BANKURA UNIVERSITY

(West Bengal Act XIX of 2013- Bankura University Act, 2013)

Main Campus, Bankura Block-II, P.O.: Purandarpur, Dist.: Bankura, Pin- 722155, West Bengal

Office of the Secretary

Faculty Council for Undergraduate Studies

BKU/FCUG/203/2023 Date: 12/07/2023

NOTIFICATION

As directed, the undersigned is pleased to inform all concerned that Bankura University has initiated the process to implement New Curriculum and Credit Framework for Undergraduate Programme, UGC 2022 (as per NEP 2020) for 4-years Undergraduate programme with Botany as Major, Minor etc. from the academic session 2023-2024. The Syllabus for the purpose will be framed and finalized as per the guidelines of appropriate authority. As an important corollary to the process, the workshop through online mode will be organized on the date mentioned herewith to get the feedback from the stakeholders. Present Students, Alumni, Guardians, Academicians and other stakeholders related to the specific programme/course are requested for their kind participation in the workshop and to present their views/ observations etc. The stakeholders may go through the draft syllabus attached herewith and convey their observations to the office of the undersigned on ugsecretaryoffice@bankurauniv.ac.in within seven days from the date of publication of notice.

Date: 14th July, 2023.

Time: 8 PM onwards

Google Meet joining info

Video call link: https://meet.google.com/adn-qmvh-xtu

Sd/-
Dr. Arindam Chakraborty
Secretary
Faculty Council for Undergraduate Studies

NEP SYLLABUS

FOR

FOUR YEARS UNDER-GRADUATE COURSE

IN

BOTANY

(*w.e.f. 2023-2024*)

BANKURA UNIVERSITY

BANKURA

WEST BENGAL

PIN 722155

CONTENTS

1. Introduction

In the present context of NEP-2020 and formulation of a new student-centric "Curriculum and Credit Framework for Undergraduate Programmes (CCFUD)", the syllabus for Botany has been framed following the UGC guidelines facilitating students to pursue their career path by choosing the subject.

Incorporation of flexible choice based credit system, multidisciplinary approach and multiple entry and exit options with a focus on the chosen major and minors as per the choices of the students has properly been made in accordance with our own infrastructure, expertise and strength.

A holistic understanding of the subject giving a substantial weightage to core courses in the major disciplines and broader understanding beyond the major disciplines, is the main objective of framing of this new syllabus.

Adequate emphasis has also been rendered on new techniques and understanding the subject in tune with the changing nature of the subject. Moreover teaching of basic skills of the subject to the students has not been ignored while framing the syllabus with this spirit that students will get the scope of securing a job & self employment opportunities after graduation, as everyone might not need to go for higher studies.

Some new topics in the fields of Discipline Specific Elective courses, Skill Enhancement course and multidisciplinary courses have been included in the syllabus for the benefit of students from both theoretical and practical points of view.

These are Research Methodology, Industrial and Environmental Microbiology, Bioinformatics, Agronomy, Stress Biology, Natural Resource Management, Analytical techniques in plant sciences, Medicinal Botany, etc.

1.1. Learning Outcome (LO)

LO	Summary	Description
LO 1	Sound Domain Knowledge	Students can acquire a strong, basic knowledge on origin, evolution and diversification in the basic and applied fields of Botany. They can develop relationship with the environments including their economic values.
LO 2	Laboratory Skill	The syllabus has the aim to develop good laboratory skills with latest advanced tools, sophisticated instruments and modern technologies to address emerging problems with scientific viewpoint.
LO 3	Overall Skill	Students will able to think logically and scientifically into structural outline, gather appropriate knowledge and skill for future career, planning and conducting independent project proposal and make appropriate report on it.

