 2010. Fundamentals of Biostatistics. Brooks/cole, Boston, USA. • Agarwal, B.L. 1988. Basic Statistics. New Age International Publishers. New Delhi. • Sahu, P.K. 2013. Research Methodology: A Guide for Researchers in Agricultural Science, Social Science and other related fields. Springer, New Delhi. 		
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Delhi.					
<ul style="list-style-type: none"> Sahu, P.K. 2013. Research Methodology: A Guide for Researchers in Agricultural Science, Social Science and other related fields. Springer, New Delhi. 					

Title of the Paper: Advances in Botany					
Course Paper				Subject code : 13QBOTC02	
Revised syllabus Year of Revision 2018	Revised syllabus Year of Revision 2018 and Modified for OBE in 2019			Unit wise Percentag e of Revision	Over all Percentag e of Revision
Nil	Objectives:				
	Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1,K2,K3,K4,K5,K6)		
Evolutionary trends amongst Algae, Fungi and Bryophytes. Evolutionary trends amongst Pteridophytes, Gymnosperms and Angiosperms.	I	Plants Evolutionary	Evolutionary trends amongst Algae, Fungi and Bryophytes. Evolutionary trends amongst Pteridophytes, Gymnosperms and Angiosperms.	-	
Genomics: Whole genome sequencing and functional genomics. Proteomics: Protein Engineering – Achievements and prospects. <i>Arabidopsis thaliana</i> and rice genome projects and their importance.	II	Genomics:	Genomics: Whole genome sequencing and functional genomics. Proteomics: Protein Engineering – Achievements and prospects. <i>Arabidopsis thaliana</i> and rice genome projects and their importance.	-	
Anthropogenic impact on Ecosystems and Climate Change; Ozone depletion, Global warming, Carbon budgeting. Biodiversity: Endemism, Variation, Biodiversity Hotspots, Biodiversity Indicators, Biodiversity	III	Ecosystems and Climate Change	Anthropogenic impact on Ecosystems and Climate Change; Ozone depletion, Global warming, Carbon budgeting. Biodiversity: Endemism, Variation, Biodiversity Hotspots, Biodiversity Indicators, Biodiversity Conservation, Invasive Alien Species.	-	-

Conservation, Invasive Alien Species.					
Plant transgenic biology and Genetic Engineering: Applications in Agriculture, Health and Industry. Secondary Metabolites: Types and their production through tissue culture. DNA sequencing methods, micro-array based techniques; isolation, separation and analysis of carbohydrates and lipid molecules; RFLP, RAPD and AFLP techniques	IV	Plant transgenic biology and Genetic Engineering:	Plant transgenic biology and Genetic Engineering: Applications in Agriculture, Health and Industry. Secondary Metabolites: Types and their production through tissue culture. DNA sequencing methods, micro-array based techniques; isolation, separation and analysis of carbohydrates and lipid molecules; RFLP, RAPD and AFLP techniques	-	
Molecular biology and recombinant DNA methods: Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods; analysis of RNA, DNA using AGE. Proteins by SDS - PAGE one and two dimensional gel electrophoresis, protein sequencing methods.	V	Molecular biology	Molecular biology and recombinant DNA methods: Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods; analysis of RNA, DNA using AGE. Proteins by SDS - PAGE one and two dimensional gel electrophoresis, protein sequencing methods.	-	
Reference <ul style="list-style-type: none"> Alexopolous, C.J., Mims, C. W. and Blackwel, M. 2002. Introductory Mycology (4th Ed.), John Wiley & Sons, Inc., New York, USA. Arie altman and Paulmichael hasegawa, 2012. Plant biotechnology and agriculture prospects for the 21 st century, Academic Press. Brown, T.A. 1999. Genomes, John Willey & Sons, New York. C. Neal Stewart, Jr. 2016. Plant Biotechnology and Genetics: Principles, Techniques, and Applications John Wiley & Sons. C.M. Govil, Ashok Aggarwal and Jitender Sharma. 2017. Plant 			Reference <ul style="list-style-type: none"> Alexopolous, C.J., Mims, C. W. and Blackwel, M. 2002. Introductory Mycology (4th Ed.), John Wiley & Sons, Inc., New York, USA. Arie altman and Paulmichael hasegawa, 2012. Plant biotechnology and agriculture prospects for the 21 st century, Academic Press. Brown, T.A. 1999. Genomes, John Willey & Sons, New York. C. Neal Stewart, Jr. 2016. Plant Biotechnology and Genetics: Principles, Techniques, and Applications John Wiley & Sons. C.M. Govil, Ashok Aggarwal and Jitender Sharma. 2017. Plant Biotechnology and Genetic Engineering, PHI Learning Pvt. Ltd. 		

