MAHARAJA SURAJMAL BRIJ UNIVERSITY, BHARATPUR

Chak Sakitara, Kumher, Rajasthan, India, 321201

M.Sc. Botany Syllabus
Session: 2024-26
(Semester I & II)
As per NEP 2020

Dr. Farbat Singh
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Acad.I

Dr. Vikas Pareek

1. Scheme of Examination:

1. Each theory paper shall carry 100 (70 for End term exam + 30 for Internal/midterm exam) marks. The Paper will be of 3 hours duration. Part "A" of theory paper shall contain 10 Short Answer Questions of 10 marks based on knowledge, understanding and applications of the topics/texts covered in the complete syllabus. Each question will carry one mark for correct answer.
2. Part "B" of paper will consist of one question from each unit i.e. total four questions with internal choice (except in case where a different scheme is specified in the syllabus) of 15 marks each.

2. Course Structure:

The details of the courses with code, title and the credits assigned are as given below.

Abbreviations Used

Course Category

DSC: Discipline Specific Core
DSE: Discipline Specific Elective
VAC: Value added course
SEM/INT/DIS: Seminar/ Internship/Dissertation
CWS: Class work (It would include attendance, assignments, class test/quiz test, ppt, play, learn by fun activities etc.)
MTE: Mid Term Exam
ETE: End Term Exam

Contact Hours

L: Lecture
T: Tutorial
P: Practical
S: Self Study

The medium of instruction and examination shall be English only.

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(Dr. Dheeraj Bhunia Lakpati)

(Dr. Tripti Gupta)

(Dr. Vikas Pareek)

M.Sc. BOTANY (SESSION 2024-26)

FIRST- SEMESTER

Curriculum Structure									
Session 2024-2025 onwards									
Name of Programme: M.Sc. Botany									
Year: First							Semester: I		
S. No.	SUBJECT CODE	Course Title	Credi	Contact hours per week			Weightage (%)		
				L	T	P	CWS	MTE	ETE
Discipline Specific Core (DSC):									
1.	PGBOT101	Phycology, Mycology and Bryology	4	4	0	0	10	20	70
2.	PGBOT102	Cell Biology and Evolution	4	4	0	0	10	20	70
3.	PGBOT103	Principles of Plant Pathology & Microbiology	4	4	0	0	10	20	70
4.	PGBOT104	General Practical Lab. (Based on PGBOT101, PGBOT102 & PGBOT 103)	6	0	0	12	45	-	105
Discipline Specific Elective (DSE):									
5.	PGBOT105	Applied Microbiology	4	4	0	0	10	20	70
OR									
6.	PGBOT106	Seed Pathology	4	4	0	0	10	20	70
7.	PGBOT107	Elective Practical Lab (PGBOT105 or PGBOT106)	2	0	0	4	15	-	35
Value Added Course (VAC):									
8.			2	0	0	2	05	10	35

Summary: I Semester		
S. No.	Particulars	Credits
1.	Discipline Specific Core (DSC)	18
2.	Discipline Specific Elective (DSE)	06
3.	Value Added Course (VAC)	02
4.	Seminar/ Internship/Dissertation (SEM/INT/DIS)	--
	Total	26
CWS (Class work): It would include attendance, assignments, class test/quiz test, ppt, play, learn by fun activities etc.		

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PGBOT101 -PHYCOLOGY, MYCOLOGY AND BRYOLOGY

Credits: 4

Objectives of the Course

- This course is designed to provide fundamental and advance knowledge about the various algae, Fungi and Bryophytes.

Course Learning Outcomes

After completion of this course, students will be able to

- Learn criteria of classification, diversity, life form, reproduction, phylogeny, nutritional and economic importance of the Algae, Fungi & Bryophytes.
- Develop critical understanding on morphology, anatomy and reproduction.
- Develop proficiency in the experimental technique and methods of appropriate analysis of plant of these groups.
- Explore many unexplored plants for the economic benefits of human like medicine, biofertilizers and other uses because Rajasthan have diversified climatic condition.
- Understand plant origin, evolution and their transition to land habitat because algae, Fungi and bryophytes are one of the basics of botany.

Unit I

15Hrs

- **Phycology:** Algae in diversified habitats (terrestrial, freshwater and marine), thallus organization, cell ultra-structure, reproduction (vegetative, asexual and sexual) classification of algae (F.E. Fritch and G.M. Smith), cell wall composition, reserved food material and flagellation. Salient features of Cyanophyta, Chlorophyta, Bacillariophyta, Xanthophyta, Pyrrophyta, Phaeophyta and Rhodophyta with special reference to Oedogonium, *Spirulina, Acetabularia, Dunaliella, Pinnularia, Gonyaulax, Polysiphonia, Laminaria,* and *Batrachospermum.*

Unit II

15Hrs

- **Economic importance of algae**: specially in industries, food, fodder, biofertilizers, Biofuels and algal bloom, isolation and culture of algae.
- **Mycology:** General characters of Fungi, substrate relationship, cell ultra-structure, thallus organization, cell wall composition, nutrition (saprobic, biotropic and symbiotic), reproduction (asexual and sexual).
- Heterothallism, heterokaryosis, Brachymeosis, parasexuality, sex hormones and recent trends in classification of fungi, phylogeny of fungi.

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Unit III

15Hrs

- **General accounts:** Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina with special reference to *Rhizopus*, *Peronospora Neurospora*, *Polyporus*, *Drechslera* and *Colletotrichum.*
- **Economic importance of fungi:** specially in industries, medicines and as food, fungi as biocontrol agents, poisonous fungi, mycorhizae.
- **Bryology:** Distribution, Classification of Morphology, structure, reproduction of bryophytes.

Unit IV

15Hrs

- **General accounts:** Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Funariales and Polytrichales with special reference to *Plagiochasma, Notothylus, Sphagnum, Physcomitrella patens* and *Polytrichum.*
- Fossil Bryophytes, evolutionary trends in Bryophytes.
- Economic importance of Bryophyta
- Role of Bryophytes in plant succession.