LO 4	Team Work	The syllabus will enhance the development of the spirit of team work; learn to harbor collaborative approach to explore new facts and facets of the subject.
LO 5	Academic and Scientific Endeavour	Students will gain cognitive development, innovative approach, technical maneuvering, entrepreneurship and managerial skills to set up a new start-up.
LO 6	Eco-friendly Approach	The course has a futuristic approach to develop eco-friendly management practices to make socio-economic upliftment.
LO 7	Ethical Awareness	Development of ethical awareness among students regarding research & publications is another outcome of the proposes course.
LO 8	Goal of life	The syllabus will help to inculcate visions in students so that they can play a vital role for the advancement of the discipline in the greater benefits of the society.

2. Scheme for NEP Curriculum

2.1. Credit Distribution across Courses

Course Type		Total Papers	Credits (Theory + Practical)
Major Stream	**Discipline Specific Core (DSC)**	14	14×4= **56**
	Discipline Specific Elective (DSE)	10 (UG Hons.) 7+ 1 Research Project/Dissertation (UG Hons, with Research)	10×4= **40** (UG Hons.) (7×4) + (1×12) = **40** (UG Hons. with Research)
Minor Stream		8	8×4= **32**
Multidisciplinary Courses		3	3×3= **9**
Ability Enhancement Courses (AEC)		4	4×2= **8**
Skill Enhancement Courses (SEC)		3	3×3= **9**
Value Aided Courses (VAC)		2	2×4= **8**
Summer Internship* (Mandatory for Semester-V)		1	1×2= **2**
Totals	**UG Hons.)**	**44 + 1 Summer Internship**	**164**
	UG Hons. with Research	**41+1 Summer Internship+ 1 Research Project/Dissertation**	

*Additional Summer Internship of 4 credit is mandatory for certificate and diploma courses.

2.2. Scheme for NEP based Curriculum in Botany

SEMESTER- I

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
S/BOT/101/MJC-1	Archegoniate & Palaeobotany (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/102/MN-1	Archegoniate & Palaeobotany (Theory & Practical) (For students of other discipline)	4 (T+P)	10	40 (T25+P15)	50	3	N.A	2
S/BOT/103/MD-1	Mushroom Culture Technology (For students of other discipline)	3 (T)	10	40	50	3	N.A.	N.A.
S/BOT/104/SEC-1	Mushroom Culture Technology	3 (T)	10	40	50	3	N.A.	N.A.
ACS/105/AEC-1	Communicative English	2	10	40	50	2	N.A	N.A
ACS/106/VAC-1	Environmental Studies	4	10	40	50	4	N.A	N.A
Total in Semester - I		**20**	**60**	**240**	**300**			

SEMESTER- II

Course Code	Course Title	Credit	Marks			No. of Hours/Week		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
S/BOT/201/MJC-2	Mycology & Phytopathology (Theory & Practical)	4 (T+P)	10	40 (T25+P15)	50	3	N.A.	2
S/BOT/202/MN-2	Mycology & Phytopathology (Theory & Practical) (For students of other discipline)	4 (T+P)	10	40 (T25+P15)	50	3	N.A	2
S/BOT/203/MD-2	Biofertilizers (For students of other discipline)	3 (T)	10	40	50	3	N.A.	N.A.
S/BOT/204/SEC-2	Biofertilizers	3 (T)	10	40	50	3	N.A.	N.A.
ACS/205/AEC-2	MIL (Santali/Bengali/Sanskrit)	2	10	40	50	2	N.A	N.A
ACS/206/VAC-2	Understanding India/ Health and wellness	4	10	40	50	4	N.A	N.A
Total in Semester - II		**20**	**60**	**240**	**300**			

2.3. Choices for DSC Major/Minor

SEMESTER	COURSE	CHOICE
SEM-I	MJC-1/ MN-1	Archegoniate and Palaeobotany
SEM-II	MJC-2/ MN-2	Mycology and Phytopathology

2.4. Choices for Discipline Specific Electives (DSE)

SEMESTER	COURSE	CHOICE
SEM-I	NA	NA
SEM-II	NA	NA

2.5. Choices for Multidisciplinary Courses

SEMESTER	COURSE	CHOICE
SEM-I	MD-1	Mushroom Culture Technology
SEM-II	MD-2	Biofertilizers

