DDU Gorakhpur University, Gorakhpur

Department of Botany

Ph. D COURSE WORK
in
BOTANY
(CBCS)

Name of the Program: PRE PhD Coursein Botany

Program Objectives

- enhancing and imparting skills and knowledge in Basic and advance research methodologies of Botany
- Solving the existing scientific problems in area of basic and applied Botany
- Creating a highly skilled professionals with expertise in current trends of research in area of Botany and Plant Sciences
- Imparting hand on experience to students of different techniques and instrumentations of advance biological/plant sciences
- Generating independent researchers who are capable of translating the research developed at laboratory scale to the industrial level.
- Imparting skills needed to become a successful academician, scientists or entrepreneur ¬ Inculcating the scientific ethics, temperament to contribute to field of science and help in nation building

Program outcomes

The Students successfully completing the course will have following skills

- Solid basic knowledge of research methodologies in area of modern biological sciences specifically Taxonomy, plant pathology, Molecular Biology, Environment, Nutracuticals, Stress Physiology, Natural plant products
- Contributing new methodologies and results in area of the basic and advanced microbiology for taking the research to next level
- Innovative scientists, skilled workforce to work in specialized area of microbiology
- Independent researchers who can contribute through fulfilling responsibility of academicians, scientist and entrepreneur
- Can start an independent research and can contribute in solving new problems faced in current science or in future.
- Develop As academicians in different university or colleges at national and international levels
- develop as a researcher at different research institute at national and international level where they can initiate their independent research
- Develop skill so that they can be absorbed by R& D sector of different biotechnological based company

Department of Botany

DDU Gorakhpur University, Gorakhpur

Faculty of Science

Course Work for Ph. D. Botany

Every student admitted in **Botany** for the Ph. D. programme will be required to pass a course work of minimum 21 credits. The division of this 21 credits course work is in three categories. Category-A (9 credits) courses are *compulsory* for all Ph. D. students of **Botany**. Category-B (6-credits) courses are *discipline-specific courses. Category-C (6 credits) courses are research theme- specific courses.*

Course Nature	Course Code	Core Courses	Credit
Category A :Compulsory Course			
Compulsory Course (CORE)	BOT 601	Research Methodology	3+1
	BOT 602	Research and Publication Ethics	1+1
	MAT 603	Computer Fundamentals and IT	1+1
	BOT 604	Credit Seminar	0+1
			09 Credits
	Category B :Elective Course (*Any two of the followings*)		
Discipline-Specific Courses (for Botany scholars)	BOT 605	Advance Techniques in Plant Sciences	2+1
	BOT 606	Advances in Mycology and Plant Pathology	2+1
	BOT 607	Advances in Plant Physiology	2+1
	BOT 608	Advances in Plant Biosystematics and Taxonomy	2+1
	BOT 609	Air pollution and climate change	2+1
	BOT 610	Biological control and Biopesticides	2+1
			06 Credits
	Category C: Open Elective Course (*Any two of the followings*)		
Research Theme-Specific Courses (open for other subject scholars)	BOT 611	Biodiversity and its conservation	2+1
	BOT 612	Phytoremediation	2+1
	BOT 613	Medicinal plants and pharmacognosy	2+1
	BOT 614	Environmental Awareness	2+1
	BOT 615	Water Resources	2+1
	BOT 616	Protein Biochemistry	2+1
			06 Credits
		Thesis	Non Credit
		Total	**21 Credits**

CATEGORY A: COURSE CONTENTS
(Compulsory Courses)