Suggested Laboratory Exercises:

Morphological study of representative members of algae, fungi and bryophytes present in your locality in their natural habitat with special reference to:

- **Phycology:** *Microcystis*, *Spirullina*, *Scytonema*, *Rivularia*, *Dunaliella*, *Aulosira*, *Spirogyra*, *Pediastrum*, *Hydrodictyon*, *Ulva*, *Pithophora*, *Stigeoclonium*, *Gelidium* and *Batrachospermum*: Isolation and culture of algae.
- **Mycology:** *Stemonites, Peronospora, Pythium, Albugo, Rhizopus, Pilobolus,* Yeast, *Emeri cella, Chaetomium, Pleospora, Morchella, Melamsora, Phallus, Polyporus, Drechslera, Curvularia, Phoma, Penicillium. Aspergillus, Colletotricum, Fusarium* and *Alternaria*:
- Isolation and culture of fungi using moistened blotters, PDA and Sabouraud's Dextrose Agar media.
- **Bryology:** *Plagiochasma, Pogonatum, Pellia, Notothylus, Andreaea* and *Polytric hum*

Suggested Readings:

1. Alexopoulus, C.J., Mims, C.W. and Blackwel, M. (1996). Introductory Mycology, John Wiley & Sons ind.
2. Anderson, R.A. (2005) Algal Culturing Techniques. Physiological Society of America. Elsevier Academic Press, USA.
3. Fritsch, F.E. (1993, 1945). The structure and Reproduction of Algae Vol. I, II. Cambridge University Press, Cambridge, UK.

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4. Kashyap, S.R. (1932) Liverworts of Western Himalayas and Punjab Plains (Vll. I & II) Reserch co. Publications, New Delhi.
5. Richardson, D.H.S. Biology of Mosses. (1981). Blackwell Scientific Publications, Oxford.
6. Bold, H. C., Alexopoulus, C.J. and Delevoryas. T. (1980): Morphology of plant and fungi (4th Ed.) Harper & Foul Co., New Work.
7. Ghemawat, M.S., Kapoor J.N., and Narayana, H.S. (1976): A text book of Algae. Ramesh Book Depot, Jaipur.
8. Gilbert, M Smith. Cryptogamic Botany, Vol. I & II (2nd Ed.) (1985). Tata McGraw Hill. Publishing Co. Ltd., New Delhi.
9. Puri, V. Bryophytes. (1985). Atmaram& sons. Delhi, Lucknow.
10. Sharma, P.D. (1996). Introduction to Bryophytes. Ramesh Book Depot, Jaipur.

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PGBOT102- CELL BIOLOGY AND EVOLUTION

Credits: 4

Objectives of the Course

- This course is designed to provide fundamental and advance knowledge about the cell biology and Evolution.

Course Learning Outcomes

After completion of this course, students will be able to

- Understand the structure and function of cell organelle at ultrastructure level
- Understand the various apoptotic pathways.
- Explore Evolutionary knowledge about Concept/theories/ hypothesis proposed by various scientist/biologist.
- Understand about the population genetics.

Unit -I

15Hrs

- **Cell Structural organization and function of organelles:** Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, structure & function of cytoskeleton and its role in motility.
- **Membrane structure and function:** Structure of model membrane, lipid bilayer and membrane protein) (diffusion, osmosis, ion channels, active transport and membrane pumps.
- **Intracellular compartments and transport:** mechanism of protein sorting in peroxisomes, nucleus, chloroplast, mitochondria & ER and regulation of intracellular transport.

Unit -II

15Hrs

- **Cell division and cell cycle**: Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle.
- **Cell signaling**: Cell signaling Hormones and their receptors, cell surface receptor, secondary messengers, signaling through G-protein coupled receptors, signal transduction pathways (Cyclic AMP, phospholipase C, Ca^{+2}-Cadmodulin & Receptor Tyrosine Kinase pathway), regulation of signaling pathways.

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Unit III

15Hrs

- **Cellular communication**: general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins.
- **Apoptosis:** Apoptosis (Programmed cell death): Mechanism of apoptosis, Apoptosis triggered by internal & external pathways, Apoptosis inducing factors, cancer, oncogenesis.
- **Evolution:** Emergence of evolutionary thoughts Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations.

Unit IV

15Hrs

- **Origin of cells and unicellular evolution:** Origin of basic biological molecules; Abiotic synthesis oforganic monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes.
- **Paleontology and Evolutionary History:** The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major groups of plants and animals.
- **Population genetics:** Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Co-evolution.

Suggested Laboratory Exercises:

- EM study of cell organelles
- Fluorescence staining with FDA for cell viability.
- Cell wall staining with Calcifluor white
- Study of stages in cell cycle
- Mitosis and Meiosis
- Histochemical localization of protein, carbohydrate, fats, starch, lignin, nucleic acids
- Isolation of mitochondria and the activity of its marker enzyme, succinate dehydrogenase(SDH).
- Isolation of chloroplast and study of its percentage intactness
- Isolation of chloroplast and study of light reaction system.
- Demonstration of SEM and TEM.
- Hardy-Weinberg numerical
- Any other practical based on theory syllabus.

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Suggested readings:

1. Krishnamurthy, K.V. (2000). Methods in Cell Wall Cytochemistry. CRC Press, Boca Raton, Florida.
2. Reeve, ECR. (2001). Encyclopedia of Genetics, F. D. Publication, Chicago, USA.
3. De, DN. (2000). Plant Cell Vacuoles: An Introduction. CSIRO Publication, Collingwood, Australia.
4. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. (VIII Edition). Lippincott Williams and Wilkins, Philadelphia.
5. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. (V Edition). ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
6. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. (VII Edition). Pearson Benjamin Cummings Publishing, San Francisco.
7. Kleinsmith, L.J. and Kish, V.M. (1995). Principles of Cell and Molecular Biology (2nd Edition). Harper Collins College Publishers, New York, USA.
8. Harris, N. and Oparka, K.J. (1994). Plant Cell Biology: A Practical Approach. IRL Press, at Oxford University Press, Oxford, U.K.
9. Gunning, B.E.S. and Steer, M.W. (1960). Plant Cell Biology: Structure and Function. Jones and Bartlett Publishers. Boston, Massachusetts.
10. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
11. Griffiths, A.J.F. et al. (2000). An introduction to genetic analysis, W. H. Freeman and Company, New York, USA.
12. Hall, J.L. and Moore, A.L. (1983). Isolation of Membranes and Organelles from Plant Cells. Academic Press, London, U.K.
13. Roy, S.C. and De, KK. (1999). Cell Biology. New Central Book Agency (P) Ltd., Calcutta.
14. Hartl, D. L. (1994). Genetics. Jones and Bartlett Publishers International, USA.

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PGBOT103- PRINCIPLES OF PLANT PATHOLOGY& MICROBIOLOGY

Credits: 4

Objectives of the Course

- This course is designed to provide fundamental and advance knowledge about the microbiology and plant pathology.