2.6. Choices for Skill Enhancement Courses

SEMESTER	COURSE	CHOICE
SEM-I	SEC-1	Mushroom Culture Technology
SEM-II	SEC-2	Biofertilizers

2.7. Question Pattern

Major Stream (DSC & DSE) and Minor Stream papers

Theory (F.M: 25)	Practical (F.M: 15)
UNIT-I 1. Any five out of eight **1×5= 5**	1. Work out/Demonstration/Experiment and/or Identification: **10/9** 2. Laboratory Record and/or Field record: **2/3** 3. Viva Voce: **3**
UNIT-II 2. Any two out of four **5×2= 10**	
UNIT-III 3. Any one out of two **10×1= 10**	

Multidisciplinary and SEC papers

Theory (F.M: 40)
UNIT-I 1. Any five out of eight **2×5= 10**
UNIT-II 2. Any four out of six **5×4= 20**
UNIT-III 3. Any one out of two **10×1= 10**

3. Major Stream:

Discipline Specific Core (DSC) Courses

Semester- I

3.1. Major DSC 1: Archegoniate and Palaeobotany

Course Code: S/BOT/101/MJC-1

Credit: 4

Theory

(Lectures 50/ Marks 25)

Course Learning Outcomes:

- Understanding of archegoniatae- Bryophytes, Pteridophytes and Gymnosperms.
- Understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms.
- Understanding of plant evolution and their transition to land habitat.
- Demonstration of proficiency in the experimental techniques and methods of appropriate analysis of Bryophytes, Pteridophytes, Gymnosperms.
- Understanding of plant evolution through time.

Unit 1: Introduction (4 lectures)
Unifying features of archegoniates; Alternation of generations and concept of sporophyte and gametophyte.

Unit 2: Bryophytes (6 lectures)
General characteristics; Economic Importance.

Unit 3: Type Studies- Bryophytes (12 lectures)
Classification (Proskauer-1957), morphology, anatomy and reproduction of *Marchantia, Anthoceros and Funaria* (developmental stages not included); Evolutionary trends among the genus (developmental stages not included).

Unit 4: Pteridophytes (6 lectures)
General characteristics; Classification; Early land plants (*Cooksonia* and *Rhynia*; Vegetative and reproductive organography of *Lepidodendron* and *Calamites*).

Unit 5: Type Studies- Pteridophytes (14 lectures)
Classification (Outline of Pichi Sermolli, 1977), Morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris* (Developmental details not to be included). Apogamy and apospory, heterospory, Ecological and economic importance.

Unit 6: Gymnosperms (14 lectures)
General characteristics, classification- Stewart & Rothwell (1993), morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum* (Developmental details not to be included); Ecological and economic importance, General account of Progymnospermopsida, *Glossopteris* plant, *Lyginopteris* plant and *Williamsonia* plant.

Unit 7: Palaeobotany (4 Lectures)

Fossils-Definition, Types of Fossils, Importance of fossils, Fossilization Processes, Geological Time-Scale and Megafloral succession.

Practical

(Marks 15)

1. ***Marchantia***- Vertical section of thallus through gemma cup, whole mount of gemmae; Vertical section of antheridiophore, archegoniophore; Longitudinal section of sporophyte.

2. ***Anthoceros***- Vertical section of thallus; T.S. and L.S. of sporophyte.

3. ***Funaria***- Antheridial and archegonial heads from permanent slides; Longitudinal section of capsule.

4. ***Selaginella***- Transverse section of stem; Longitudinal section of strobilus.

5. ***Equisetum***- Morphology, transverse section of internode; Longitudinal section of strobilus, transverse section of strobilus.

6. ***Pteris***- Morphology; Transverse section of rachis; Vertical section of sporophyll; Whole mount of sporangium; Whole mount of spores.

7. ***Cycas***- Whole mount of microsporophyll; Transverse section of rachis; Vertical section of leaflet; Whole mount of spores; Longitudinal section of ovule (from permanent slides).