<p>Biotechnology and Genetic Engineering, PHI Learning Pvt. Ltd.</p> <ul style="list-style-type: none"> • Chawla, H.S. 2000. Introduction to biotechnology. Oxford and IBH publishing Co., New Delhi. • Dubey, R.C. 2008. A Textbook of Biotechnology. S.Chand Company Pvt. Ltd. New Delhi. • Dwivedi, P. 2004. Plant Tissue culture. Scientific publishers, New Delhi. • Gupta, P.K. 2006. Biotechnology and Genomics, Rastogi Publishers, Meerut. • Harry Levine. 2006. Genetic Engineering: A Reference Hand book. ABC – CLIO, Inc, California. • Huang .P.C., 2012. Genetic Engineering Techniques: Recent Developments. Elsevier. • Isil Aksan Kurnaz, 2015. Techniques in Genetic Engineering. CRC Press. • Kumar, H.D. 2004. Introduction Phycology, (2nd Ed.), Affiliated East-West Press Pvt.Ltd., New Delhi. • Lee, R.E. 2008. Phycology, Cambridge Univ. Press, Cambridge. • Odum, E.P. 1996. Fundamentals of Ecology, Natraj Publishers, Dehra Dun. • Odum, E.P. and Barbett, G.W. 2006. Fundamentals of Ecology, East-West Press, USA. • Primrose, S.B. and Twyman, R.M. 2006. Principles of Gene Manipulation and Genomics, Blackwell Publishing, USA. • Rashid, A. 2006. An Introduction to Broyophyta, Vikas Publishing House Pvt. Ltd., New Delhi. • Reinert, J, Bajaj, Y.P.S. 1997. Plant Cell 		<ul style="list-style-type: none"> • Chawla, H.S. 2000. Introduction to biotechnology. Oxford and IBH publishing Co., New Delhi. • Dubey, R.C. 2008. A Textbook of Biotechnology. S.Chand Company Pvt. Ltd. New Delhi. • Dwivedi, P. 2004. Plant Tissue culture. Scientific publishers, New Delhi. • Gupta, P.K. 2006. Biotechnology and Genomics, Rastogi Publishers, Meerut. • Harry Levine. 2006. Genetic Engineering: A Reference Hand book. ABC – CLIO, Inc, California. • Huang .P.C., 2012. Genetic Engineering Techniques: Recent Developments. Elsevier. • Isil Aksan Kurnaz, 2015. Techniques in Genetic Engineering. CRC Press. • Kumar, H.D. 2004. Introduction Phycology, (2nd Ed.), Affiliated East-West Press Pvt.Ltd., New Delhi. • Lee, R.E. 2008. Phycology, Cambridge Univ. Press, Cambridge. • Odum, E.P. 1996. Fundamentals of Ecology, Natraj Publishers, Dehra Dun. • Odum, E.P. and Barbett, G.W. 2006. Fundamentals of Ecology, East-West Press, USA. • Primrose, S.B. and Twyman, R.M. 2006. Principles of Gene Manipulation and Genomics, Blackwell Publishing, USA. • Rashid, A. 2006. An Introduction to Broyophyta, Vikas Publishing House Pvt. Ltd., New Delhi. • Reinert, J, Bajaj, Y.P.S. 1997. Plant Cell and Organ Culture. Narosa publishing House, New Delhi. • Schofield, W.B. 1985. Introduction to Phycology, Macmillan, UK. • Simpson, R.J. 2003. Proteins and Proteomics, I. K. International Pvt. Ltd., New Delhi. • Singh, B.D. 1998. Biotechnology. Kalyani publishers, Ludhiana. • Smith, R.H. 2000. Plant tissue Culture – techniques and Experiments. Academic Press, New York. 		
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<p>and Organ Culture. Narosa publishing House, New Delhi.</p> <ul style="list-style-type: none"> • Schofield, W.B. 1985. Introduction to Phycology, Macmillan, UK. • Simpson, R.J. 2003. Proteins and Proteomics, I. K. International Pvt. Ltd., New Delhi. • Singh, B.D. 1998. Biotechnology. Kalyani publishers, Ludhiana. • Smith, R.H. 2000. Plant tissue Culture – techniques and Experiments. Academic Press, New York. • Suresh Kumar Gahlawat, Raj Kumar Salar, Priyanka Siwach, Joginder Singh Duhan, Suresh Kumar, Pawan Kaur. 2017. Plant Biotechnology: Recent Advancements and Developments Springer. • Webster, J. 1999. Introduction to Fungi, Cambridge Univ. Press, Cambridge. • Whitford, D. 2005. Proteins, Structure and Function, John Wiley & Sons Ltd., New York. • RanjithaKumari, B.D. 2008. Plant Proteomics. APH Publishers, New Delhi. • Sanaj.J. and Thelen, J.J. 2007. Plant proteomics. Springer, New York. • Agarwal, G.K. and Rakwal, R. 2008. Plant Proteomics Technologies; Strategies and Applications. John Wiley & Sons, Inc, USA. • <u>Arthur Lesk</u>, 2012. Introduction to Genomics, OUP Oxford. • John M. Archibald, 2018. Genomics: A 		<ul style="list-style-type: none"> • Suresh Kumar Gahlawat, Raj Kumar Salar, Priyanka Siwach, Joginder Singh Duhan, Suresh Kumar, Pawan Kaur. 2017. Plant Biotechnology: Recent Advancements and Developments Springer. • Webster, J. 1999. Introduction to Fungi, Cambridge Univ. Press, Cambridge. • Whitford, D. 2005. Proteins, Structure and Function, John Wiley & Sons Ltd., New York. • RanjithaKumari, B.D. 2008. Plant Proteomics. APH Publishers, New Delhi. • Sanaj.J. and Thelen, J.J. 2007. Plant proteomics. Springer, New York. • Agarwal, G.K. and Rakwal, R. 2008. Plant Proteomics Technologies; Strategies and Applications. John Wiley & Sons, Inc, USA. • <u>Arthur Lesk</u>, 2012. Introduction to Genomics, OUP Oxford. • John M. Archibald, 2018. Genomics: A Very Short Introduction Oxford University Press. • Dhavendra Kumar, 2012. Genomics and Health in the Developing World.OUP USA. • <u>Richard M. Twyman</u>, 2013. Principles of Proteomics, Garland Science. • Devarajan Thangadurai, Jeyabalan Sangeetha, 2015. Genomics and Proteomics: Principles, Technologies, and Applications, CRC Press. 		
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<p>Very Short Introduction Oxford University Press.</p> <ul style="list-style-type: none"> • Dhavendra Kumar, 2012. Genomics and Health in the Developing World.OUP USA. • <u>Richard M. Twyman</u>, 2013. Principles of Proteomics, Garland Science. • Devarajan Thangadurai, Jeyabalan Sangeetha, 2015. Genomics and Proteomics: Principles, Technologies, and Applications, CRC Press. 					
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Title of the Paper: Plant Tissue Culture: Applications and Prospects		GUIDE PAPER			
		Subject code : 13QBOTE01			
Revised syllabus Year of Revision 2018	Revised syllabus Year of Revision 2018 and Modified for OBE in 2019			Unit wise Percentag e of Revision	Over all Percentag e of Revision
Nil	Objectives:				
	Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1,K2,K3,K4,K5,K6)		
Application of Biotechnology in conservation of plant generic resources, Gene banks. Application of tissue culture in Agriculture: Plant improvement through tissue culture technology; production of resistant lines to biotic and abiotic stresses.	I	Application of Biotechnology	Application of Biotechnology in conservation of plant generic resources, Gene banks. Application of tissue culture in Agriculture: Plant improvement through tissue culture technology; production of resistant lines to biotic and abiotic stresses.	-	
Applications of tissue culture in horticulture: micropropagation of some tree species like Morus, Ficus etc. Application of tissue culture in	II	Applications of tissue culture in	Applications of tissue culture in horticulture: micropropagation of some tree species like Morus, Ficus etc. Application of tissue culture in forestry: In vitro establishment of Mycorrhiza forest	-	

forestry: In vitro establishment of Mycorrhiza forest species, orchids, and other related improvements in forest species Eg. Tectona, Pinus etc. Prospects in plant tissue culture industry in India; Applications in public sector.		horticulture	species, orchids, and other related improvements in forest species Eg. Tectona, Pinus etc. Prospects in plant tissue culture industry in India; Applications in public sector.		-
Secondary metabolite production – Secondary metabolites from callus, cell cultures, cell suspension, biotransformation. Procedure for process design and product recovery from cultures plant cells. Factors affecting product yield. Secondary metabolites form immobilized plant cell.	III	Primary and secondary metabolites	Secondary metabolite production – Secondary metabolites from callus, cell cultures, cell suspension, biotransformation. Procedure for process design and product recovery from cultures plant cells. Factors affecting product yield. Secondary metabolites form immobilized plant cell.	-	
Transgenic plants for crop improvement. Marker genes and their use in transformed plants, selectable markers, reporter genes. Molecular farming, bioreactor, edible vaccines, edible antibodies.	IV	crop improvement	Transgenic plants for crop improvement. Marker genes and their use in transformed plants, selectable markers, reporter genes. Molecular farming, bioreactor, edible vaccines, edible antibodies.	-	
Intellectual property; IPR: Intellectual property Rights, Intellectual property protection, IPR and Plant Genetic Resources GATT and TRIPS. Patent systems in India, Sources of patent information; a case study, patenting biotechnological inventions: Patent of higher plants, Patent of genes and DNA Sequences, Plant breeders rights and farmer's right.	V	Intellectual property	Intellectual property; IPR: Intellectual property Rights, Intellectual property protection, IPR and Plant Genetic Resources GATT and TRIPS. Patent systems in India, Sources of patent information; a case study, patenting biotechnological inventions: Patent of higher plants, Patent of genes and DNA Sequences, Plant breeders rights and farmer's right.	-	
References <ul style="list-style-type: none"> Altman, A, 1998. Agricultural Biotechnology. Marcel Dekker, New York. Chavala, H.S. 1998. Biotechnology in crop improvement. International Book Distributing Co. New Delhi. Glick, B.R. and Pasternak, J.J. 1994. Molecular Biotechnology – Principles and applications of recombinant DNA. ASM Press, Washington. Kakralya, B.L.and Ahuja, 1.2001. Transgenic Plants – Promise or Danger. 			Reference <ul style="list-style-type: none"> Altman, A, 1998. Agricultural Biotechnology. Marcel Dekker, New York. Chavala, H.S. 1998. Biotechnology in crop improvement. International Book Distributing Co. New Delhi. Glick, B.R. and Pasternak, J.J. 1994. Molecular Biotechnology – Principles and applications of recombinant DNA. ASM Press, Washington. Kakralya, B.L.and Ahuja, 1.2001. Transgenic Plants – Promise or Danger. Agrobios, India. Ravishankar, G.A. and Venkatarman, L.V. 1997. Biotechnological applications of plant tissue Scientific Publishers, jodhpur, India. 		