Course Learning Outcomes

After completion of this course, students will be able to

- Understand the general characteristic, Classification & Reproduction of bacteria.
- Develop a good knowledge of characteristics of different microorganisms and their significance.
- Identify plant diseases ant their control measures.
- Develop skill to perform basic experiments to grow and study vegetative and reproductive structureof microorganism in laboratory.

o Unit -I

15Hrs

- **Microbiology:** History, scope and developments in Microbiology, Roert Kochs postulates, Griffith Experiment; Bergey's manual of systematic bacteriology.
- **Morphology, ultra structure and reproduction of bacteria:** Morphology and ultrastructure of bacteria, cytoplasmic inclusions, plasmids and endospores, reproduction, Quorum Sensing.

Unit -II

15Hrs

- **Introductory Virology**: Nomenclature and general characteristics of plant viruses, ultrastructure of TMV and Bacteriophage. Life cycle, Economic importance of viruses.
- **Phytoplasma**: General characters, morphology and Identification techniques of phytoplasma.
- **Plant diseases:** Introduction and General Account of disease development History of plant pathology Nature and concept of Plant Disease and Symptoms of Plant Diseases caused by plant pathogen.

Unit -III

15Hrs

- **Pathogenesis**: Biotic and Abiotic factors in pathogenesis, pathogen factors in disease development: Enzymes and Toxin in Plant Disease –Host specific and non-host specific toxin.
- **Disease Development**: Mechanism of Penetration of Pathogens, hypersensitive

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response. Protective and defense mechanism in plants-Morphological and Biochemical

Unit -IV

15Hrs

- **Plant disease management:** Physical, Chemical and biological means of disease control. Biotechnological approaches to disease resistance, IPM.
- **History, symptomology, causal organism, etiology and management of:**
  - **Fungal diseases:** Wheat - Flag smut, Karnal bunt. Rust of Linseed, Tikka disease of Groundnut
  - **Bacterial diseases:** Crown gall of stone fruits Black rot of Crucifer
  - **Viral diseases:** Cadang –Cadang disease of Coconut Sandal spike
  - **Nematode disease:** Root Knot of Brinjal, Ear Cockle of Wheat
  - **Non-Parasitic Diseases** Black Heart of Potato Mango necrosis

Suggested Laboratory Exercises:

- Culture media for microorganisms
- Growth curve of bacteria
- Gram staining
- Virus indexing
- Study of following diseases:
- Wheat - Flag smut, Karnal bunt. Rust of Linseed
- Tikka disease of Groundnut Crown gall of stone fruits Black rot of Crucifer
- Cadang –Cadang disease of Coconut Sandle spike
- Root Knot of Brinjal, Ear Cockle of Wheat
- Any other practical based on theory.

Suggested Reading:

1. Agrios, G.N. (2005). Plant Pathology, 5th edition. Academic Press, New York, USA.
2. Alexopoulos, C.J., C.W. Mims and M. Blackwell. (1996). Introductory Mycology. 4th edition, John Wiley and Sons, Inc., New York, USA.
3. Mehrotra, R.S. and A. Agarwal. (2003). Plant Pathology. 2nd Edition. TATA McGraw Hill. Pub. Company Ltd. New Delhi.
4. Singh, R.S. (1989). Plant Pathogens: The Prokaryotes. Oxford and IBH Publ. Company, New Delhi, India.
5. Tortora, G. j., Funke, B. R. and case, C. L. (2010) Microbiology- An Introduction. Addison Wesley Longman, Inc. California. 10th edition.

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6. Prescott L, Harley J, Klein D (2005) Microbiology, 6 th edition, McGraw-Hill.
7. SubbaRao NS (1982) Advances in Agriculture Microbiology, Butterworth-Heinemann.

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PGBOT105: DSE: APPLIED MICROBIOLOGY

Credits:4

Objectives of the Course

- This course is designed to provide fundamental and advance knowledge about the applied microbiology.

Course Learning Outcomes

After completion of this course, students will be able to

- Understand the role of microbiology in food and dairy industries.
- Develop a good knowledge of characteristics of different methods of bioremediation & sustainable agriculture.
- Develop practical skill to perform basic & advanced experiments in applied microbiology.

Unit -I

15Hrs

- **Food and Dairy Microbiology**: Microbial spoilage of food products including cereals, fruits, vegetables, meat, fish, and dairy products, Factors influencing microbial growth in foods - extrinsic and intrinsic.
- Principles of food preservation, Food preservatives and their uses, Fermented food, wine, bakery products, cereals, and milk products, Bacteriocins and their application in food preservative (Nisin, Lacto coccus lactis), food additives. Nutritional value of fermented foods
- Microbiological examination of milk and milk products, source of their contamination and control.

Unit -II

15Hrs

- **Applications of Microbes in Waste Treatment:** Solid waste treatment (Landfills, incineration, composting, anaerobic digestion and pyrolysis). Waste water treatment: Pretreatment, primary, secondary (activated sludge, surface aerated basins, fluidized bed reactors, trickling filter, bio tower, rotating biological contactors, membrane bioreactors and secondary sedimentation) and tertiary treatment, disinfection and odor control; Application of biofilm in waste water treatment. Microorganisms as indicators of water quality.
- **Role of Microbes in Environment:** Biodegradation of recalcitrant compounds – Pesticides, Petroleum, Polychlorinated biphenyls and other organopollutants; Lignin degradation: Lignocellulolytic microorganisms, enzymes and their applications in: Biopulping, Biobleaching, Textiles, Biofuels, Animal feed production.

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Unit -III

15Hrs

- **Bioremediation:** *In situ* & *Ex situ* remediation, Concept of bioremediation technologies, Microbial consortium, Microbial remediation of oil spills, paper and pulp mill effluents and textile effluents; Biostimulation and Bioaugmentation. Bioaccumulation of metals and detoxification. Genetically Modified Organisms released and its environmental impact assessment; Molecular approach to environmental management, Degradative plasmids, Genetic exchange in xenobiotic chemicals.
- Biodeterioration of buildings and monuments of heritage value, Microbial deterioration of paper, leather, wood, textiles, metal surfaces– mode of deterioration, organisms involved, its disadvantages and methods of prevention.