8. ***Pinus***- Transverse section of Needle; Transverse section of stem; Longitudinal section of/ transverse section of male cone (from permanent slides).

9. **Identification**-Petrified fossil (*Calamites* and *Lyginopteris*), Impression fossil (*Glossopteris*).

10. Botanical excursions are to be organized in botanically rich area, field report and photographic documents of plant specimens to be submitted during practical examination (No need to submit any living, preserved or herbarium specimen).

Suggested Readings

1. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.
2. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
3. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.
4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
5. Vanderpoorten, A. & Goffinet, B. (2009). Introduction to Bryophytes. Cambridge University Press.
6. Stewart W.N., Rothwell, G.W. (2005). Paleobotany and the Evolution of Plants, 2nd Edition, Cambridge University Press (USA).

Semester-II

3.2. Major DSC 2: Mycology and Phytopathology

Course Code: S/BOT/201/MJC-2

Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcomes:

- Developing the knowledge on fungi and basic concept on common plant diseases.
- Practice of skill development in laboratory and field work related to mycology and plant pathology.
- Understanding the knowledge of allied groups of fungi and lichens and the approach of their utilizations in applied fields.

Unit 1: Introduction to fungi (4 lectures)

General characteristics; Thallus organization; Cell wall composition and cell organization; Nutrition; Classification (Ainsworth, 1973).

Unit 2: Chytridiomycota and Zygomycota (5 lectures)

Characteristic features; Ecology and significance; Thallus organization; Reproduction; Life cyclewith reference to *Synchytrium, Rhizopus.*

Unit 3: Oomycota (4 lectures)

General characteristics; Ecology; Life cycle and classification with reference to *Phytophthora, Albugo.*

Unit 4: Ascomycota (10 lectures)

General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle; Heterokaryosis; Life cycle and classification with reference to *Saccharomyces, Ascobolus.*

Unit 5: Basidiomycota (8 lectures)

General characteristics; Reproduction; Ecology; Life cycle of *Lycoperdon* and *Agaricus*; fairy rings.

Unit 6: Deuteromycota (3 lectures)

General accounts, conidial morphology, parasexual cycle; Study of *Alternaria* and *Fusarium.*

Unit 7: Allied Fungi (2 lectures)

General characteristics; Status of slime molds, occurrence, types of plasmodia, types of fruiting bodies.

Unit 8: Symbiotic associations (4 lectures)

Lichen – occurrence, general characteristics, forms and range of thallus organization, Nature of associations of algal and fungal partners, reproduction, importance; Mycorrhiza-ectomycorrhiza, endomycorrhiza and their significance.

Unit 9: Applied Mycology (10 Lectures)

Role of fungi in biotechnology; Application of fungi in food industry (flavour & texture, fermentation, baking, organic acids, enzymes, mycoproteins); Secondary metabolites (pharmaceutical preparations); agriculture (biofertilizers); biological control (mycofungicides, mycoherbicides, mycoinsecticides, myconematicides).

Unit 10: Phytopathology (10 lectures)

Terms and concepts; Koch's postulates; general symptoms; geographical distribution of diseases; Etiology; host-pathogen relationships; disease cycle and environmental relation (disease triangle); bacterial diseases – citrus canker and bacterial blight of rice; Viral diseases – tobacco mosaic disease; Fungal diseases – late blight of potato, black stem rust of wheat, brownspot of rice.

Practical

Mycology

1. ***Rhizopus*:** study of asexual stage from temporary mounts and sexual structures through permanent slides.
2. ***Albugo*:** Study of symptoms of plants infected with *Albugo*; Asexual phase study through section/temporary mounts and sexual structures through permanent slides.
3. ***Ascobolus*:** Sectioning through ascocarp.
4. ***Puccinia*:** Herbarium specimens of black stem rust of wheat and infected barberry leaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.
5. ***Agaricus*:** Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*.