<ul style="list-style-type: none"> Agrobios, India. Ravishankar, G.A. and Venkatarman, L.V. 1997. Biotechnological applications of plant tissue Scientific Publishers, jodhpur, India. Mitra, S. 1996. Genetic Engineering – principles and practice. Mcmilan, India ltd. 			<ul style="list-style-type: none"> Mitra, S. 1996. Genetic Engineering – principles and practice. Mcmilan, India ltd. 		
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Title of the Paper: Microbiology and Plant Pathology		GUIDE PAPER			
					Subject code : 13QBOTE01
Revised syllabus Year of Revision 2018	Revised syllabus Year of Revision 2018 and Modified for OBE in 2019			Unit wise Percentag e of Revision	Over all Percentag e of Revision
Nil	Objectives:				
	Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1,K2,K3,K4,K5,K6)		
Classification of Fungi, General character of fungi, fungal cell and its structure; fungal nutrition, Reproduction, Factors affecting asexual spore formation, maturation, spore dispersal mechanisms, dormancy and germination. Use of fungi in immobilized cell technology.	I	Mycology	Classification of Fungi, General character of fungi, fungal cell and its structure; fungal nutrition, Reproduction, Factors affecting asexual spore formation, maturation, spore dispersal mechanisms, dormancy and germination. Use of fungi in immobilized cell technology.	-	
Fungi as symbionts - Ectomycorrhiza - Structure and development, Growth and carbon economy, Nitrogen and phosphorous nutrition, Ectendomyorrhizas. Endomyorrhiza - Arbuscular mycorrhiza: fungi involved, Root colonization and anatomy, Genetic, Cellular and	II	Host and Microbes Interaction	Fungi as symbionts - Ectomycorrhiza - Structure and development, Growth and carbon economy, Nitrogen and phosphorous nutrition, Ectendomyorrhizas. Endomyorrhiza - Arbuscular mycorrhiza: fungi involved, Root colonization and anatomy, Genetic, Cellular and molecular interactions, Growth and carbon economy of AM plants, Mineral nutrition, heavy metal accumulation and water	-	-

molecular interactions, Growth and carbon economy of AM plants, Mineral nutrition, heavy metal accumulation and water relations of AM plants. Role of mycorrhizas in ecosystems - AM in agriculture and horticulture - Mycorrhizas in managed environment: forest production, interactions with other microorganisms and pollutants.			relations of AM plants. Role of mycorrhizas in ecosystems - AM in agriculture and horticulture - Mycorrhizas in managed environment: forest production, interactions with other microorganisms and pollutants.		
Effects of pathogens on host physiology, Genetic basis of host - Pathogen interaction – Mechanism of infection. Role of enzymes and toxins in pathogenesis - Toxins - Definition, Classification, Chemistry, production and mode of action of bacterial toxins with special reference to wildfire toxin - Chemistry production and synthesis of fungal toxins with reference to Helminthosporium toxin - Host defense mechanisms - Epidemiology, assessment and forecasting of plant diseases.	III	Plant pathology	Effects of pathogens on host physiology, Genetic basis of host - Pathogen interaction – Mechanism of infection. Role of enzymes and toxins in pathogenesis - Toxins - Definition, Classification, Chemistry, production and mode of action of bacterial toxins with special reference to wildfire toxin - Chemistry production and synthesis of fungal toxins with reference to Helminthosporium toxin - Host defense mechanisms - Epidemiology, assessment and forecasting of plant diseases.	-	
Microbes and soil fertility: Nitrogen fixing organisms (Symbiotic, nonsymbiotic and associative) - phosphate solubilizers (bacteria and fungi) - Inoculum production Microbes in plant protection: Biological control of plant pathogens - Mechanism - bioinsecticides, bio-herbicides, biofungicides.	IV	Applied microbiology	Microbes and soil fertility: Nitrogen fixing organisms (Symbiotic, nonsymbiotic and associative) - phosphate solubilizers (bacteria and fungi) - Inoculum production Microbes in plant protection: Biological control of plant pathogens - Mechanism - bioinsecticides, bio-herbicides, biofungicides.	-	
Biofertilizers-Types: Nitrogenous (Symbiotic, Non-symbiotic), Phosphate solubilizers - Biopesticides: Bacillus thuringiensis, Pseudomonas, Viruses. Xenobiotics- microbial mechanism, microbial mining, ore leaching - Solid waste management (composting)-vermicomposting- biofuel (Algae)- oil spill remediation- Wastewater treatment: primary, secondary and tertiary (Biological), heavy metal removal- Steroid biotransformation. Microorganisms as source of food - single cell protein, Cultivation of mushrooms	V	Industrial Applications	Biofertilizers-Types: Nitrogenous (Symbiotic, Non-symbiotic), Phosphate solubilizers -Biopesticides: Bacillus thuringiensis, Pseudomonas, Viruses. Xenobiotics- microbial mechanism, microbial mining, ore leaching - Solid waste management (composting)-vermicomposting- biofuel (Algae)- oil spill remediation- Wastewater treatment: primary, secondary and tertiary (Biological), heavy metal removal- Steroid biotransformation. Microorganisms as source of food - single cell protein, Cultivation of mushrooms	-	

<p>References:</p> <ul style="list-style-type: none"> • J. E. Smith, D. R. Berry and B. Kristiansen (Editors), The Filamentous Fungi Volume 4: Fungal Technology. London 1983. Edward Arnold. ISBN: 0-7131-2857-7 • V. W. Cochrane. Physiology of fungi. 3rd. Ed. 1965. Pub. John Wiley, UK • J. H. Burnett. The fundamentals of Mycology. 1971. ELBS London. • R.S. Mehrotra and K.R. Aneja . An Introduction to Mycology. 1990. New Age International (P) Ltd., Publishers. New Delhi • W. M. Hess and D. J. Weber. Form and Function in Basidiomycete spores sp. In the fungal spores. 1976. Eds. D. Weber and W. H. Hess, John Wiley Sons, New York • G.W. Agrios, Plant Pathology 1970. • Johnson and C. Boothe, 1983. Plant pathologists "Pocket Book 2nd ed." Commonwealth mycological institute, London. • Pelczar, Read and Chan, 1986. Microbiology Tata Mac. Hill, New Delhi. • H. S. Schlegel, 1986. General Microbiology 6th Ed. (Translated by M. Kugut Cambridge University Press, London). • S. E. Smith and D. J. Read, Mycorrhizal Symbiosis , 1997. London - Academic Press. • J. C. Walker, 1953. Plant Pathology. • M. Ahmed and S. K. Basumatary (2006). „Food Microbiology“, in Applied Microbiology,MJP publishers, 		<p>References:</p> <ul style="list-style-type: none"> • J. E. Smith, D. R. Berry and B. Kristiansen (Editors), The Filamentous Fungi Volume 4: Fungal Technology. London 1983. Edward Arnold. ISBN: 0-7131-2857-7 • V. W. Cochrane. Physiology of fungi. 3rd. Ed. 1965. Pub. John Wiley, UK • J. H. Burnett. The fundamentals of Mycology. 1971. ELBS London. • R.S. Mehrotra and K.R. Aneja . An Introduction to Mycology. 1990. New Age International (P) Ltd., Publishers. New Delhi • W. M. Hess and D. J. Weber. Form and Function in Basidiomycete spores sp. In the fungal spores. 1976. Eds. D. Weber and W. H. Hess, John Wiley Sons, New York • G.W. Agrios, Plant Pathology 1970. • Johnson and C. Boothe, 1983. Plant pathologists "Pocket Book 2nd ed." Commonwealth mycological institute, London. • Pelczar, Read and Chan, 1986. Microbiology Tata Mac. Hill, New Delhi. • H. S. Schlegel, 1986. General Microbiology 6th Ed. (Translated by M. Kugut Cambridge University Press, London). • S. E. Smith and D. J. Read, Mycorrhizal Symbiosis , 1997. London - Academic Press. • J. C. Walker, 1953. Plant Pathology. • M. Ahmed and S. K. Basumatary (2006). „Food Microbiology“, in Applied Microbiology,MJP publishers, Chennai: 272-274. • W. Cruger and A. Creuger. Text book of Industrial Microbiology, by Published 1993 by Wiley-Interscience. • Anisworth, G.C.1971. A Dictionary of the fungi. Commonwealth Mycological Institute, Kew, Surrey, England. • Alexopoulos, C.J. and Mims, C.W. 1979. Introductory Mycology. Wiley Eastern Ltd., New Delhi, 632 		
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Chennai: 272-274. <ul style="list-style-type: none"> • W. Cruger and A. Creuger. Text book of Industrial Microbiology, by Published 1993 by Wiley-Interscience. • Anisworth, G.C.1971. A Dictionary of the fungi. Commonwealth Mycological Institute, Kew, Surrey, England. • Alexopoulous, C.J. and Mims, C.W. 1979. Introductory Mycology. Wiley Eastern Ltd., New Delhi, 632 					
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Title of the Paper: Medicinal Botany		GUIDE PAPER			
				Subject code : 13QBOTE01	
Revised syllabus Year of Revision 2018	Revised syllabus Year of Revision 2018 and Modified for OBE in 2019			Unit wise Percentag e of Revision	Over all Percentag e of Revision
Nil	Objectives:				
	Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1,K2,K3,K4,K5,K6)		
Medical Botany; introduction, History, Definition-Classification- Common medicinal plants cultivation, storage, collection and habitats of medicinal plants- importance of medicinal plants.	I	Medicinal plants and their Importance	Medical Botany; introduction, History, Definition-Classification- Common medicinal plants cultivation, storage, collection and habitats of medicinal plants- importance of medicinal plants.	-	
Indian systems of medicine of medicine-Siddha, Ayurveda, Homeopathy & Unani- Local medicine plants- Useful parts-chemical constituents- medicinal uses-medicinal plants drugs.	II	Indian System of Medicine	Indian systems of medicine of medicine-Siddha, Ayurveda, Homeopathy & Unani- Local medicine plants- Useful parts-chemical constituents- medicinal uses-medicinal plants drugs.	-	
Herbal medicines for human ailment-heart, kidney, liver, eye, skin, hair, stomach problems,		Herbal	Herbal medicines for human ailment-heart, kidney, liver, eye, skin, hair, stomach problems, diabetics, blood pressure, headache, cough,	-	-