Unit -IV

15Hrs

- **Methods for sustainable agriculture:** - Bioleaching of copper, gold and uranium from ore by microbes. Bio- recovery of petroleum. Microbial plastics, Biodiesel.
- **Application sustainable agriculture**: - Biofertilizer for sustainable agriculture- Rhizobium, Azospirillium, Azotobacter, Azolla, BGA-mass production methods- application methods of biofertilizers - significance of biofertilizers.

  Mycorrhizal fungi: Diversity of endo and ectomycorrhizal fungi, culturing and benefits, role in bioremediation of soil. Fungal endophytes as biocontrol agents. Agriculturally important fungi in sustainable agriculture with special emphasis on Biopesticides, Mycoweedicides and Mycoinsecticides.

Suggested Laboratory Exercises:

- Microbiological examination of food.
- Detection of number of bacteria in milk by standard plate count (SPC).
- Assay of quality of milk sample using MBRT test.
- Adulteration tests for milk.
- Isolation and identification of Lactobacillus from fermented dairy products.
- Isolation and identification of microorganisms from contaminated food and dairy samples.
- Sampling and analysis of microbial load on food contact surfaces.
- Microorganisms degrading oil/ textile dyes/ petrol.
- Biodeterioration of paper/textiles.
- Bacteriological examination of water (Potable/hospital waste): Presumptive test; ConfirmedTest and Completed Test.

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- Design and operation of multistage reactor for degradation of waste water.
- Isolation of xenobiotic compound degrading bacteria by enrichment culture technique.

Suggested Readings:

1. Alexander, M. Microbial ecology. John Wiley and Sons, New York.
2. Singh, B.D. Biotechnology, Kalyani Publishers, New Delhi
3. Agrios, G.N. (1999). Plant Pathology. Academic Press.
4. Kale, V. and Bhusari, K. Applied Microbiology, Himalaya Publishing House.
5. Aneja K.R., Jain P. and Aneja R., (2008), A textbook of basic and applied microbiology, NewAge Int. Publications, New Delhi.
6. Eldowney, S., and Waites, S. Pollution: Ecology and biotreatment. Longman, Harlow.
7. Baker, K.H. and Herson, D.S. Bioremediation. McGraw- Hill, New York. .
8. Madigan, M.T., Martinko, J.M. and Parker, J. Brock biology of microorganisms. PrenticeHall, New Jersey.
9. Mitchell, R. and Gu, J.D. Environmental microbiology. Wiley-Blackwell, New Jersey.
10. Evans, G.M. and John, J.C.F. Environmental biotechnology: Theory and applications. JohnWiley and Sons, New York.
11. Waste Water Microbiology 2nd Edition by Bitton.
12. Satyanarayana, T., Johri, B.N. and Prakash, A. Microorganisms in environmental management: Microbes and environment. Springer Verlag, New York.
13. Adams M.R and Moss M.O: Food microbiology: Royal society of chemistry
14. Dennis Allsopp and Seal, K.J. 1986. Introduction to Biodeterioration. E Edward Arnold Ltd.
15. Cappucino, J. and Sherman, N. Microbiology: A laboratory manual. Benjamin CummingsPublishing Company, San Francisco.
16. Prescott, L.M. and Harley, J.P. Laboratory exercises in microbiology. McGraw-Hill, NewYork.
17. Singer, S. Experiments in applied microbiology. Academic Press, New York.
18. Pepper, I.L., Gerba, C.P. and Brendecke, J.W. Environmental microbiology: A laboratorymanual. Academic Press, San Diego.

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PGBOT106: DSE: SEED PATHOLOGY

Credits: 4

Objectives of the Course

- This course is designed to provide fundamental and advance knowledge about the Seed pathology.

Course Learning Outcomes

After completion of this course, students will be able to

- Understand the basic knowledge about history and introduction of seed pathology.
- Develop a good knowledge about pathogen detection methods & mechanism of infection.
- Develop a knowledge about disease transmission & various control methods
- Develop practical skill to perform basic & advanced experiments in seed pathology.

Unit -I

15Hrs

- **General Introduction & History:** - Introduction and importance of Seed Pathology in modern agriculture. History of Seed Pathology.
- **Methods for pathogen Detection & Mechanism of seed infection:** - Various methods for testing seed borne fungi, bacteria and viruses (Dry seed examination, seed washing test, incubation methods, cultural, biochemical, serological, nucleic acid-based methods). Mechanism of seed infection and its types, environment influencing seed infection, infected/contaminated part of seed, morphology and anatomy of seeds in relation to invasion, location of inoculum of the pathogen in seed- seed coat and pericarp, endosperm and perisperm and embryo.

Unit -II

15Hrs

- **Seed-borne diseases:** - Seed-borne diseases of some important crops with particular reference to the state of Rajasthan and India. Typical case of infection by: fungi (wheat- smuts and bunts, Sesame- charcoal rot; bacteria (Brassicas- black rot, cluster bean- bacterial blight); viruses (tomato mosaic virus, pea seed borne mosaic virus,) and nematodes (wheat- ear cockle, rice- whitetip).

Unit -III

15Hrs

- **Inoculum:** - Seed-borne inoculum, inoculum density and assessment of seed borne inoculum in relation to plant infection, epiphytotics due to seed borne inoculum, disease forecast based on infected seed samples, tolerance limits of seed borne pathogens

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- **Disease Transmission:** - Transmission of seed borne disease: Systemic and non-systemic seed transmission, types of disease transmission, mode of establishment and course of disease from seed to seedling and plant, factors affecting seed transmission.

Unit -IV

15Hrs

- **Disease Management**: - Management of seed-borne disease, principles of control, seed treatments (physical, chemical and biological), mechanism of action of seed treatments, major seed treatments for important seed borne pathogens and their methods of application.

Suggested Laboratory Exercises:

- Dry seed examination of seed lots.
- Isolation and identification of seed-borne mycoflora by standard blotter method.
- Preparation of culture media (PDA and NA).
- Plating seeds on PDA/NA for identification of seed borne fungi and bacteria.
- Other methods of plating e.g. deep freezing; 2,4D- blotter method.
- Water agar test tube seedling symptom test.
- Study of any seed borne nematode disease.
- Detection of bacterial and viral pathogens in seeds.
- LOPAT tests for detection of seed- borne bacteria.
- Nucleic acid based detection of seed borne pathogens.
- Histopathology of infected seed samples.
- Physical control of seed-borne pathogens.
- Antibiotic/fungicidal assay against seed-borne pathogens
- Biological control of seed borne pathogens.
- Field visits: Crop fields, FCI, NSC, Seed testing Labs., quarantine station (e.g. NBPGR)

etc.