Phytopathology

1. **Phytopathology:** Herbarium specimens of bacterial diseases: Citrus Canker; Viral diseases: TMV, Fungal diseases: Late blight of potato, black stem rust of wheat, brownspot of rice and white rust of crucifers.

Suggested Readings

1. Agrios, G.N. (1997). Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley &Sons (Asia) Singapore. 4th edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press,Cambridge. 3rd edition.
4. Deacon, J.W. (2013). Fungal Biology, 4th edition, John Wiley &Sons Ltd.

5. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan PublishersIndia Ltd.
6. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India
7. H. C. L. Gwynne-Vaugham and B. Barnes (2014). Fungi: Their Structure and Development, Biotech Books.
8. Gopinath Hait. 2016. A Text Book of Mycology, New Central Book Agency (P) Ltd.
9. R. S. Mehrotra and A. Aggarwal. 2010. Plant Pathology (Second Edition), Tata Mc Graw Hill Education Pvt. Ltd.

4. Major Stream:

Discipline Specific Elective (DSE) Courses

5. Minor Stream Courses

Semester- I

5.1. Minor 1: Archegoniate and Palaeobotany

Course Code: S/BOT/102/MN-1

Credit: 4

Theory

(Lectures 50/ Marks 25)

Course Learning Outcomes:

- Understanding of archegoniatae- Bryophytes, Pteridophytes and Gymnosperms.
- Understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms.
- Understanding of plant evolution and their transition to land habitat.
- Demonstration of proficiency in the experimental techniques and methods of appropriate analysis of Bryophytes, Pteridophytes, Gymnosperms.
- Understanding of plant evolution through time.

Unit 1: Introduction (4 lectures)
Unifying features of archegoniates; Alternation of generations and concept of sporophyte and gametophyte.

Unit 2: Bryophytes (6 lectures)
General characteristics; Economic Importance.

Unit 3: Type Studies- Bryophytes (12 lectures)
Classification (Proskauer-1957), morphology, anatomy and reproduction of *Marchantia, Anthoceros and Funaria* (developmental stages not included); Evolutionary trends among the genus (developmental stages not included).

Unit 4: Pteridophytes (6 lectures)
General characteristics; Classification; Early land plants (*Cooksonia* and *Rhynia*; Vegetative and reproductive organography of *Lepidodendron* and *Calamites*).

Unit 5: Type Studies- Pteridophytes (14 lectures)
Classification (Outline of Pichi Sermolli, 1977), Morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris* (Developmental details not to be included). Apogamy and apospory, heterospory, Ecological and economic importance.

Unit 6: Gymnosperms (14 lectures)
General characteristics, classification- Stewart & Rothwell (1993), morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum* (Developmental details not to be included); Ecological and economic importance, General account of Progymnospermopsida, *Glossopteris* plant, *Lyginopteris* plant and *Williamsonia* plant.

Unit 7: Palaeobotany (4 Lectures)

Fossils-Definition, Types of Fossils, Importance of fossils, Fossilization Processes, Geological Time-Scale and Megafloral succession.

Practical

(Marks 15)

1. ***Marchantia***- Vertical section of thallus through gemma cup, whole mount of gemmae; Vertical section of antheridiophore, archegoniophore; Longitudinal section of sporophyte.

2. ***Anthoceros***- Vertical section of thallus; T.S. and L.S. of sporophyte.

3. ***Funaria***- Antheridial and archegonial heads from permanent slides; Longitudinal section of capsule.

4. ***Selaginella***- Transverse section of stem; Longitudinal section of strobilus.

5. ***Equisetum***- Morphology, transverse section of internode; Longitudinal section of strobilus, transverse section of strobilus.

6. ***Pteris***- Morphology; Transverse section of rachis; Vertical section of sporophyll; Whole mount of sporangium; Whole mount of spores.

7. ***Cycas***- Whole mount of microsporophyll; Transverse section of rachis; Vertical section of leaflet; Whole mount of spores; Longitudinal section of ovule (from permanent slides).