BOT 601:ResearchMethodology Credit: 3+1

- Sampling technique, sterilization technique, various methods for isolation of pure culture methods for measurement of microbial growth, manipulation of environment, nutritional and genetic parameters, maintenance and preservation of microbes (pure culture).
- Chromatographic techniques – Gel filtration, ion exchange chromatography, hydrophobic interaction and reverse phase chromatography, affinity chromatography, gas chromatography, high performance liquid chromatography, fast protein liquid chromatography; Application in separation of proteins including enzymes.
- General concepts of microscopy, bright field, darkfield, ecltron microscopy, modern tools in microscopy
- General concepts of plants collection from nature, sampling, cataloguing, preservation, herbarium techniques.
- Basics of Electrophoretic and centrifugation techniques - SDS and Native PAGE, Agarose gel electrophoresis, isoelectric focusing and two-dimensional electrophoresis, proteome analysis; 2 Differential and density gradient centrifugation, analytical ultracentrifugation, separation of DNA/RNA using ultracentrifugation technique, determination of molecular weight and Sedimentation coefficient.
- Quantitative methods; Principles and Designs of Experiments; Tools Parametric and Non~parametric statistics. Probability, Chi square test, t-test, Confidence interval, Errors. Levels of significance, Regression and Correlation coefficient. Analysis of variance for one way and two way classifications; Multiple Comparisons – Least Significant Difference Test, Duncan's New Multiple Range Test; Factorial Analysis; Analysis of Covariance.
- Scientific writing, types of citation, literature search, graphical abstracts, peer review. Research proposal and report writing, format and structure of research paper. Major research Institutes and funding agencies related to plant sciences.

SUGGESTED READING:

1. Marder M P (2011) Research Methods for Science, Cambridge University Press

2. Rosner B (2010) Fundamentals of Biostatistics, 7th Edition, Brooks/Cole Cengage Learning Publication

3. Dunleavy P (2003) Authoring a PhD: How to Plan, Draft, Write and Finish a Doctoral Thesis or Dissertation. Palgrave Macmillan

4. Kothari, C.R.(2004). Research Methodology: Methods and Techniques, New Age International Publishers, New Delhi

5. Arya., P.P. and Pal, Y.(2001) Research Methodology in Management: Theory and case Studies. Deep and Deep Publishers Pvt. Ltd., New Delhi

Course Code: BOT 602: Research and Publication Ethics **Credits: 1+1**

Theory:-

1. Philosophy and Ethics: Introduction to philosophy, definition, nature and scope, concept, branches, Ethics definition, moral philosophy, nature of moral judgments and reactions.

2. Scientific conduct: Ethics with respect to science and research, Intellectual honesty and research integrity, scientific misconduct: Falsification, Fabrication and Plagiarism (FFP), Redundant publication: duplicate and overlapping publication, salami slicing, Selective reporting and misrepresentation of data.

3. Publication Ethics: definition, introduction and importance, best practices/ standard setting initiatives and guidelines: COPE, WAME, etc, conflict of interest, publication misconduct, definition concept, problems that lead to unethical behavior and vice-versa, types, Violation of publication Ethics, Authorship and contributor ship, identification of publication misconduct, complain and appeals, Predatory publisher and journals.

Practice:-

1. Open Access Publishing: open Access publication and initiatives, SHERPA/ RoMEO online resource to check publisher copyright and self-archiving policies, Software tool to identify predatory publication developed by SPPU, Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester,etc.
2. Publication Misconduct: Group Discussion regarding subject specific Ethical Issues, FFP, Authorship, conflict of Interest, complaints and appeals: example and fraud from India andabroad.
3. Software tools: Use of plagiarism software like Turnitin, Urkund and other open source softwaretools
4. Databases and Research Metrics: Databases: Indexing databases, Citation database: web of Science, Scopus etc. Research Metrics: Impact factor of journal as per journal citation report, SNIP, SJR, IPP, Cite, Metrics: h-index, g-index, i10 index,altmetrics.

REFERENCES

(1) P. Chaddah, (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN:978-9387480865

(2) Resnik, D. B. (2011). What is ethics in research & why is it important. National Institute of Environmental Health Sciences, 1-10. Retrived from http://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm

(3) Indian National Science Academy (INSA), Ethics in Science Education, Reasearch and Governance(2019),ISBN:978-81-939482-1-7. http://www.insaindia.res.in/pdf/Ethics_Book.pdf

(4) Bird, A. (2006)- Philosophy of Science.

(5) Maclntyre, Alasdair (1967)- A short History of Ethics.