diabetics, blood pressure, headache, cough, cold, fever, digestive problems, joint pains.	III	medicines	cold, fever, digestive problems, joint pains.		
Pharmacognosy – Introduction commercial drugs, crude drugs- classifications of drugs history – pharmaceuticals aids- chemistry of drug and drug evaluation of natural products.	IV	Pharmacognosy	Pharmacognosy – Introduction commercial drugs, crude drugs- classifications of drugs history – pharmaceuticals aids- chemistry of drug and drug evaluation of natural products.	-	
Drug adulteration and detection - substitution - detection of adulterations Elementary knowledge on Alkaloids, Volatile oils, Resins, Triterpenoid drugs.	V	Herbal products	Drug adulteration and detection - substitution - detection of adulterations Elementary knowledge on Alkaloids, Volatile oils, Resins, Triterpenoid drugs.	-	
References <ul style="list-style-type: none"> • Kumar, N.C., An Introduction to Medical Botany & pharmacognosy. • Shaha, S.C. and Qudary (1993). A text book of pharmacognosy. • Nadkarni, 1981. Indian Material Medica. • Jain, S.J., Rao, C. 1976. A hand book of field and Herbarium techniques. • Gamble, J.S., 1973, Flora of the Presidency of Madras. 			References <ul style="list-style-type: none"> • Kumar, N.C., An Introduction to Medical Botany & pharmacognosy. • Shaha, S.C. and Qudary (1993). A text book of pharmacognosy. • Nadkarni, 1981. Indian Material Medica. • Jain, S.J., Rao, C. 1976. A hand book of field and Herbarium techniques. • Gamble, J.S., 1973, Flora of the Presidency of Madras. 		

Title of the Paper: Algal Biology and Biotechnology		GUIDE PAPER			Subject code : 13QBOTE01	
Revised syllabus Year of Revision 2018	Revised syllabus Year of Revision 2018 and Modified for OBE in 2019			Unit wise Percentag e of Revision	Over all Percentag e of Revision	
Nil	Objectives:					
	Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1,K2,K3,K4,K5,K6)			
Introduction – Review of algological studies – algal taxonomy – thallus organization and ultra structure of algae - biochemical, Physiological, Ecological and cytological importance of algae.	I	Fundamentals of Phycology	Introduction – Review of algological studies – algal taxonomy – thallus organization and ultra structure of algae - biochemical, Physiological, Ecological and cytological importance of algae.	-	-	
Introduction – methods and techniques of collection, preservation and their importance – Culturing techniques – Fresh and marine water - cultivation, culture media and staining of algae.	II	Cultivation methods of Algae	Introduction – methods and techniques of collection, preservation and their importance – Culturing techniques – Fresh and marine water - cultivation, culture media and staining of algae.	-		
Research and development in algae – Economic importance of algae - Biofertilizer – Pharmaceuticals – biofuel – Industrial uses – harmful aspects – algal indicators – algal blooms - Fossil algae.	III	Utilization of Algae	Research and development in algae – Economic importance of algae - Biofertilizer – Pharmaceuticals – biofuel – Industrial uses – harmful aspects – algal indicators – algal blooms - Fossil algae.	-		
Algal biodiesel; method of preparation – applications and their advantages – Blue Green Algae(BGA), Seaweed Liquid Fertilizer (SLF)	IV	Applications of Algae	Algal biodiesel; method of preparation – applications and their advantages – Blue Green Algae(BGA), Seaweed Liquid Fertilizer (SLF) method of preparation, applications and their importance in	-		

method of preparation, applications and their importance in organic manures			organic manures		
Biotechnological potential of algae - Algal immobilization and its applications – Algal causing biological disturbances; control methods of algae; Phycoremediation – role of algae in nanobiotechnology.	V	Biotechnological approaches	Biotechnological potential of algae - Algal immobilization and its applications – Algal causing biological disturbances; control methods of algae; Phycoremediation – role of algae in nanobiotechnology.	-	
References <ul style="list-style-type: none"> • Trivedi, P.C. 2001. Algal Biotechnology. Printer publishers, Jaipur, India. • Barsanti, L. and Gualtieri. P. 2006. Algae: Anatomy, Biochemistry and Biotechnology, CRC press, USA. • Khattar, J.I.S., Singh, D.P., and Gurpreet Kaur. 2009. Algal Biology and Biotechnology. I. K. International (Pvt) Ltd. New Delhi. • Vanden Hoek, C., Mann, D.G., and Jahns, H.M. 1995. Algae: an Introduction to phycology, University of Cambridge, New York. • Linda. E. Graham, James M. Graham and Lee Warren Wilcox. 2009. Algae. Benjamin- Cummings Company. • Sambamurthy, A.V.S.S. 2005. A text book of Algae. I.K. International Pvt. Ltd. New Delhi. • Sharma, O.P. 2011. Algae. Tata MC Graw Hill, New Delhi. • Robert Arthur Anderson. 2005. Algal Culturing techniques. Elsevier. USA. • Chen, F and Jiang, Y. 2001. Algae and their biotechnological potential. Kluwer Academic Publishers. Netherland. 			References <ul style="list-style-type: none"> • Trivedi, P.C. 2001. Algal Biotechnology. Printer publishers, Jaipur, India. • Barsanti, L. and Gualtieri. P. 2006. Algae: Anatomy, Biochemistry and Biotechnology, CRC press, USA. • Khattar, J.I.S., Singh, D.P., and Gurpreet Kaur. 2009. Algal Biology and Biotechnology. I. K. International (Pvt) Ltd. New Delhi. • Vanden Hoek, C., Mann, D.G., and Jahns, H.M. 1995. Algae: an Introduction to phycology, University of Cambridge, New York. • Linda. E. Graham, James M. Graham and Lee Warren Wilcox. 2009. Algae. Benjamin- Cummings Company. • Sambamurthy, A.V.S.S. 2005. A text book of Algae. I.K. International Pvt. Ltd. New Delhi. • Sharma, O.P. 2011. Algae. Tata MC Graw Hill, New Delhi. • Robert Arthur Anderson. 2005. Algal Culturing techniques. Elsevier. USA. • Chen, F and Jiang, Y. 2001. Algae and their biotechnological potential. Kluwer Academic Publishers. Netherland. 		

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Title of the Paper: Plant Biodiversity – Conservation and Management GUIDE PAPER					
				Subject code : 13QBOTE01	
Revised syllabus Year of Revision 2018	Revised syllabus Year of Revision 2018 and Modified for OBE in 2019			Unit wise Percentage of Revision	Over all Percentage of Revision
Nil	Objectives:				
	Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1,K2,K3,K4,K5,K6)		
Biodiversity – Definition – Plant Biodiversity – plants as natural resources - Utilization of plant resources – Industrial value – and other useful aspects.	I	Plants as Natural Resources	Biodiversity – Definition – Plant Biodiversity – plants as natural resources - Utilization of plant resources – Industrial value – and other useful aspects.	-	
Plant biodiversity – Forest biodiversity – Agricultural biodiversity - Loss – Endemism – rare, endangered and threatened species – challenge of plant biodiversity - red data book – Hot spots – vegetation types and Bio-geographical regions of India.	II	Significance of Plant biodiversity	Plant biodiversity – Forest biodiversity – Agricultural biodiversity - Loss – Endemism – rare, endangered and threatened species – challenge of plant biodiversity - red data book – Hot spots – vegetation types and Bio-geographical regions of India.	-	
Plant biodiversity conservation – aims and objectives -genetic diversity, species diversity,		Conservation of Plant	Plant biodiversity conservation – aims and objectives -genetic diversity, species diversity, ecosystem diversity, plant community	-	