Suggested Readings:

1. Agarwal, P. C., Mortensen, C. N. and Mathur, S. B. (1989). Seed-borne diseases and seed health testing of rice. Technical Bull. No.3, Danish government institute of seed Pathology for Developing Countries (DGISP), Copenhagen and CAB International Mycological Institute, (CMI) UK.
2. Agarwal, V.K. (2006). Seed Health. International Book Distributing Company. Charbagh, Lucknow, India.
3. Agarwal, V.K. and Sinclair, J.B. (1987). Principles of Seed-pathology, II edition CRC Lewis Publishers, Boca Raton, New York, London.
4. Agrawal, R.L. (1980). Seed Technology. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.

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5. Agrios, G.N. (2005). Plant Pathology. Academic Press, London., New York
6. Anonymous (1985, 2014). International rules for seed testing. International Seed Testing Association (ISTA). http://www.seedtest.org/en/home.html; http://www.seedtest.org/en/international-rules-_content---1--1083.html
7. Cliffton, A. (1958). Introduction to the Bacteria. McGraw Hill Book Co., New York.
8. Khare, D. and Bhale, M.S. (2014). Seed Technology. Scientific Publishers (India),Jodhpur. Revised 2nd Ed.
9. Mandahar, C.L. (1978). Introduction to plant viruses. S. Chand & Co. Ltd., Delhi.
10. Mathur, S.B. and Cunfer, B.M. (1993). Seed-borne diseases and Seed health Testing of Wheat. Danish Government Institute of Seed Pathology for Developing Countries. Hellerup, Denmark.
11. Neergaard, P. (1977). Seed Pathology. Vol. I & II. The Mac Millan Press Ltd., London.
12. Rangaswamy, G. & Mahadevan, A. (1999). Diseases of crop plants in India (4th edition). Prentice Hill of India, Pvt. New Delhi.
13. Richardson, M. J. (1990). An annotated list of seed borne diseases 4th edn. Proc. Int Seed Test Assoc. Zurich, Switzerland.
14. Schaad, N. W. (1980). Laboratory guide for identification of plant pathogenic bacteria (edt.). Bacteriology Committee of American Phytopathological Society, St. Paul, Minnesota.
15. Schaad, N. W. (1988). Laboratory guide for identification of plant pathogenic bacteria (2nd eds.). APS Press (The American Phytopathological Society), St. Paul, Minnesota.
16. Singh, D. and Mathur, S. B. (2004). Histopathology of seed-borne infections. CRC Press, Boca Raton, London, New York, Washington DC.pp 296.
17. Singh, K.G. and Manalo, P.L. (1986). Plant Quarantine and Phytosanitary Barriers inthe Asean. Asean Plant Quarantine Centre and Training Institute, Malays

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M.Sc. BOTANY (SESSION 2024-26)

SECOND- SEMESTER

Curriculum Structure									
Session 2024-2025 onwards									
Name of Programme: M.Sc. Botany									
Year: First						Semester: II			
S. No.	SUBJECT CODE	Course Title	Credit	Contact hours per week			Weightage (%)		
				L	T	P	CWS	MTE	ETE
Discipline Specific Core (DSC):									
1.	PGBOT201	Genetics	4	4	0	0	10	20	70
2.	PGBOT202	Pteridophytes, Gymnosperm & Paleobotany	4	4	0	0	10	20	70
3.	PGBOT203	Research Methodology	4	4	0	0	10	20	70
4.	PGBOT204	General Practical Lab. (Based on PGBOT201, PGBOT202 & PGBOT203)	6	0	0	12	45	-	105
Discipline Specific Elective (DSE):									
5.	PGBOT205	Bioinformatics & Biostatistics	4	4	0	0	10	20	70
OR									
6.	PGBOT206	Principles Of Plant Breeding	4	4	0	0	10	20	70
7.	PGBOT207	Elective Practical Lab (PGBOT205 or PGBOT206)	2	0	0	4	15	-	35
Value Added Course (VAC):									
8.			2	0	0	2	05	10	35

Summary: II Semester		
S. No.	Particulars	Credits
1.	Discipline Specific Core (DSC)	18
2.	Discipline Specific Elective (DSE)	06
3.	Value Added Course (VAC)	02
4.	Seminar/ Internship/Dissertation (SEM/INT/DIS)	--
	Total	26
CWS (Class work): It would include attendance, assignments, class test/quiz test, ppt, play, learn by fun activities etc.		

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PGBOT201- GENETICS

Credits:4

Objectives of the Course

- This course is designed to provide the advance theoretical as well as practical knowledge of Genetics.

Course Learning Outcomes

After completion of this course, students will be able to

- To develop conceptual understanding of chromosomes, law of inheritance, genetic basis ofloci, alleles and their linkage.
- Comprehend the effect of chromosomal abnormalities in numerical as well as structural changes leading to genetic disorders and study of chromosomal basis of inheritance.
- Develop conceptual understanding of Mutation.
- Learning the practical methods of genetics.

Unit -I

15Hrs

- **Inheritance and allelism**: Chromosome theory of inheritance; Mendelian laws; Organelle inheritance: mitochondrial, chloroplast genome: Evolution, structure and organization.
- **Cytogenetics:** Chromosome: Structure and nomenclature, centromere and telomere; Sex determination: mechanisms, sex chromosomes.

Unit -II

15Hrs

- **Chromosomal aberrations:** Duplications, deficiencies/deletions, inversions, interchanges/translocations; Role of chromosomal aberrations in crop evolution; Ploidy changes: Haploids, polyploids and aneuploids.
- **Gene:** Fine structure of gene, concept, cis-trans test. Gene interactions: complementary, supplementary, epistasis, duplicate genes.

Unit -III

15Hrs

- **Mutation and mutagenesis**: Spontaneous and induced mutations, physical and chemical mutagens, types of mutations; Molecular basis of mutations; Transposons and their use in mutagenesis and site directed mutagenesis; Behavioral genetics; Population genetics and Quantitative genetics.

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Unit -IV

15Hrs

- **Chromosome mapping:** Linkage and crossing over: basic concepts, linkage maps, correlation of genetic and physical maps, molecular markers and construction of linkage maps; Molecular mechanism of recombination.
- **Molecular Cytogenetics:** C value paradox, cot curve and its significance, multigene families and their evolution, in situ hybridization- concept and technique, flow cytometry.