(6) National Academy of Science, National Academy of Engineering and institute of Medicine (2009) On being a Scientist: A Guide of Responsible Conduct in Research.

Beall, J. (2012) – Predatory publishers are corrupting open access. Nature, 489(7415).

Course Code: MAT 603: Computer Fundamentals and IT Credits: 02 (1+1)

Computer Basics: Definition, Characteristics of Computers, Evolution of Computer, Generations of Computer, Classification of Computers, Applications of Computers, Computer System and its Components, Computer Memory, Memory Capacity, Input and Output Devices, Software and Hardware, System Software and Application Software, Operating System Definition and Functions, Working with Windows, File Management in Windows, System Utilities in Windows.

Introduction of MS-Word: The screen and its elements, Creating new documents, Writing and Simple Formatting, Page layout, Table, Pictures and Graphics.

Introduction of MS-Excel and Power Point: Basics of MS-Excel, Perform calculation on data, Manage worksheet, Analyze alternative data sets, Create and Manage slides, Insert and Manage Simple Graphics, Add sound and movements of slides.

Introduction of Internet and email: How to create e-mail, E-mail- sending a message, E-mail-attaching a document, How to use internet in research work.

PRACTICE:

Working with MS-Word: Prepare a word document of Ph. D. Synopsis, Prepare word document of Research Paper, Prepare word document of References.

Working with MS-Excel and Power Point: Prepare Tables and Charts (Pi-chart, Bar-chart), Insert pictures in a worksheet, Prepare Power Point presentation of the Ph.D. Synopsis, Prepare power point presentation having animation graphics and sound.

Internet and e-mail: Creating e-mail in different ways and websites,How to search research papers in Google Scholar and any Journal, How to search information related to research.

Suggested Readings:

1. Introduction to Information Technology, ITL Education Solutions, Pearson Education.
2. Introduction to Computer Science, ITL Education Solutions, Pearson Education.
3. Computer Fundamentals by P.K.Sinha&Priti Sinha, BPB Publications.

Course code: BOT-604: Credit Seminar Credit: 0+1

The seminar paper will be related to the area of research of the candidate and the candidate should have to give a seminar presentation of it.

CATEGORY B: Discipline-Specific Courses (for Botany scholars)

BOT-605: Advance Techniques in Plant Sciences **Credits: 2+1**

Tissue culture techniques: Media preparation, sterilization, in vitro regeneration.

Sampling of soil, water and air; Vegetation sampling and analysis. Field techiques for plant identification based on key characters.

Molecular Biology and spectroscopic techniques – Comet Assay; Real time PCR; RAPD, RFLP, ARDRA and Fluorescence in situ hybridization techniques. Atomic absorption spectroscopy, infrared spectroscopy, nuclear magnetic resonance spectroscopy, mass spectrometry including ESI MS and MALDI-TOF MS and Applications. .Methods of chromosome study: Protocols for squash method, karyotype analysis, chromosome banding techniques. Measurement of radioisotopes and their applications in biological system. Bioinformatics: Basic concepts and applications.

Suggested Readings:

1. J.B. Harborne, 1998. Phytochemical Methods- A Guide to Modern Techniques of Plant Analysis. Chapman & Hall, London, U.K.
2. S. Sadasivam and A. Manickam, 2005. Biochemical Methods. New Age International Private Ltd., New Delhi.
3. D. Heard (ed.) 2006. Analytical Techniques for Atmospheric Measurements. Blackwell Publishing Ltd., UK.
4. G.K. Agrawal, R. Rakwal, (Ed.) 2008. Plant Proteomics- Technologies, Strategies and Application. John Wiley & Sons, New York, USA.
5. M. Radojević and V.N. Bashkin, 1999. Practical Environmental Analysis. Royal Society of Chemistry, Cambridge, UK.
6. American Public Health Association (APHA), 1998. Standard Methods for the Examination of Water and Wastewater 19th edition. Washington, D.C.