ecosystem diversity, plant community diversity – role of biotechnology in conservation of plant resources – Ex-situ – in-situ conservation techniques (National parks, Biosphere Reserves Programme, Tissue culture, Botanical gardens, gene and seed banks.	III	Biodiversity	diversity – role of biotechnology in conservation of plant resources – Ex-situ – in-situ conservation techniques (National parks, Biosphere Reserves Programme, Tissue culture, Botanical gardens, gene and seed banks.		
Medicinal plant biodiversity – Introduction – History – Classification – Cultivation of medicinal plants – Industrial utilization of medicinal plants – Indigenous medicinal plants and their utilization – phytochemicals and pharmaceuticals from medicinal plants - conservation and sustainable uses of medicinal plants – Sacred plants and their importance.	IV	Medicinal Plant biodiversity	Medicinal plant biodiversity – Introduction – History – Classification – Cultivation of medicinal plants – Industrial utilization of medicinal plants – Indigenous medicinal plants and their utilization – phytochemicals and pharmaceuticals from medicinal plants - conservation and sustainable uses of medicinal plants – Sacred plants and their importance.	-	
Emerging trends in plant biodiversity conservation – plant resources management – Nursery and horticultural practices – Applications in organic manure - Bio-control agents – Phytoremediation – Bioprospecting and Pharmaceuticals.	V	Management of Plant biodiversity	Emerging trends in plant biodiversity conservation – plant resources management – Nursery and horticultural practices – Applications in organic manure - Bio-control agents – Phytoremediation – Bioprospecting and Pharmaceuticals.	-	
References <ul style="list-style-type: none"> • Frankel, O.H., Anthony Brown, H.D. and Jermy, Burdon, J. 1995. The conservation of Plant Biodiversity. University of Cambridge. USA. • Muthuchelian, K. 2013. Perspectives in Plant Biodiversity. Astral International Pvt. Ltd. New Delhi. • Muthuchelian, K. 2012. Biodiversity Conservation and Management. Astral International Pvt. Ltd. New Delhi. • Hawksworth. ,D.L and Bull, A.T. 2007. Plant Conservation and Biodiversity. Springer. • Singh, M.P., Singh, B.S., and Soma Dey. 2002. Plant Biodiversity and taxonomy. Daya Publishing house, New 			References <ul style="list-style-type: none"> • Frankel, O.H., Anthony Brown, H.D. and Jermy, Burdon, J. 1995. The conservation of Plant Biodiversity. University of Cambridge. USA. • Muthuchelian, K. 2013. Perspectives in Plant Biodiversity. Astral International Pvt. Ltd. New Delhi. • Muthuchelian, K. 2012. Biodiversity Conservation and Management. Astral International Pvt. Ltd. New Delhi. • Hawksworth. ,D.L and Bull, A.T. 2007. Plant Conservation and Biodiversity. Springer. • Singh, M.P., Singh, B.S., and Soma Dey. 2002. Plant Biodiversity and taxonomy. Daya Publishing house, New Delhi. • Arvind Kumar. 2005. Biodiversity and Conservation. APH Publishers, New Delhi. • Krishnamurthy, K.V.K. 2003. A text book of Biodiversity. Science Publishers, USA. 		

<p>Delhi.</p> <ul style="list-style-type: none"> • Arvind Kumar. 2005. Biodiversity and Conservation. APH Publishers, New Delhi. • Krishnamurthy, K.V.K. 2003. A text book of Biodiversity. Science Publishers, USA. • Tandon, P., Abrol, Y.P. and Kumaria, S. 2007. Biodiversity and its Significance. I.K. International Publications. New Delhi. • Chaudhuri, G.A. 2007. Endangered Medicinal Plants. Daya Publishing house. New Delhi. 			<ul style="list-style-type: none"> • Tandon, P., Abrol, Y.P. and Kumaria, S. 2007. Biodiversity and its Significance. I.K. International Publications. New Delhi. • Chaudhuri, G.A. 2007. Endangered Medicinal Plants. Daya Publishing house. New Delhi. 		
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Title of the Paper: Plant Breeding with Molecular Tools		Guide Paper		Subject code : 13QBOTE01	
Revised syllabus Year of Revision 2018	Revised syllabus Year of Revision 2018 and Modified for OBE in 2019			Unit wise Percentag e of Revision	Over all Percentag e of Revision
Nil	Objectives: This course is designed to provide basic and practical knowledge of plant breeding, cytogenetics, mutation and molecular breeding.				
	Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1,K2,K3,K4,K5,K6)		
Historical perspective on Genetics; Mendelian principles; Mobile genetic elements and dynamic nature of genome; Cell division; behaviour of chromosomes during meiosis and its significance. Chromosome structure: Karyotype analysis. Numerical variation in chromosome and their utility.	I	Principles of Genetics	Principles of Cytogenetics and Plant Breeding Historical perspective on Genetics; Mendelian principles; Mobile genetic elements and dynamic nature of genome; Cell division; behaviour of chromosomes during meiosis and its significance. Chromosome structure: Karyotype analysis. Numerical variation in chromosome and their utility. Introduction, domestication and acclimatization. Patterns of evolution in crop plants, centres of origin, gene pool concept. Plant genetic resources and diversity in plant breeding, collection, evaluation and conservation of germplasm. Heritability and genetic advance. Selection, Heterosis - concept and theories.	-	13
Introduction, domestication and acclimatization. Patterns of evolution in crop plants, centres of origin, gene pool concept. Plant genetic resources and diversity in plant breeding, collection, evaluation and conservation of germplasm. Heritability and genetic advance. Selection,	II	Mutation on crop improvement	Mutagenesis and Breeding strategies for Crops Mutagenic agents: Physical - Radiation types and sources: Ionising and non-ionizing radiations viz., X rays, γ rays, α and β particles, protons, neutrons and UV rays. Chemical mutagens- Classification - Base analogues, alkylating agents, acridine dyes, EMS, Colechine,	-	

<p>Heterosis - concept and theories. Methods of breeding self-pollinated, cross-pollinated and asexually propagated crops. Completely randomized design.</p>			<p>Sodium azide and other mutagens: Other causes of mutation - direct and indirect action, comparative evaluation of physical and chemical mutagens. Design of experiment-basic principles, randomized block design and split plot design. Observing mutagen effects in generation mutagenic efficiency and effectiveness – spectrum of mutants - Factors influencing the mutant spectrum: genotype, pleiotropy and linkage etc. Comparative evaluation of physical and chemical mutagens for creation of variability in the same species.</p>		
<p>Eminent Plant Breeders and their achievements; Breeding methods of specific crops like cereals (wheat, rice, barley, maize, sorghum and millets); pulses (Black gram, pea, lentil, pigeonpea, mungbean, cowpea and lathyrus); oilseeds (Brassica, soybean, groundnut), fibre crops (cotton, jute); forage crops (oat) and asexually propagated crops; National and international institutes for crop improvement.</p>	<p>III</p>	<p>Breeding Management</p>	<p>Plant Breeding Management Mutagens- oligogenic and polygenic variations –In vitro mutagenesis – callus and pollen irradiation; Handling of segregating generations and selection procedures; Validation of mutants; Mutation breeding for various traits (disease resistance, insect resistance, quality improvement, etc) in different crops- Procedures for micromutations breeding/polygenic mutations- Achievements of mutation breeding- varieties released across the world- Problems associated with mutation breeding. Evolution and distribution of species and forms (Cereals, grains, millets); Wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc - Tree fodders: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc, palatability studies.</p>	<p>7</p>	
<p>History of experimental mutagenesis. Nature of mutations, spontaneous mutations, Physical and Chemical mutagens. Transposons as mutagens, Somaclonal variation. Screening techniques and selection procedures of induced mutations and its application. Specificity of mutation induction and</p>	<p>IV</p>	<p>Genomics and Proteomics</p>	<p>Genomics and proteomics approaches in plant breeding DNA isolation, quantification; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs etc.</p>	<p>-</p>	