Suggested Laboratory Exercises:

- Problems related to linkage, crossing over and gene interaction
- Problems related to gene mapping
- Construction of restriction map
- Linear differentiation in Chromosome through banding technique
- Isolation of chlorophyll mutants following irradiation and treatment with chemicalmutagen
- Quantitative estimation of DNA by diphenyamine method
- Karyotype analysis
- Induction of polyploidy
- To study the application of colchicines treatment.
- Selfing and crossing technique
- Demonstration of flow cytometery and confocal microscopy
- Presentation of chart and models related to syllabus
- Any other exercise based on theory syllabus

Suggested Reading:

1. Benjamin Lewin (2000). Genes VII. Oxford university press.
2. Gardner E J, Simmons M J, Snustad D P (1991). Principles of Genetics (III Edn). John Wiley and Sons Inc.
3. Snustad D P, Simmons M J (2000). Principles of Genetics (III Edn). John Wiley andSons.
4. Strickberger (2005). Genetics (III Edn). Prentice Hall of India Pvt. Ltd.
5. William S Klug, Michael R Cummings (1994). Concepts of Genetics. Prentice Hall.
6. Robert J Brooker (2009). Genetics: Analysis and principles (III Edn). McGraw Hill.
7. Daniel L Hartl, Elizabeth W Jones (2009). Genetics: Analysis of genes and genomes (VII Edn). Jones and Bartlett publishers.
8. D Peter Snustad, Michael J Simmons (2010). Principles of genetics (V Edn). JohnWiley and Sons.

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9. Acquaah G (2007). Principles of Plant Genetics and Breeding, Blackwell Publishing Ltd. USA.
10. Hartl DL and Jones EW (2007). Genetics – Analysis of Genes and Genomes, 7th edition, Jones and Barlett publishers.
11. Hartwell LH, Hood L, Goldberg ML, Reynolds AE, Silver LM, Veres RC (2006). Genetics – From Genes to Genomes, 3rd edition, McGraw Hill.
12. Lewin B (2008). Genes IX, Jones and Barlett Publishers.
13. Singh RJ (2002). Plant Cytogenetics, 2nd edition, CRC Press.
14. Strickberger MW (2008). Genetics, 3rd Edition, Pearson (Prentice Hall).
15. Weising K, Nybom H, Wolff K and Kahl G (2005) DNA Fingerprinting in Plants

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PGBOT202- PTERIDOPHYTA, GYMNOSPERMS AND PALEOBOTANY

Credits:4

Objectives of the Course

- This course is designed to provide fundamental and advance knowledge about the Pteridophytes, Gymnosperms and Palaeobotany.

Course Learning Outcomes

After completion of this course, students will be able to

- Understand about the evolution of stellar system and heterospory.
- Gain knowledge about the general character and classification of pteridophytes.
- Understand about the general character of gymnosperms.
- Learn about evolutionary relationship of Cycadopsida, Coniferopsida, Gnetopsida, Coniferales etc.
- Understand about the basic principle of paleobotany and know about prominent scientist.

Unit -I

15Hrs

- **Pteridophytes:** Distribution, classification by International Committee of Botanical Nomenclature (ICBN), Economic importance of Pteridophytes.
- General account of fossil Pteridophytes, Psilopsida, Lycopsida, Sphenopsida and Pteropsida classes.
- Morphology, anatomy, reproduction, classification, life history of: *Tmesipteris, Lycopodium, Gleichenia, Isoetes, Ophioglossum* and *Azolla.*

Unit -II

15Hrs

- **Gymnosperms:** Distribution, morphology, anatomy, reproduction; classification, life history and evolution. Cycadales (*Zamia*), Ginkgoales (*Ginkgo*), Coniferales (*Pinus, Taxus, Araucaria* and *Biota*), Welwitschiales (*Welwitschia*), Gnetales (*Gnetum*).

Unit -III

15Hrs

- **Paleobotany:** History of paleobotany, formation and types of fossils, techniques of study of fossils, Geological time scale. Brief account of Pteridospermales (*Lygenopteris, Medullosa, Caytonia* and *Glossopteris*).

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Unit -IV

15Hrs

- Brief account of Cycadeoidales (Cycadeoidea), Cordaitales (Cordaites).
- Paloeobotany and the evolution of vascular plants.
- Origin and evolution of stele, heterospory and seed habit.
- Applied aspects of paleobotany, use in coal and petroleum exploration.

Suggested Laboratory Exercises:

- Morphological and anatomical study of representative members of Pteridophytes and Gymnosperms in their natural habitat found in your locality with special reference to, *Lycopodium, Isoetes, Gleichenia, Ophioglossum* and *Azolla* in Pteridophytes.
- *Zamia, Ginkgo, Pinus, Taxus, Araucaria, Biota* and *Gnetum* in Gymnosperms. Collection and study of fossils.

Suggested Readings:

1. Parihar, N.S. 1996. Biology & Morphology of Pteridophytes. Central Book Depot, Allahabad.
2. Sporne, K.K. 1991. The Morphology of Pteridophytes.B.I. Publishing Pvt. Ltd.,Bombay.
3. Stewart, W.N. and Rathwell, G.W. 1993. Paleobotany and the Evolution of Plants.Cambridge University Press, UK.
4. Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperms. New Age International Pvt. Ltd., New Delhi.
5. Singh, H. 1978, Embryology of Gymnosperms, Encyclopaedia of Plant Anatomy X.Gebruder Bortraeger, Berlin, Germany.
6. Smith, G.M. 1955. Cryptogamic Botany Vol II Tata McGraw Hill Book Co, NY.
7. Pandey, B.P.1993. College Botany. Vol. II. S. Chand and Company Ltd., New Delhi.
8. Arnold, Chester, A. 2000. An Introduction to Paleobotany. Agrobios, (India).
9. Rashid.A.2001.An introduction to Pteridophyta(II edition). Vikas publishing house, Pvt. Ltd., New Delhi.
10. Sunderrajan,S (2007), Introduction to Pteridophyta, New Age International Publishers, New Delhi.

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PGBOT203: RESEARCH METHODOLOGY

Credits;4

Objectives of the Course

- A basic understanding of how to pursue research.
- A basic understanding of how to learn mathematics.
- A basic understanding of set theory.
- A basic understanding of the software that supports the mathematical research.