8. ***Pinus***- Transverse section of Needle; Transverse section of stem; Longitudinal section of/ transverse section of male cone (from permanent slides).

9. **Identification**-Petrified fossil (*Calamites* and *Lyginopteris*), Impression fossil (*Glossopteris*).

10. Botanical excursions are to be organized in botanically rich area, field report and photographic documents of plant specimens to be submitted during practical examination (No need to submit any living, preserved or herbarium specimen).

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3. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.
4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
5. Vanderpoorten, A. & Goffinet, B. (2009). Introduction to Bryophytes. Cambridge University Press.
6. Stewart W.N., Rothwell, G.W. (2005). Paleobotany and the Evolution of Plants, 2nd Edition, Cambridge University Press (USA).

Semester-II

5.2. Minor 2: Mycology and Phytopathology

Course Code: S/BOT/202/MN-2

Credit: 4

Theory

(Lectures 50/Marks 25)

Course Learning Outcomes:

- Developing the knowledge on fungi and basic concept on common plant diseases.
- Practice of skill development in laboratory and field work related to mycology and plant pathology.
- Understanding the knowledge of allied groups of fungi and lichens and the approach of their utilizations in applied fields.

Unit 1: Introduction to fungi (4 lectures)

General characteristics; Thallus organization; Cell wall composition and cell organization; Nutrition; Classification (Ainsworth, 1973).

Unit 2: Chytridiomycota and Zygomycota (5 lectures)

Characteristic features; Ecology and significance; Thallus organization; Reproduction; Life cyclewith reference to *Synchytrium*, *Rhizopus.*

Unit 3: Oomycota (4 lectures)

General characteristics; Ecology; Life cycle and classification with reference to *Phytophthora*, *Albugo.*

Unit 4: Ascomycota (10 lectures)

General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle; Heterokaryosis; Life cycle and classification with reference to *Saccharomyces*, *Ascobolus.*

Unit 5: Basidiomycota (8 lectures)

General characteristics; Reproduction; Ecology; Life cycle of *Lycoperdon* and *Agaricus*; fairy rings.

Unit 6: Deuteromycota (3 lectures)

General accounts, conidial morphology, parasexual cycle; Study of *Alternaria* and *Fusarium.*

Unit 7: Allied Fungi (2 lectures)

General characteristics; Status of slime molds, occurrence, types of plasmodia, types of fruiting bodies.

Unit 8: Symbiotic associations (4 lectures)

Lichen – occurrence, general characteristics, forms and range of thallus organization, Nature of associations of algal and fungal partners, reproduction, importance; Mycorrhiza-ectomycorrhiza, endomycorrhiza and their significance.

Unit 9: Applied Mycology (10 Lectures)

Role of fungi in biotechnology; Application of fungi in food industry (flavour & texture, fermentation, baking, organic acids, enzymes, mycoproteins); Secondary metabolites (pharmaceutical preparations); agriculture (biofertilizers); biological control (mycofungicides, mycoherbicides, mycoinsecticides, myconematicides).

Unit 10: Phytopathology (10 lectures)

Terms and concepts; Koch's postulates; general symptoms; geographical distribution of diseases; Etiology; host-pathogen relationships; disease cycle and environmental relation (disease triangle); bacterial diseases – citrus canker and bacterial blight of rice; Viral diseases – tobacco mosaic disease; Fungal diseases – late blight of potato, black stem rust of wheat, brownspot of rice.

Practical

Mycology

6. ***Rhizopus*:** study of asexual stage from temporary mounts and sexual structures through permanent slides.

7. ***Albugo*:** Study of symptoms of plants infected with *Albugo*; Asexual phase study through section/temporary mounts and sexual structures through permanent slides.

8. ***Ascobolus*:** Sectioning through ascocarp.

9. ***Puccinia*:** Herbarium specimens of black stem rust of wheat and infected barberry leaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.

10. ***Agaricus*:** Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*.