<p>directed mutagenesis; targeted gene replacement; gene silencing.</p>			<p>Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis, Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants. Regulation of Plant gene expression - Functional genomics - Expression Analysis using Microarrays – Transposon tagging and Insertional mutagenesis- methods and significance- Diversity Array Technology. Genome sequencing in plants; Applications of sequence information in plant genome analyses; Comparative genomics- Classical and advanced approaches. Detection of Single Nucleotide Polymorphism; TILLING and EcoTILLING; transcriptomics, proteomics and metabolomics in linking genome and phenome; Importance of understanding the phenotypes for exploiting the outcome of genomic technologies- Knock out mutant studies and high throughput phenotyping. Proteomics- 1D, 2D PAGE and Maldi-TOF for protein analysis.</p>		
<p>Introduction to plant genetic engineering and biotechnology, gene identification, gene isolation, synthesis of genes and gene cloning. Biotic and abiotic stress. Breeding for tolerance to abiotic stresses: moisture, salinity, alkalinity, water logging, temperature. Molecular markers assisted selection Molecular Breeding - morphological, biochemical and DNA based markers. Molecular mapping and tagging of agronomically important traits. QTLs analysis in crop plants.</p>	<p>V</p>	<p>Techniques and Statistical analyses</p>	<p>Instrumentation and Statistical tools</p> <p>Techniques- ESR, FTIR, GCMS, NMR, XRD, HPLC, Chlorophyll fluorescence, SEM and TEM. Statistics- Data collection and interpretation. Frequency distribution. Measures of central tendency, probability theory and its application in genetics. Probability distribution and tests of significance. Correlation, Regression, PATH analysis. Genetic divergence, Multivariate analysis. Introduction to statistical package (SPSS, Origin, DOSBOX).</p>	<p>19</p>	
<p>References: Allard, R.W. 1960. Principles of Plant Breeding. John Wiley & Sons, New York.</p> <p>1. Auerbach, C. 1976. Mutation Research, Problems Results and Perspectives. Chapman and Hall, London.</p>			<p>References</p> <ol style="list-style-type: none"> 1. Chopra VL & Nasim A. 1990. Genetic Engineering and Biotechnology: Concepts, Methods and Applications. Oxford & IBH. 2. Gupta PK. 1997. Elements of Biotechnology. Rastogi 		

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<p>Crops. AVI Publishing Company, Connecticut.</p> <p>12. Prasad, G. 1998. Introduction to Cytogenetics. Kalyani Publishers, New Delhi.</p> <p>13. Sharma, J.R. 1998. Statistical and Biometrical Techniques in Plant Breeding. New Age International Publishers, New Delhi</p> <p>14. Singh, B.D. 2000. Plant Breeding-Principles and Methods. Kalyani Publishers, New Delhi.</p> <p>15. Singh, R.K. and Chaudhary, B.D. 1997. Biometrical Methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi.</p> <p>16. Sinha, U. and Sinha S. 1998. Cytogenetics, Plant Breeding and Evolution. Vikas Publishing House Pvt. Ltd., New Delhi.</p> <p>17. Strickberger, M.W. 1996. Genetics (3rd edn.). Mac Millan Publishing Co., New Delhi.</p> <p>Swaminathan, M.S., Gupta, P.K. and Sinha, U.1974. Cytogenetics of Crop Plants. Mac Millan India Ltd., New Delhi.</p>			<p>17. Hays, H.K. Immer, F.R. and Smith, D.C. 1955. Methods of Plant Breeding. McGraw Hill Book Company Inc., New York.</p> <p>18. IAEA, 1995. Induced Mutations and Molecular Techniques for Crop Improvement Proc. FAO/IAEA Symposium, Vienna.</p> <p>19. IAEA. 1991. Plant Mutation Breeding for Crop Improvement. Proc. FAO/IAEA Symposium (Vol. 1&2). IAEA, Vienna.</p> <p>20. Jain, H.K. (1999). Genetics - Principles, Concepts and Implications. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.</p> <p>21. Micke, A. 1991. Induced Mutations for Crop Improvement. Gamma Field Symposia No. 30. Institute of Radiation Breeding, Pullman, USA.</p> <p>22. Poehlman, J.M. 1986, Breeding Field Crops. AVI Publishing Company, Connecticut.</p> <p>23. Prasad, G. 1998. Introduction to Cytogenetics. Kalyani Publishers, New Delhi.</p> <p>24. Sharma, J.R. 1998. Statistical and Biometrical Techniques in Plant Breeding. New Age International Publishers, New Delhi</p> <p>25. Singh, B.D. 2000. Plant Breeding-Principles and Methods. Kalyani Publishers, New Delhi.</p> <p>26. Singh, R.K. and Chaudhary, B.D. 1997. Biometrical Methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi.</p> <p>27. Sinha, U. and Sinha S. 1998. Cytogenetics, Plant Breeding and Evolution. Vikas Publishing House Pvt. Ltd., New Delhi.</p> <p>28. Strickberger, M.W. 1996. Genetics (3rd edn.). Mac Millan Publishing Co., New Delhi.</p> <p>29. Swaminathan, M.S., Gupta, P.K. and Sinha, U.1974. Cytogenetics of Crop Plants. Mac Millan India Ltd., New</p>		
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Title of the Paper: Plant Physiology		Guide Paper		Subject code : 13QBOTE01	
Revised syllabus Year of Revision 2018	Revised syllabus Year of Revision 2018 and Modified for OBE in 2019			Unit wise Percentag e of Revision	Over all Percentag e of Revision
Nil	Objectives: The aim of this course isto provide current knowledge to students about the basic theories and principles of plant physiology, plant regulation mechanisms, stress physiology.				
	Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1,K2,K3,K4,K5,K6)		
Structure of atoms, molecules and chemical bonds, principles of physiological chemistry, Principles of thermodynamics, free energy, Redox potentials Dissociations and association's constants, Activation energy, binding energy. Photosynthesis: Light harvesting complexes; mechanisms of electron transport; photo protective mechanisms; CO ₂ fixation-C3, C4 and CAM pathways. Photorespiration and its regulation. Respiration- RQ, Factor affecting respiration	Unit I	Cell Organelles and Water relation	Cell organelles and their physiological functions Structure and physiological functions of cell wall, cell inclusions. Cell membrane structure and functions. Water and its role in plants, properties and functions of water in the cell, water relations, water potential of plant cells. Mechanism of water uptake by roots transport in roots, movement of water in plants, water loss from plants, energy balance, solar energy, input energy dissipation at crop canopy level. Evapotranspiration, plant factors influencing transpiration rate. Stomata, structure function - Mechanism of stomatal movement, antitranspirants. Physiology of water high temperature and salinity stress in plants. Influence of water stresses at cell, organ, plant and canopy levels. Indices for assessment of drought resistance.	100	80
Regulation of water supply, Aquaporins and facilitated water Transport, soil plant atmosphere continuum (SPAC), recent concept in stomatal physiology, signal transduction in guard cell. Respiration and photorespiration: citric acid cycle and plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photo respiratory pathway. Glycolysis in plant and it regulation, regulation of pentose phosphate pathway and TCA cycle. Regulation of electron	Unit II	Bioenergetics	Structure of atoms, molecules and chemical bonds, principles of physiological chemistry, Principles of thermodynamics, free energy, Redox potentials Dissociations and association's constants, Activation energy, binding energy. Regulation of water supply, Aquaporins and facilitated water Transport, soil plant atmosphere continuum (SPAC), recent concept in stomatal physiology, signal transduction in guard cell.	-	

transport chain and role of alternate oxidase.					
Regulation of starch and sucrose biosynthesis, synthesis and degradation of cellulose. A brief idea of pectin biosynthesis and enzymes involved in pectin degradation. Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles	Unit III	Metabolic Process and Growth Regulation	Photosynthesis: Light harvesting complexes; mechanisms of electron transport; photo protective mechanisms; CO ₂ fixation-C ₃ , C ₄ and CAM pathways. Photorespiration and its regulation. Photosynthetic efficiency rate (LICOR), Respiration- RQ, Factor affecting respiration. Respiration and photorespiration: citric acid cycle and plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photo respiratory pathway. Glycolysis, pentose phosphate pathway and TCA cycle. Regulation of electron transport chain and role of alternate oxidase. Nitrogen metabolism. Inorganic nitrogen species (N ₂ , N ₀₃ , NH ₃) and their reduction, protein synthesis, nucleic acids. Sulphate uptake and reduction. Lipid metabolism- storage, protective and structural lipids. Secondary metabolites and their significance in plant defence mechanism. Growth and differentiation, hormonal concept of growth and differentiation, plant growth hormones (auxins, gibberellins, cytokinins, ABA, ethylene etc.), biosynthesis of growth hormones and their metabolism, synthetic growth regulators, growth retardant, apical dominance, senescence, fruit growth, abscission, photomorphogenesis, photoreceptors, phytochrome, physiology of flowering, photoperiodism and vernalisation.	100	
Assimilation of nitrate and ammonium ion, amino acid biosynthesis. –NR, NIR, GDH and GS/GOGAT pathways, Transamination and other method. Integration of nitrogen and carbohydrate Metabolisms.	Unit IV	Abiotic Stress Responses in Plants	Water potential in the soil-plant-air continuum. Development of water deficits, energy balance concept, transpiration and it's regulation. Drought resistance mechanisms: Escape, dehydration postponement. Osmotic adjustment Osmoprotectants, stress proteins. Water use efficiency as a drought resistance trait. Molecular responses to water deficit stress perception, expression of regulatory and function genes and significance of gene products. Stress and hormones-ABA as a signaling molecule – Cytokinin as negative signal. Oxidative stress: reactive oxygen species (ROS) – role of scavenging systems (SOD, catalase etc.). High temperature stress: tolerance mechanisms- role of membrane lipids in high temperance tolerance. Functions of HSPs chilling stress; effects on physiological processes. Crucial role of membrane lipids. Salinity:	100	