BOT -606: Advances in Mycology and Plant PathologyCredits: 2+1

Current scenario of Mycology and Plant Pathology in India; Role of Fungi in Biotechnology: Selection, Production formulation and Commercial use of fungi in biocontrol of plant diseases, insect and weeds. Ganomedicines.Plant Diseases: Molecular techniques for Identification and classification of fungi; Seed pathology: Major seed borne plant pathogens of fungal, bacterial and viral origin. Techniques involved in identification of seed bornepathogens.Plant Defense: Recent concept of plant defence: Mechanism of sensing pathogenecity, Biochemical defence, Regulation of lignification indefence.Fungal Biotechnology: Fungal protoplast: Isolation, mycolytic enzymes, hyphal organization and protoplast formation, PEG induced and electrofusion of protoplast, Application and feature prospect of protoplast, Chemical management of plant pathogens.

Suggested Reading:

1. Dennis, E.S.et al, 1992 Plant Gene Research: Basic knowledge and Application. Springer-Verlag Wien Publ. NewYork.
2. Gengopadhyay, S 1984 Clinical plant pathology, Kalyani Publ. NewDelhi
3. Nane Y.1 and Thapliyal 1979, Fungicides in plant disease control. Oxford IBH, Publ. New Delhi.
4. Smith, J.E and D.R. Berry. 1978. The filamentous fungi. Vol-I Industrial mycology. Vol-II Development Mycologym, Edward Arnold Publ.London
5. Taiz, 1, and E. Zeiger. 1998. Plant physiology, Sinquer Assoc Inc. Publ. NewYork.
6. Trehan. K.1994. Biotechnology, Wiley Eastern Ltd, NewDelhi.
7. Vaidya, J.G 1995 Biology of the fungi, SatyajeetPrakashan,Pune.
8. Vyas, S.C.1992. Hand Book of Systemic fungicides, Vol-I, II, III, Tata McGraw Hill, NewDelhi.
9. Whipps, J.M. and R.D. Lumsden. 1989. Biotechnology of Fungi for Improving plant Growth. Cambridge Univ. Press, NewYork.

BOT 607: Advances in Plant Physiology **Credits: 2+1**

Lipids and Amino Acids Biosynthesis: Lipids- structural and storage lipids and their functions; Amino acid biosynthesis and assimilation inplants. Secondary Metabolites: Secondary metabolites- Role of natural products in plant defense, pharmaceuticals and cosmetics; Development of transgenic plants for abiotic stress tolerance; Phytoremediation Stress Proteins in plants- HSP, osmotin, PR, BSIPS, salt-, cold- and UV light- inducedproteins.

Stress physiology: Biotic and Abiotic stress; Physiological and Biochemical responses of plants to environmental stress; Plant responses to salinity and chilling stress; Abiotic stress and secondary metabolite production.

Hormones & Signal Transduction: Hormonal regulation of plant growth and development, signal Transduction, Role of PGR in agriculture and horticulture, Status of Plant Physiology Research inIndia.

Suggested Reading:

1. L. Taiz and E. Zeiger (2002) Plant Physiology (Second Edition) Simauer Associates Inc Publishers Sunderlands,Massachusetts
2. H.W. Heldt (1997) Plant Biochemistry and Molecular Biology Oxford University Press
3. W.G. Hopkins (1985) Introduction to Plant Physiology John Wiley and Sons, Inc. NewYork
4. Methods in Enzymology Colowick and Caplan Academic Press, New York
5. Coombs, Hall, Long and Scurlik (1985) Techniques in Bioproductivity and Photosynthesis, PergmonPress,Oxford
6. Hall, Sccurlik, Bolhar, NordenKamf, Leagood and Long (1993) Photosynthesis and production in a Changing Environment. A Field and Laboratory Manual, Chapman and HallPublication
7. Buchnan, B.B., Gruissem, W. and Jones, R.L. (2000) Biochemistry and MolecularBiologyofPlants.I.K.InternationalPvt.Ltd.,NewDelhi.

