

**Tribhuvan University**  
**Institute of Science and Technology**  
**Central Department of Botany**  
**Kirtipur, Kathmandu**



**Curriculum of MSc Botany Semester System**

**2074 (2017)**

## COURSE OUTLINE (2074/2017)

### SEMESTER I: Theory + practical (lab/field work)

**Credit: 17; Full marks: 425**

Course No	Title	Credit	FM
BOT 501	Diversity and Evolution of Virus, Bacteria, Fungi and Lichen (theory)	3	75
BOT 502	Diversity and Evolution of Virus, Bacteria, Fungi and Lichen (practical)	1	25
BOT 503	Diversity and Evolution of Non-Vascular Plants: Algae and Bryophytes (theory)	3	75
BOT 504	Diversity and Evolution of Non-Vascular Plants: Algae and Bryophytes (practical)	1	25
BOT 505	Diversity and Evolution of Vascular Plants I: Pteridophytes and Gymnosperms (theory)	3	75
BOT 506	Diversity and Evolution of Vascular Plants I: Pteridophytes and Gymnosperms (practical)	1	25
BOT 507	Diversity and Evolution of Vascular Plants II: Angiosperms (theory)	2	50
BOT 508	Diversity and Evolution of Vascular Plants II: Angiosperms (practical)	1	25
BOT 509	<b>Field work</b> (techniques of specimen collection, preservation and curation – 2 times each of 7 days) and <b>seminar</b>	2	50
<b>Total</b>		<b>17</b>	<b>425</b>

### SEMESTER II: Theory + Practical (Lab/Fieldwork)

**Credit: 18; Full mark: 450**

Course No	Title	Credit	FM
BOT 551	Ecology (theory)	3	75
BOT 552	Ecology (practical)	1	25
BOT 553	Cytology and Genetics (theory)	3	75
BOT 554	Cytology and Genetics (practical)	1	25
BOT 555	Plant Physiology (theory)	3	75
BOT 556	Plant Physiology (practical)	1	25
BOT 557	Plant Systematics (theory)	3	75
BOT 558	Plant Systematics (practical)	1	25
BOT 559	<b>Field work</b> (techniques of ecological sampling, vegetation and floristic study – 1 time of at least 15 days duration) and <b>seminar</b>	2	50
<b>Total</b>		<b>18</b>	<b>450</b>

**SEMESTER III: Theory + practical (Lab/field work)****Credits: 18; Full marks: 450****1. Compulsory Paper – 6credits**

Course No	Title	Credit	FM
BOT 601	Research Design and Biological Data Analysis (theory)	3	75
BOT 602	Research Design and Biological Data Analysis (practical)	2	50
BOT 603	Dissertation Proposal and Seminar	1	25
<b>Total</b>		<b>3+3</b>	<b>150</b>

**2. Special Paper [any one group]\*– 8 credits**

Course No	Title	Credit	FM
	<b>Group A</b>		
BOT 611	Functional Plant Ecology (theory)	3	75
BOT 612	Functional Plant Ecology (practical)	1	25
BOT 613	Landscape and Global Change Ecology (theory)	3	75
BOT 614	Landscape and Global Change Ecology (practical)	1	25
	<b>Group B</b>		
BOT 615	Applied Systematics (theory)	3	75
BOT 616	Applied Systematics (practical)	1	25
BOT 617	Biodiversity and Biogeography (theory)	3	75
BOT 618	Biodiversity and Biogeography (practical)	1	25
	<b>Group C</b>		
BOT 619	Plant Biotechnology (theory)	3	75
BOT 620	Plant Biotechnology (practical)	1	25
BOT 621	Genetic Engineering (practical)	3	75
BOT 622	Genetic Engineering (theory)	1	25
	<b>Group D</b>		
BOT 623	Applied Mycology (theory)	3	75
BOT 624	Applied Mycology (practical)	1	25
BOT 625	Advanced Plant Pathology (theory)	3	75
BOT 626	Advanced Plant Pathology (practical)	1	25
<b>Total</b>		<b>6 + 2</b>	<b>200</b>

**3. Applied Paper [any one of the following]\*– 4 credits**

Course No	Title	Credit	FM
BOT 631	Natural Resources Management (theory)	3	75
BOT 632	Natural Resources Management (practical)	1	25
BOT 633	Plant Conservation Biology (theory)	3	75
BOT 634	Plant Conservation Biology (practical)	1	25
BOT 635	Molecular Biology (theory)	3	75
BOT 636	Molecular Biology (practical)	1	25
BOT 637	Food Security and Food Safety (theory)	3	75
BOT 638	Food Security and Food Safety (practical)	1	25
<b>Total</b>		<b>3+1</b>	<b>100</b>

\* Department will run all or any of the given special and applied paper based on the availability of resources.