. Course Learning Outcomes

After completion of this course, students will be able to

- Understand mathematics more efficiently and clearly.
- Understand how to write a basic mathematics article.
- Make students analyze a given fact or concept and how to reach a concept.
- Make students curious enough to read the most recent trends in mathematics.
- Understand the basic ideas of how to write an algorithm and related ideas. Understand the effective use of open-source software to write mathematical articles.

Unit -I

15Hrs

- **Nature of Scientific Inquiry**- Scientific Methods- Induction, Deduction Hypothesis and Theory and their Interpretation, Nature and Scope of Social Research for Multi-Disciplinary Inter-Disciplinary Approach in Commerce. Planning of Research-Selection of a Problem for Research-Sample, Design-Census and Sample Surveys- Sampling Techniques, Sample size.

Unit -II

15Hrs

- **Research Design-** Important Aspects of Research Design. Methods of Data Collection- Sources of data Use of secondary data- Methods of collecting primary data- Observation- Interviews- Questionnaires and Schedules.

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Unit -III

15Hrs

- **Processing and Analysis of Data:** Processing Operations- Types of Analysis- Presentation and Interpretation of Data-Editing, Classification and Tabulation, Interpretation.
- **Preparation of a Report-** Types of Report- Research Report- Format- Principles of Writing Reports- Documentation- Footnotes and Bibliography

Unit -IV

15Hrs

- **Quantitative Tools-** Measures of Central Tendency- Dispersion- Measures of Correlation- Simple and Multiple Correlation-testing of Hypothesis-Tests based on t-P, Z, and Chi square, Time Series Analysis, Trend Measurement, Moving Averages.

Suggested Laboratory Exercises:

- Experiments based on chemical calculations.
- Experiments based on quantitative tools.
- Hands on training in Computer application
- The art of imaging of samples through microphotography and field photography.
- Poster presentation on defined topics.
- Technical writing on topics assigned.

Suggested Reading:

1. Srivastava, S.C. (1990) Foundation of Social Research and Economics Techniques, Himalaya Publishing House.
2. Sharma H.D. and Mukherji S.P. (1992) Research Methods in Economics and Business, New York: The Macmillan Company.
3. Gerber R. and Verdoom, P.J. (1992) Research Methods in Economics and Business, New York, The Macmillan Company.
4. Krishna swami O.R. (1993) Methodology of Research in Social Sciences, Himalaya Publishing House.
5. Menden HYall and Varacity: Reinmuth J.E. (1982) Statistics for Management and Economics (2nd Edition).
6. Courtis J.K.(ed.) (1980) Research and Methodology in Accounting & Financial Management.

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PGBOT205: DSE: BIOINFORMATICS & BIOSTATISTICS

Credits:4

Objectives of the Course

- This course is designed to provide the advance theoretical knowledge about the Bioinformatics Biostatistics.

Course Learning Outcomes

After completion of this course, students will be able to

- Understand the basic principle of Bioinformatics & Biostatistics.
- Explore various bioinformatics database.
- Understand the applications of bioinformatics.
- Develop the knowledge about fundamentals of statistics, central tendency and dispersion.
- Learn the application of correlation, regression and analysis of variance.

Unit -I

15Hrs

- **Concepts of Bioinformatics**: Introduction and future prospects; Applications in genomics and proteomics; Public databases; Gene bank; Database searches: sequence retrieval systems; Similarity searching: BLAST, FASTA; Multiple sequence alignment: CLUSTALW; Detecting functional sites in DNA; Motif and domain prediction and analysis; Identification of open reading frames (ORF); Gene annotation technology.
- **Databases and online tools**: Biological Databases: - Types and applications; Sequence databases: - Gene Bank, EMBL, DDBJ, PIR-PSD, SWISS-PROT; Structure Databases: - PDB, SCOP, NDB; Derived Databases: - PROSITE, PRINTS, TIGR, Online tools: - Gene tool; STRING; I-TASSER; Bioedit; BioGRID; MEGA; Sequin, Bankit.

Unit -II

15Hrs

- **Applications of Bioinformatics**: Computational methods for sequence analysis: Dot blot and dynamic programming methods; Phylogenetic analysis; Virtual and electronic cell; Internet tools for DNA sequence translation; Restriction enzyme mapping; Prediction of secondary structure of proteins; Application tools- primer designing, molecular mapping and concept and tools of computer aided drug designing.

Unit -III

15Hrs

- **Fundamentals of statistics**: Arithmetic mean, median, mode: theory and simple numerical

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problem; Measures of variation: standard deviation, variance, coefficient of variation; Correlation, types and methods: simple, multiple, linear and nonlinear correlation, spearman's correlation, rank correlation; Regression: linear and curvilinear regression (for two variable X and Y only), Regression lines by least square method; regression equations of X on Y and Y on X only; Sample size; Power of study.

Unit -IV

15Hrs

- **Tests of significance**: Null hypothesis; Standard error; Level of significance; Degrees of freedom; Significance of mean for large samples; Significance in means for small samples (students t-test); Significance in ratio of two samples; F test (for difference between variance of two samples); Chi square test; Analysis of variance test (ANOVA) for one- and two-way classification; Calculation of an unknown variable using regression equation.
- Laws of probability, theorem of total probability

Suggested Laboratory Exercises:

- Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB etc.
- Sequence retrieval using BLAST
- Sequence alignment
- Phylogenetic analysis using clustalW
- Protein structure prediction
- Picking out a given gene from genomes using Genscan or other software (promoter region identification, repeat in genome, ORF prediction).
- Prediction of different features of a functional gene
- Determination of Statistical averages/ central tendencies
  a) Arithmetic mean b) Median c) Mode
- Determination of measures of Dispersion
  a) Mean deviation b) Standard deviationand coefficient of variation c) Quartile deviation
- Tests of Significance-Application of following
  a) Chi- Square test b) t- test c)Standard error
- To learn graphical representations of statistical data with the help of computers (e.g. MS Excel).