Phytopathology

1. **Phytopathology:** Herbarium specimens of bacterial diseases: Citrus Canker; Viral diseases: TMV, Fungal diseases: Late blight of potato, black stem rust of wheat, brownspot of rice and white rust of crucifers.

Suggested Readings

3. Agrios, G.N. (1997). Plant Pathology, 4th edition, Academic Press, U.K.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley &Sons (Asia) Singapore. 4th edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press,Cambridge. 3rd edition.
4. Deacon, J.W. (2013). Fungal Biology, 4th edition, John Wiley &Sons Ltd.

5. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan PublishersIndia Ltd.
6. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India
7. H. C. L. Gwynne-Vaugham and B. Barnes (2014). Fungi: Their Structure and Development, Biotech Books.
8. Gopinath Hait. 2016. A Text Book of Mycology, New Central Book Agency (P) Ltd.
9. R. S. Mehrotra and A. Aggarwal. 2010. Plant Pathology (Second Edition), Tata Mc Graw Hill Education Pvt. Ltd.

6. Multidisciplinary Course

Semester- I

6.1. Multidisciplinary 1: Mushroom Culture Technology

Course Code: S/BOT/103/MD-1

Credit: 3

Theory

(Lecture 30/ Marks 40)

Course Learning Outcomes

- Idea about various types and categories of mushrooms as edible staff.
- Demonstrate various types of mushroom cultivating technologies.
- Value the economic factors associated with mushroom cultivation.

Unit 1: (5 Lectures)
Introduction, history, Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms .Types of edible mushrooms available in India *Volvariella volvacea, Pleurotus citrinopileatus, Agaricus bisporus*.

Unit 2: (12 Lectures)
Cultivation Technology: Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation-paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation-Low cost technology, Composting technology in mushroom production. Mushroom weeds and pest and its control.

Unit 3: (8 Lectures)
Storage and nutrition: Short-term storage (Refrigeration-up to 24 hours) Long term Storage (canning, pickels, papads), drying, storage in salt solutions. Nutrition-Proteins-amino acids, mineral elements nutrition- Carbohydrates, Crude fibre content-Vitamins.

Unit 4: (5 Lectures)
Food Preparation: Types of foods prepared from mushroom. Research Centres-National level and Regional level. Cost benefit ratio- Marketing in India, Export Value.

Suggested Readings

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan,M.(1990) Food and Nutrition. Bappco, The Bangalore Printingand Publishing Co.Ltd., No.88, Mysore Road, Bangalore-560018.

3. Tewari, Pankaj Kapoor, S.C.,(1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Handbook of Mushrooms, II Edition, Vol.I & Vol.II.
5. B. C. Suman and V. P. Sharma (2011): Mushroom cultivation and Uses (Agrobios)
6. V. N. Pathak, N. Yadav and M. Gaur. (2011): Mushroom Production and Processing Technology (Agrobios)
7. Reeti Singh and U. C. Singh (2011): Modern Mushroom cultivation (Agrobios)

Semester-II

6.2. Multidisciplinary 2: Biofertilizers

Course Code: S/BOT/203/MD-2

Credit: 3

Theory

(Lecture 30/Marks 40)

Course Learning Outcomes:

- Know about Biofertilizers which are best defined as biologically active products which help in crop production without any side effects.
- Aware about social justice and wellbeing of rural communities.
- Develop concepts regarding green manuring and organic fertilizers.
- Develop good public health and food security.
- Develop financial sequirity.
- Develop knowledge about vermicomposting and VAM for better crop production.

Unit 1: (4 lectures)
General account about the microbes used as biofertilizer. Rhizobium: isolation, identification, mass multiplication, carrier based inoculants. Actinorrhizal symbiosis.

Unit 2: (8 lectures)
Azospirillum: Isolation and mass multiplication, carrier based inoculant, associative effect of different microorganisms. *Azotobacter*: isolation, identification, mass multiplication, carrier based inoculants.