			species variation in salt tolerance. Salinity effects at cellular and whole plant level, tolerance mechanisms.		
<p>Sensory photobiology: structure, function and mechanism of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks. phytochromes mediated processes. Physiology of flowering and fruit ripening, physiology of seed germination, dormancy of seed, causes and methods of breaking dormancy. Ageing and senescence types, physiological and biochemical changes.</p> <p>Types of plant hormones and applications; auxins, gibberellins, cytokinins, ethylene and abscisic acid, Biosynthesis physiological effects and mechanisms action. in agricultural and horticultural, physiology of growth retardants. Response of plant to biotic (pathogenic and insects) and abiotic (water, temperature, salt and metal) stresses; mechanism of resistant to biotic stress and tolerance to abiotic stress. Free Radicals and Antioxidants.</p>	Unit V	Molecular Biology and Proteomics approaches in Stress Physiology	<p>Techniques: DNA sequencing methods -Sanger sequencing method, Next generation sequencing methods. Polymerase chain reaction and its applications, Altering genes Site-directed mutagenesis- Primer extension method for site directed mutation, PCR based site directed mutagenesis. DNA markers for genome analysis (RFLP, RAPD, AFLP, SNPs). 2-D gel electrophoresis – Mass Spectrometry (GCMS, HPLC, LCMS) – Principles – MALDI-TOF - RP chromatography /Tandem mass spectrometry - Protein sequence analysis - N-terminal determination methods-Protein modification – Protein microarrays – Tissue microarray – Infra red Protein array with Quantitative Readout (IPAQ)- X-ray crystallography - Nuclear Magnetic Resonance - X-ray Tomography. Statistical analysis of Data (ANOVO, Correlation, Regression, Principal Component Analysis, Cluster Analysis).</p>	100	
<p>Suggested Reading</p> <ol style="list-style-type: none"> 1. Buchanan B. B, Grissem W. and Jones R. L 2000.Biochemistry and molecular 2. Biology of plants. American society of plant physiologists Maryland, USA 3. Dennis D.T., Turpin, D.H. Lefebvre D.D. and Layzell D.B. (eds) 1997. Plant 4. Metabolism (Second Edition) Longman, Essex, England. 5. Galstone A.W. 1989. Life processes in plant. Scientific American Library, 			<p>Suggested Reading</p> <ol style="list-style-type: none"> 14. Buchanan B. B, Grissem W. and Jones R. L 2000.Biochemistry and molecular 15. Biology of plants. American society of plant physiologists Maryland, USA 16. Dennis D.T., Turpin, D.H. Lefebvre D.D. and Layzell D.B. (eds) 1997. Plant 17. Metabolism (Second Edition) Longman, Essex, England. 18. Galstone A.W. 1989. Life processes in plant. Scientific American Library, Springer Verlag, New York, USA. 19. Moore T. C. 1989. Biochemistry and Physiology of plant 		

<p>Springer Verlag, New York, USA.</p> <ol style="list-style-type: none"> 6. Moore T. C. 1989. Biochemistry and Physiology of plant Hormones Springer-Verlag, New York, USA. 7. Verma S. K and Verma Mohit 2007. A. T. B of plant physiology, Biochemistry and Biotechnology, S. Chand Publication. 8. Bidwell, R.C.S. (1979); Plant Physiology. 9. Sadashivam and Manikam (1996): Plant Biochemical Methods 10. Jain, V.K. 2000. Fundamentals of Plant Physiology (5th ed.), S. Chand & Co Ltd; New Delhi 11. Machlis, L. and Torrey, J.G. 1956. Plant in action: Laboratory manual of plant physiology. W.H. Freeman publisher, SanFrancisco 12. S N Pandey & B K Sinha PLANT PHYSIOLOGY fourth edition. 13. C.P. Malik & A.K. Srivastava Text Book of Plant Physiology <p>Reference Books</p> <ol style="list-style-type: none"> 1. Park S. Nobel. (2009), Physicochemical and Environmental Plant Physiology 2. William G. Hopkins, Norman P. A. Hüner Introduction to Plant Physiology, 4th Edition ISBN: 978-0-470-24766-2 Dec 2008 		<p>Hormones Springer- Verlag, New York, USA.</p> <ol style="list-style-type: none"> 20. Verma S. K and Verma Mohit 2007. A. T. B of plant physiology, Biochemistry and Biotechnology, S. Chand Publication. 21. Bidwell, R.C.S. (1979); Plant Physiology. 22. Sadashivam and Manikam (1996): Plant Biochemical Methods 23. Jain, V.K. 2000. Fundamentals of Plant Physiology (5th ed.), S. Chand & Co Ltd; New Delhi 24. Machlis, L. and Torrey, J.G. 1956. Plant in action: Laboratory manual of plant physiology. W.H. Freeman publisher, SanFrancisco 25. S N Pandey & B K Sinha PLANT PHYSIOLOGY fourth edition. 26. C.P. Malik & A.K. Srivastava Text Book of Plant Physiology 27. Jain, J.K. 2007. Fundamentals of plant physiology, S.Chand & Company Ltd., New Delhi. 28. Purohit, S.S, 2005. Plant physiology, Student edition, Jodhpur. 29. Ray Noggle, G. and Fritz, G. J., 1991. Introductory Plant Physiology. Prentice Hall of India Pvt. Ltd., New Delhi. 30. Taiz. L. and Zeiger. E., 2006. Plant Physiology. Publishers: Sinauer Associates, Inc., Massachusetts, USA. <p>Reference Books</p> <ol style="list-style-type: none"> 3. Park S. Nobel. (2009), Physicochemical and Environmental Plant Physiology 4. William G. Hopkins, Norman P. A. Hüner Introduction to Plant Physiology, 4th Edition ISBN: 978-0-470-24766-2 Dec 2008 	
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Title of the Paper: Plant Nutrient Technology					
Guide Paper					
Subject code : 19PMBOTG01					
Revised syllabus Year of Revision 2018	Revised syllabus Year of Revision 2018 and Modified for OBE in 2019			Unit wise Percentag e of Revision	Over all Percentag e of Revision
Nil	Objectives: The aim of this course isto provide current knowledge to students about the basic theories and principles of plant physiology, plant regulation mechanisms, stress physiology.				73.18
	Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1,K2,K3,K4,K5,K6)		
Nutrition and water uptake (transpiration, respiration, absorption, adhesion-cohesion theory) Essential Macro elements: functions and deficiency symptom of element, Nitrate and Ammonium, Phosphate, Potassium, Magnesium, Calcium, Sulphur microelements: Zinc, Molybdenum, Manganese, Cobalt, Copper, Iron, Chlorine, Boron, Integrated nutrient management.	Unit I		Nutrition and water uptake (transpiration, respiration, absorption, Adhesion-cohesion theory), essential macroelements:functions and deficiency symptom of elements, nitrate and Ammonium, Phosphate, Potassium, Magnesium, Calcium, Sulphur microelements: Zinc, Molybdenum, Manganese, Cobalt, Copper, Iron, Chlorine,Boron.Integrated nutrient management. Rhizosphere and root biology: root growth-influence of microorganisms in nutrient acquisition, release and uptake by roots. Yield and mineral nutrient concept of nutrient use efficiency, mineral nutrient under adverse soil condition (drought,salinity and acidity).	60	
Definition, Plant Growth Promoting Rhizobium with practical as application as biofertilizer, Rhizobium spp., Advantages and Constrains of Biofertilizers. Classification of fertilizers (synthetic fertilizers and natural fertilizers), Organic Fertilizers, Biofertilizers, compatibility of Fertilizer Materials, Fertilizer Application Method, Compositing.	Unit II		Biofertilizers: Definition and types, importance of biofertilizers in agriculture, Characteristics of biofertilizers: <i>Rhizobium</i>, <i>Azotobactor</i>, <i>Azospirillum</i>, Phosphate solubilizing microorganisms, cyanobacteria, Azolla, Mycorrhizae. Fertilizers use and management: Trends of fertilizer use in India.Imbalanced use of fertilizers.Application of biofertilizers, role of microorganisms in decomposition of organic farm wastes, methods of quality control assessment in respect of biofertilizers, Strategies of mass multiplication and packing registration of biofertilizers.	100	
Mycorrhizae - Ecto and endomycorrhizae and their importance in agriculture. Isolation of AM	Unit III		Mycorrhizal fungi as biofertilizers - Introduction, scope. A general account of Ecto, Endo and Arbuscularmycorrhizae (AM). Methods	52.9	