BOT 608 : Advances in Plant Biosystematics and Taxonomy Credits: 2+1

Molecular methods plant taxonomy: Angiosperm phylogeny groups (APG); DNA barcoding and its practical implications. Application of DNA markers in angiosperm taxonomy. Botanical nomenclature: International code of nomenclature (ICN); Principles: rules and recommendations; typification, priority, rules of effective and valid publications; retention and choice of names; Conservation of names, Name changes, Synonyms, Basionyms. Phylogenetic tree

Floristics and monographs; Taxonomic literature; Flora of Uttar Pradesh; Ethnobotanical works in India; Role of palynology in plant taxonomy. The plasticity of phenotypes; Internal variability of population; Ecological differentiation and population; Centres of taxonomic work in India. Major plant repositories and herbarium collections.

SUGGESTED READINGS

, M.L. 1950. Gray's Manual of Botany. 8th Ed. American Book Company, New York.

Gleason, H.A. 1968. The New Britton and Brown Illustrated Flora. 3 vols. Hafner Publishing Company, New York.

Gleason, H.A., and A. Cronquist. 1991. Manual of the Vascular Plants of Northeastern United States and Adjacent Canada. 2nd Edition. The New York Botanical Garden, Brooklyn, NY.

Harmon, P.J. 2000. Atlas of the Vascular Plants of West Virginia. West Virginia Department of Natural Resources. Draft Edition.

Holmgren, N. H. 1998. Illustrated Companion to Gleason and Cronquist's Manual. The New York Botanical Garden, N.Y. Selected Journal Readings. Reprints on file in the lab.

Stuessy, T. 1990. Plant Taxonomy: The Systematic Evaluation of Comparative Data. Columbia University Press. N.Y.

Stuessy, T. 1994. Case Studies in Plant Taxonomy. Columbia University Press, NY

Walters, D.R., and D. J. Keil. 1998. Vascular Plant Taxonomy. 4th Edition. Kendal/Hunt Publishing Company, Dubuque, Iowa.

BOT 609: Air Pollution and Climate Change Credits: 2+1

Atmospheric composition and climate; Gaseous and particulate pollutants, emission trends and scenarios; climate change, drivers of climate change, greenhouse gas emission scenarios; indoor air pollution. Major green house gases and their role in climate change.

Stratospheric ozone depletion: Phenomenon, causes, irradiation scenarios; effects of enhanced UV-B on plants, microbes and human health, biological actionspectra. Greenhouse effects: Process; consequences, global warming, sea level rise, albedo, oceanic influences, agriculture, natural vegetation; effects of increased CO2 on plants; humanimplications. Acid rain: Formation, dispersion and deposition, trends; consequences on soil fertility, rivers and lakes; effects on plants, leaf injury, buffering, reproduction; forest decline; effects onfisheries.

Biomonitoring of air pollution: Concept, active and passive monitoring; bioindicator parameters; air pollution tolerance indices; control of air pollution by plants. Major Agencies working on climate change. Climate change and food security.

Suggested Readings:

1. A.B. Pittock, 2009, Climate change, the Science, Impacts and Solution.
   (2nd edition). CSIROpublication.
2. Hirt Heribert, Kazuoshinozaki (Eds.), 2004, Plant Responses to AbioticStress.Springer-Verlag Berlin.
3. J.N.B. Bell and M. Treshow (Eds.), 2004. Air Pollution and Plant Life. John Wiley and Sons,England

BOT 610: Biological control and Biopesticides Credits: 2+1

Basic concept of Biological control. Biological control of plant pathogen and pests. Role of phylloplane and rhizoplane in pathogen control. Mode of action, interaction used for biological control. Biological control of nematodes and insects. Role of yeast in biological control.

Principles of Biopesticides, commercial production, Commercial biocontrol agents and regulation and standardization of BGA. Plant based botanicals, types, their activity against different pathogens and their application. Importance of herbal pesticides and their commercialization and regulation.