Unit 3: (4 lectures)
Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, blue green algae(BGA) and *Azolla* in rice cultivation

Unit 4: (8 lectures)
Mycorrhizal association, types of mycorrhizal association, VAM: isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

Unit 5: (6 lectures)

Organic farming: Green manuring and organic fertilizers; Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods; Types and method of vermicomposting, its field Application.

Suggested Readings

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay _Publication, NewDelhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and Organic Farming, Akta Prakashan, Nadiad.
7. Acaharya, K., Sen, S., Rai, M. (20190 Biofertilizers and Biopesticides, Techno World, Kolkata.

7. Skill Enhancement Courses (SEC)

Semester- I

7.1. SEC 1: Mushroom Culture Technology

Course Code: S/BOT/104/SEC-1

Credit: 3

Theory

(Lecture 30/ Marks 40)

Course Learning Outcomes

- Idea about various types and categories of mushrooms as edible staff.
- Demonstrate various types of mushroom cultivating technologies.
- Value the economic factors associated with mushroom cultivation.

Unit 1: (5 Lectures)
Introduction, history, Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms .Types of edible mushrooms available in India *Volvariella volvacea, Pleurotus citrinopileatus, Agaricus bisporus*.

Unit 2: (12 Lectures)
Cultivation Technology: Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation-paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation-Low cost technology, Composting technology in mushroom production. Mushroom weeds and pest and its control.

Unit 3: (8 Lectures)
Storage and nutrition: Short-term storage (Refrigeration-up to 24 hours) Long term Storage (canning, pickels, papads), drying, storage in salt solutions. Nutrition-Proteins-amino acids, mineral elements nutrition- Carbohydrates, Crude fibre content-Vitamins.

Unit 4: (5 Lectures)
Food Preparation: Types of foods prepared from mushroom. Research Centres-National level and Regional level. Cost benefit ratio- Marketing in India, Export Value.

Suggested Readings

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan,M.(1990) Food and Nutrition. Bappco, The Bangalore Printingand Publishing Co.Ltd., No.88, Mysore Road, Bangalore-560018.

3. Tewari, Pankaj Kapoor, S.C.,(1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Handbook of Mushrooms, II Edition, Vol.I & Vol.II.
5. B. C. Suman and V. P. Sharma (2011): Mushroom cultivation and Uses (Agrobios)
6. V. N. Pathak, N. Yadav and M. Gaur. (2011): Mushroom Production and Processing Technology (Agrobios)
7. Reeti Singh and U. C. Singh (2011): Modern Mushroom cultivation (Agrobios)

Semester-II

7.2. SEC- 2: Biofertilizers

Course Code: S/BOT/204/SEC-2

Credit: 3

Theory

(Lecture 30/Marks 40)

Course Learning Outcomes:

- Know about Biofertilizers which are best defined as biologically active products which help in crop production without any side effects.
- Aware about social justice and wellbeing of rural communities.
- Develop concepts regarding green manuring and organic fertilizers.
- Develop good public health and food security.
- Develop financial sequirity.
- Develop knowledge about vermicomposting and VAM for better crop production.

Unit 1: (4 lectures)
General account about the microbes used as biofertilizer. Rhizobium: isolation, identification, mass multiplication, carrier based inoculants. Actinorrhizal symbiosis.

Unit 2: (8 lectures)
Azospirillum: Isolation and mass multiplication, carrier based inoculant, associative effect of different microorganisms. *Azotobacter*: isolation, identification, mass multiplication, carrier based inoculants.

Unit 3: (4 lectures)
Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, blue green algae(BGA) and *Azolla* in rice cultivation

Unit 4: (8 lectures)
Mycorrhizal association, types of mycorrhizal association, VAM: isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

Unit 5: (6 lectures)

Organic farming: Green manuring and organic fertilizers; Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods; Types and method of vermicomposting, its field Application.

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5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and Organic Farming, Akta Prakashan, Nadiad.
7. Acaharya, K., Sen, S., Rai, M. (20190 Biofertilizers and Biopesticides, Techno World, Kolkata.