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Suggested Readings:

1. Introduction to Bioinformatics, Arthur M. Lesk, Oxford University Press.
2. Introduction to Bioinformatics, Attwood, Pearson Education.
3. A Textbook of Systems Biology, E. Klipp, W. Liebermeister, C. Wierling, Axel Kowald, H. Lehrach, R. Herwig (2009), Wiley-VCH Verlag GmbH & Co.
4. Bioinformatics: Sequence and Genome Analysis, David W. Mount (2001), Cold Spring Harbor

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(CSH) Laboratory Press.
5. Plant System Biology, Coruzzi, G.M. (2009), Wiley Publishing House.
6. Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins. 2nd Edition by Baxevanis.
7. Bioinformatics: Sequence, structure and Data Bank: A Practical Approach by Higgis.
8. Bioinformatics - from Genomes to drug. 2 volumes by Lenganer.
9. Bioinformatic Methods and Protocols - Misener.
10. Bioinformatics: Sequence and Genome analysis.
11. . Introduction to Bioinformatics by Altwood.
12. Proteome Research: New Frontiers in Functional Genomics: Principles and Practices.
13. Genomics: The Science and Technology behind the human project.
14. Protein Biotechnology. Edited by Felix Franks. Humana Press, Totowa, New Jarsey.
15. Practical Statistics for experimental biologist by Wardlaw, A.C. (1985).
16. Statistical Methods in Biology - 2000 by Bailey, N.T. J. English Univ. Press.
17. Biostatistics - 7th Edition by Daniel 8. Fundamental of Biostatistics by Khan
18. Statisticsfor Biologist by CampbellR.C. (1974) Cambridge University Press
19. Introduction to Biostatistics, Le and Chap (2009), Wilay and Sons.
20. Fundamentals of Biostatistics, B. Rosner (2005), Duxbury Press.
21. Medical Statistics from Scratch, Bowers (2008), Wiley and Sons.

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PGBOT206: DSE: PRINCIPLES OF PLANT BREEDING

Credits:4

Objectives of the Course

- This course is designed to provide the advance theoretical knowledge of principles of plant breeding.

Course Learning Outcomes

After completion of this course, students will be able to

- To develop conceptual understanding of plant breeding.
- Develop conceptual understanding of plant genetic resources, plant breeding, gene bank and gene pool.
- Learning the methods of crop improvement through plant breeding
- Leaning the practical methods of plant breeding.

Unit -I

15Hrs

- **Overview & Historical perspectives:** History of Plant Breeding-the pioneers, their theories and plant breeding techniques.
- **Population and quantitative Genetic principles:** Concept of Population, gene pool, gene frequency and inbreeding and its implications in breeding, Qualitative genetics versus Quantitative genetics, the concept of Population Improvement.
- **Reproductive systems:** Importance of Mode of Reproduction, Types of Reproduction, Autogamy, Haploids and double haploids: their application in plant breeding, Allogamy, Inbreeding depression, hybrid vigour, Hybridization, wide crosses, clonal propagation and *In vitro* culture.

Unit -II

15Hrs

- **Germplasm for Breeding:** Variation-Types, origin and scale, Plant Domestication- Centres & Models, Plant Genetic Resources-Importance & Sources of Germplasm, Concept of Gene pools, Crop vulnerability, Germplasm conservation: *In situ*& *Ex situ,* Types of Germplasm collection, Germplasm storage technologies, Plant explorations & Introductions & their impact on agriculture.

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Unit -III

15Hrs

- **Breeding Objectives:** Yield and morphological trait- Yield potential, Harvest Index, breeding for lodging resistance, shattering resistance, plant stature & early maturity; Quality traits-breeding for improved protein content, improved fatty acid content, seedlessness in fruits,

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delayed ripening & novel traits, Breeding for resistance to disease & insect pests – Resistance Breeding strategies; Abiotic Stresses –Breeding for drought resistance, cold tolerance, salt tolerance, heat stress, aluminium toxicity, oxidative stress, resistance to water logging.

Unit -IV

15Hrs

- **Selection Methods:** Breeding -self-pollinated species- Mass selection, pure line selection, Pedigree selection & Bulk population; cross pollinated species -hybrid cultivars and clonally propagated species.
- **Molecular Breeding:** Molecular markers- classification, Mapping of Genes- gene maps & QTL mapping, Marker assisted selection, Mutagenesis and Polyploidy in Plant Breeding
- **Marketing and Societal issues in Breeding:** Performance and Evaluation for crop cultivar release, Seed certification and commercial seed release, Regulatory and Legal issues, Value driven concepts and social concerns, International Plant breeding Efforts. Plant cultivar protection, legislation, patenting and transgenics.

Suggested Laboratory Exercises:

- Vegetative propagation methods of important crops of the locality.
- Emasculation, selfing and crossing techniques.
- Floral biology in self pollinated species.
- Floral biology in cross pollinated species.
- Floral biology in self pollinated species.
- Selection methods in segregating populations and evaluation of breeding material.
- Germplasm conservation methods- In situ & Ex situ methods.
- Haploid production.
- In situ & ex situ conservation methods
- Analysis of variance (ANOVA).
- Maintenance of experimental records
- Field inspection at different growth stages to study various breeding objectives.

Suggested Readings:

1. George Acquaah, (2012) Principles of Plant Genetics and Breeding.Wiley-Blackwell.
2. B.D.Singh and A.K.Singh, (2015).Marker Assisted Plant Breeding, Springer.
3. B.D.Singh, (2015). Plant Breeding principles & Methods, Kalyani Publishers.
4. Jack Brown, Peter Caligari and Hugo campos, (2014). An Introduction to Plant Breeding, Wiley.
5. Brown and Caligari, (2008). An Introduction to Plant Breeding, Blackwell Publishing.
6. Chopra VL. (2001). Breeding Field Crops. Oxford & IBH.
7. Chopra VL. (2004). Plant Breeding. Oxford & IBH.
8. Gupta SK. (2005). Practical Plant Breeding. Agribios. Jodhpur.
9. Roy D. (2003). Plant Breeding, Analysis and Exploitation of Variation. Narosa Publ.House.
10. Sharma JR. (2001). Principles and Practice of Plant Breeding. Tata McGraw-Hill.

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11. Simmonds NW. (1990). Principles of Crop Improvement. English Language BookSociety.
12. Dana, Sukumar. (2001). Plant Breeding. Naya Udyog, Colcutta. 700 006.
13. Kucku, Kobabe and Wenzel, (1995). Fundamentals of Plant Breeding. Narosa Publishing House.
14. Singh BD. (2006). Plant Breeding. Kalyani.
15. Singh P. (2002). Objective Genetics and Plant Breeding. Kalyani.
16. Singh P. (2006). Essentials of Plant Breeding. Kalyani.
17. Singh S & Pawar IS. (2006). Genetic Bases and Methods of Plant Breeding. CBS.
18. Stoskopf, N C, Tomes, D T and Christie, (1993). Plant breeding: theory and Practice. Scientific Publishers (India) Jodhpur.

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