Suggested Readings

1. New direction in biological control by baker,R.R and P.E.Dann(EDS)1990,Wileylies,New York.
2. Biological control by Natural enemies by Debach,P and Rosen,D,1991,Cambridge Universitypress,Cambridge,U.K.
3. Principles of Insect Pest Management by Dhaliwal,G.S and Arora,R.2006, Kalyani Publisher,New Delhi.
4. Botanicals and Biopesticides by Parmar,B.P and C.Devakumar,1993,Westvill publishing house.New Delhi.
5. Principles of Insect Pest Management by Dhaliwal,G.S and Arora,R.2006, Kalyani Publisher,New Delhi.

CATEGORY C: Research Theme- Specific Courses (open for other subject scholars)

BOT-611: Biodiversity and its Conservation Credits: 2+1

Introduction to biodiversity. Levels of biodiversity: Genetic, species, community andecosystem, Magnitude and distribution: Diversity gradients and related hypotheses, methods for biodiversity monitoring, megadiversity zones and hotspots. Biodiversity and ecosystem functions: Concepts andmodels. Biodiversity and ecosystem services: Provisioning, regulating, supporting andcultural. Threats to biodiversity: Causes of biodiversity loss, species extinction, vulnerability of species to extinction, IUCN threat categories, Reddata book. Strategies for biodiversity conservation: Principles of biodiversity conservation, in-situ and ex-situ conservation strategies; Biodiversity acts and regulations.

Suggested Readings:

1. V.H. Heywood, and R.T. Watson, 1995. Global Biodiversity Assessment. UNEP, Cambridge UniversityPress.
2. D. Hill, M.Fasham, and P. Shaw, 2005. Handbook of Biodiversity Methods: Survey, Evaluation and Monitoring. Cambridge University Press.
3. A.E. Magurran, 1988. Ecological Diversity and Its Measurement. Princeton University Press, Princeton, NewJersey.
4. J.S Singh, S.P Singh, S.R. Gupta, 2006. Ecology Environment and Resource Conservation. Anamaya Publishers, NewDelhi
5. Van Dyke, Fred, 2008. Conservation Biology: Foundations, Concepts, Applications, 2nd edition McGraw Hill, New York,USA
6. Peter J. Bryant, 2009, Biodiversity and Conservation, University of California, Irvine,USA

BOT-612: Phytoremediation Credits: 2+1

Basic Physiological Processes: Microbial processes, bio-catalysis, symbiosis with plant; roots, plant processes, inorganic nutrition, water uptake and transpiration, photosynthetic production of phytochemicals, root exudation and root turnover, biometabolism.

.Mechanism of Phytoremediation: Phytosequestration, Rhizodegradation, Phytoextraction, Phytodegradation, Phytovolatilization, Evapotranspiration

Applications of Phytoremediation: Containment strategies: groundwater hydraulic barriers, covers for infiltration control, erosion control and soil/sediment stabilization; Treatment strategies: surface soil clean up, treatment wetlands for sediment/surface water clean up. Containment and treatment strategies; riparian buffers for surface water protection, in-situ groundwater/subsurface soil treatment, ex-situ rhizofiltration. .

Enzyme transferring biomolecules to organic foreign compounds: A role for Glucosyltransferase and Glutathione S-transferase in Phytoremediation. Soil Plant Microbe Interaction: Mycorrhizal Fungi as helping agents in "phytoremediation of degraded and contaminated soils; The Rhizosphere Ecology; Rhizoremediation potential for selective plant microbe pairs. Phytoremediation of Pollutants: Organic and Inorganic pollutants; Phytoremediation of Polychlorinated Biphenyls, Volatile Organic Compounds and Heavy metals from soil; Exploitation of fast growing trees in metal remediation.Regulatory Evaluation and Acceptance Issues for Phytotechnologies: Assessing risks and containing or mitigating gene flow of phytoremediating plants

Suggested reading:

1. D.T. Tsao. (2003) Phytoremediation (Advances in Biochemical Engineering Biotechnology). 151 edition, Springer
2. Todd A. Anderson. (1994) Bioremediation through Rhizosphere Technology. 15t edition, An American Chemical Society Publication
3. Mackova, Martina; Dowling, David; Macek, Tomas. (2006) Phytoremediation and Rhizoremediation. Springer

BOT-613: Medicinal Plants and Pharmacognosy **Credits: 2+1**

Introduction and Scope of Pharmacognosy: Pharmacognosy and modern medicine. Crude plant drugs. Ethnopharmocology, Indigenous traditional drugs and their market adulteration.Importance of active principles and uses of medicinal plants in different traditional systems of medicine.