fungi - Wet sieving method and sucrose gradient method. Mass production of AM inoculants and field applications. Isolation and Purification of phosphate solubilizers. Mass multiplication and field applications of phosphate solubilizer (<i>Pseudomonas striata</i>).			of collection, wet sieving and decanting method and inoculum production. Cultural characteristics of Ectomycorrhizal fungi. Isolation and method of inoculation of Arbuscularmycorrhizae (AM). Mass production of am inoculants and field applications.		
The Nematodes, The Microfauna, Protozoa and Archezoa, Algae; Green Algae, diatoms, Environmental effects, Fungi: types of fungi, functional roles, symbiotic nitrogen fixation. Soil Organic Matter and Humus. Soil borne pathogens.	Unit IV		Soil microbiology, Microbial groups in soil, microbial transformations of carbon, nitrogen, phosphorus and sulphur. Soil enzymes, Biological nitrogen fixation, microbes in composting, Beneficial microorganisms in Agriculture; Biofertilizer (Bacterial, Cyanobacterial and fungal)), microbial insecticides, Microbial agents for control of plant diseases, Biodegradation. Bio pesticides, (IPM) Integrated pest management & (ISR) induced systematic resistance).	100	
Production technology: Strain selection, sterilization, growth and fermentation, mass production of various biofertilizer. Application technology: Standards and quality control, application for field and tree crops, nursery plants and seedlings. Extension, promotion and marketing. Biofertilizers - Storage, shelf life, quality control.	Unit V		Production technology: Strain selection, sterilization, growth and fermentation, mass production of various bio fertilizers. Mass production of PGPR. Application technology: Standards and quality control, application for field and tree crops, nursery plants and seedlings. Extension, promotion and marketing: Extension strategies, diagnosis for the effectiveness of inoculation, improvement in distribution system. National and Regional Biofertilizers Production and Development Centres. Zero budget natural farming.	53	
References <ul style="list-style-type: none"> • Bagyaraj, D.J. and A. Manjunath. 1990. Mycorrhizal symbiosis and plant growth, Univ. of Agricultural Sciences, Bangalore, India. • Purohit, S.S., P.R. Kothari and S.K. Mathur, 1993. Basic and Agricultural Biotechnology, Agro Botanical Pub. India. • Subba Rao, N.S., G.S. Venkataraman and S. Kannaiyan 1993. Biological nitrogen fixation, ICAR Pub., New Delhi. • Somani, L.L., S.C. Bhandari, K.K. Vyas 			References <ol style="list-style-type: none"> 1. PC, Trivedi, P.C. 2008. biofertilizers, Pointer Publishers, India. 2. Subbarao N.S. 2002. Soil microbiology, (4th ed) soil microorganisms and plant growth. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi. 3. Alexander M. 1997. Introduction to soil microbiology. John Wiley & Sons, New York. 4. Dirk J, Elsas V, Trevors JT, Wellington, EMH (1997) Modern Soil Microbiology, Marcel Dekker INC, New York. 5. Tilak, K.V.B. 1991. Bacterial biofertilizers, ICAR Publications, New Delhi. 		

<p>and S.N. Saxena. 1990. Biofertilizers, Scientific Publishers - Jodhpur.</p> <ul style="list-style-type: none"> • Tilak, K.V.B. 1991. Bacterial Biofertilizers, ICAR Pub., New Delhi. • Alexander M. (1977) Introduction to soil microbiology. John Wiley & Sons, Inc., New York. • Rogers JE and Writman WB (1991) Microbial production and consumption and green house gases: Methane: Nitrogen oxides and Halomethanes. American Society for Microbiology, Washington DC. • Dirk J, Elias V, Trevors JT, Wellington, EMH (1997) Modern Soil Microbiology, Marcel Dekker INC, New York. 					
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Title of the Paper: Nanobiotechnology					Guide Paper		Subject code : 19PMBOTG01	
Revised syllabus Year of Revision 2018	Revised syllabus Year of Revision 2018 and Modified for OBE in 2019			Unit wise Percentag e of Revision	Over all Percentag e of Revision			
Nil	Objectives: The aim of this course isto provide current knowledge to students about the basic theories and principles of plant physiology, plant regulation mechanisms, stress physiology.							
	<i>Unit</i>	<i>Unit Title</i>	Intended Learning Chapters (Programme specific qualification attributes K1,K2,K3,K4,K5,K6)					
	Unit I	Introduction of Nanoscience and Nanobiotechnology	Introduction – Historical background and Definition of Nanoscience and Nano technology – Nanobiotechnology - Scope and Recent scenario in nanotechnology - Different concepts of Nanobiotechnology – Nanobiotechnology as Inter and Multidisciplinary emerging field in research - Applications of Nanobiotechnology.	100		100		
	Unit II	Synthesis and characterization of Nanoparticles	Synthesis of different nanoparticles – different methods – Nanoscale devices – Biomaterials (First, Second and Third Generation Biomaterials) – Biomaterials in Tissue engineering – UV-Vis Spectrophotometer – XRD – FTIR – EDAX – SEM – TEM – Elemental mapping – X- ray Photoelectron Spectroscopy (XPS) – Differential Scanning Calorimeter (DSC) – Differential Thermal Analyzer (DTA) – Thermo Gravimetric Analysis.	100				
	Unit III	Various applications of nanobiotechnology	Nanotechnology in Biomedicine – Textile – Cosmetics – Defence – Agriculture – Food Technology – Environment and Health – Nano Toxicology and Drug Delivery System – Paints - Catalysis - Biochips- analytical devices - Biosensors.	100				
	Unit IV	Recent biological research in	Green Synthesis and Characterization of different nanoparticles in medicinal plants – Seaweeds – Seagrasses – Microalgae – Fungi –	100				

		nanobiotechnology	Bacteria with special reference to anticancer studies.		
	Unit V	Advanced nanobiotechnology	Types of Nanomaterials (rods, wires, particles, capsules, membranes, meshe, fibres, catalys and carbaon tubes) - Nanomaterial characterization (AFM, HR-TEM, Particle size analyzer and Zetasizer) - DNA nanotechnology- DNA and protein computers - Micro-fabricated Devices for cell biological applications and cell migration – Q dots and imaging applications – single molecular analysis - Lab-on-a-chip.	100	
			<p>References</p> <ul style="list-style-type: none"> • Murty BS, Shankar P, Baldev Raj, Rath BB and James Murday. 2013. Textbook of Nanoscience and Nanotechnology. Springer. University Press (India) PVT LTD. • Subbiah Balaji. 2010. Nanobiotechnology. MJP Publishers, Chennai. • Jeremy Ramsden, 2016. Nanotechnology: An Introduction. William Andrew. • Geoffrey Hunt, Michael Mehta, 2013. Nanotechnology: Risk, Ethics and Law Taylor & Francis. • Jo Anne Shatkin, 2012. Nanotechnology: Health and Environmental Risks, Second Edition CRC Press. • Jesus M. de la Fuente, V. Grazu. 2012. Nanobiotechnology: Inorganic Nanoparticles Vs Organic Nanoparticles Elsevier. • Michael R. Hamblin, Pinar Avci, Tarl Prow, 2016. Nanoscience in Dermatology. Academic Press. • Makio Naito, Toyokazu Yokoyama, Kouhei Hosokawa, Kiyoshi Nogi 2018. Nanoparticle Technology Handbook, Elsevier. • Monique A. V. Axelos, Marcel Van de Voorde, 2017. Nanotechnology in Agriculture and Food Science, John Wiley & Sons. • Claudia Atavilla, Enrico Ciliberto, 2017. Inorganic Nanoparticles: Synthesis, Applications, and Perspectives CRC Press. 		

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