Types of Plant drugs and their Pharmacognostic study. Drug from roots, leaves, rhizhomes, bark flower, seed and fruit.Evaluation of the drugs; Organoleptic, Microscopic, Physical, Chemical and Biological methods of evaluation. A brief account of various drug constituents: Carbohydrates, Cardiac glycosides, alkaloids, volatile oils, resins quinines and steroids.Large scale Industrial preparation of Crude Drugs. Their commercialization, marketing and regulation.. Conservation of Medicinal Plants; Threatened and endangered Medicinal Plants – in-situ and ex-situ conservation.

Suggested reading

Cultivation of Medicinal plants-Purohit & Vyas CBS, 2006

Introduction to Medicinal Chemistry (12996). AlerGingauz. Wiley publications.

Medicinal Chemistry (2001). Graham L. Patrick. Oxford University Press

BOT-614: Environmental Awareness **Credits: 2+1**

Multidisciplinary nature of environmental studies, Renewable and non-renewable resources: Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.Water resources: Use and overutilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.Energy resources: Growing energy needs, renewable and non- renewable energy sources, use of alternate energy sources. Case studies. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources.Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Public awareness. Role of Information Technology in Environment and human health, Case Studies

BOT-615: Water resources Credits: 2+1

Water Resources, Diversity of Aquatic Habitats. Quality of Water, Physico-chemical Properties of Freshwater, Water Quality Parameters and Standards, Water Pollution and its Sources, threats to ground and surface water. Water stress in plants, adaptation, effect of water stress on agriculture. Water Management Strategies, Management of Ground Water, Rain Water Harvesting, Recharging of Ground Water, Recycling of Waste Water. Waste water treatment. Use of technology in potable water. Water borne disease and detection of water borne microbes. Government regulation for water conservation and International efforts for water conservation in era of Climate change.

Suggested reading

Modi, P. N. (2003). Water Supply Engineering and Wastewater Engineering, Volume I & II, Standard Book House, Delhi.

Raju, B. N. S. (1995) Water Supply and Wastewater Engineering, Tata McGraw Hill Company Ltd, New Delhi.

Shah, C.S. (1998). Water supply and Sanitation. Golgotia Publishing Company, New Delhi.

Sharma, J.L. (2000). Public health Engineering, Satya Prakashan, New Delhi. 8. Standard Methods for Examination of Water and Wastewater, Edition 21st (2005). American Public Health Association, USA.

BOT-616: Protein BiochemistryCredits: 2+1

Protein Basics: Amino acids; Primary, secondary, tertiary & quaternary structure of proteins; post translational modifications. Structural organization of soluble & membrane proteins; structure-function relationships.Isolation, Purification & Characterization of Proteins: Precipitation, fractionation & chromatographic methods; Electrophoresis: SDS-PAGE, Native PAGE, chromatofocussing& isoelectric focussing; determination of amino acid composition & sequence, assignment of disulphide bonds, molecular weight & oligomeric structure; bioinformatics tools for protein characterization, western blotting & functional characterization ofproteins.Protein Engineering, Folding & Prediction: Protein folding themes, folding proteins in vitro, protein structure prediction & modeling, prediction of protein function; Protein engineering: codon shuffling & codon optimization.Protein Structure Determination: Circular dichroism, X-ray crystallography & Nuclear magneticresonance

Suggested Readings:

1. Nelson DL and Cox MM (2001) Lehninger Principles of Biochemistry, 3rd Edition, Macmillan Worth Publishers, NewDelhi.
2. Voet D and Voet JG (2001) Biochemistry, 3rd Edition, John Wiley & Sons, NewYork.
3. Keith Wilson , John Walker. Practical Biochemistry: Principles and Techniques, Edition 5thCambridge universitypress.