## **SEMESTER IV: Compulsory Paper (Dissertation)**

**Credits: 8; Full marks: 200**

<b>Course No.</b>	<b>Title</b>	<b>Credit</b>	<b>FM</b>
BOT 651	Dissertation**	8	200
Total		<b>8</b>	<b>200</b>

*\*\* Evaluation will be made based on (i) two mid-term progress reports submitted during the six months period, and (ii) final report and viva voce.*

Tribhuvan University  
**Institute of Science and Technology**  
**Central Department of Botany**

**M.Sc. Botany Syllabus**

**First Semester**

**2074**

## Course Outline

### SEMESTER I: Theory + practical (lab/field work)

**Credit: 17; Full marks: 425**

Course No	Title	Credit	FM
BOT 501	Diversity and Evolution of Virus, Bacteria, Fungi and Lichen (theory)	3	75
BOT 502	Diversity and Evolution of Virus, Bacteria, Fungi and Lichen (practical)	1	25
BOT 503	Diversity and Evolution of Non-Vascular Plants: Algae and Bryophytes (theory)	3	75
BOT 504	Diversity and Evolution of Non-Vascular Plants: Algae and Bryophytes (practical)	1	25
BOT 505	Diversity and Evolution of Vascular Plants I: Pteridophytes and Gymnosperms (theory)	3	75
BOT 506	Diversity and Evolution of Vascular Plants I: Pteridophytes and Gymnosperms (practical)	1	25
BOT 507	Diversity and Evolution of Vascular Plants II: Angiosperms (theory)	2	50
BOT 508	Diversity and Evolution of Vascular Plants II: Angiosperms (practical)	1	25
BOT 509	<b>Field work</b> (techniques of specimen collection, preservation and curation – 2 times each of 7 days) and <b>seminar</b>	2	50
<b>Total</b>		<b>17</b>	<b>425</b>

## Diversity and Evolution of Fungi, Bacteria, Virus and Lichen

**Course title:** Diversity and Evolution of Fungi, Bacteria, Virus and Lichen

**Full marks:** 75

**Course No.:** BOT 501

**Pass marks:** 37.5

**Nature of course:** Theory

**Credits:** 3

**Level:** MSc, I Semester

**Credit hours:** 48

### Objectives

The general aim of this course is to provide theoretical and practical knowledge on biology and diversity of microbial life. The specific objectives are to (i) develop understanding on the structural and reproductive diversities of fungi, bacteria, virus and lichens; (ii) develop understanding on origin, evolution and phylogeny of fungi, bacteria, virus and lichens; and (iii) elaborate knowledge on ecology, physiology, interactions, economic importance and human relation of fungi, bacteria, virus and lichens.

### Course content

**Unit I. Overview of fungi:** Introduction and general characteristics; classification (Alexopolous and Mims 1996, Hibbett et al. 2007); overview on structure, reproduction, mode of nutrition; growth and development of fungi. [3 h].

**Unit II. Structural and reproductive diversity:** Comparative account of structural and reproductive diversities in Gymnomycotina (Maxomycetia), Mastigomycotina (Chytridiomycetes) and Amastigomycotina (Zygomycetes, Ascomycetia, Basidiomycetia and Deuteromycetes). [14 h].

**Unit III. Phylogeny:** Origin and phylogenetic relationship of fungi. [3 h].

**Unit IV. Fungal physiology and interaction:** Physico-chemical factors affecting fungal growth and development; parasitism and pathogenicity; fungal metabolites and their significance; microbial diversity in soil; rhizosphere, rhizoplane, mycorrhizae; fungi and insect interaction. [7 h].

**Unit V. Fungi and human affairs:** Distribution and present status of mushrooms in Nepal; concept of cultivation, utilization and conservation of medicinal and culinary mushrooms; mushroom toxicity; food, medicinal, industrial and agricultural value of fungi; pathogenic fungi to plant and animals and human affairs. [5 h].

**Unit VI. Bacteria, virus and lichens:** (i) *Bacteria*: an overview on bacterial diversity (Archebacteria and Eubacteria); general characteristics of plant pathogenic bacteria; ultra-structure and reproduction; nutrition and growth factors of bacteria; phylogeny and economic importance. (ii) *Virus*: ultra-structure of virus; isolation, purification, detection and characterization of virus; viral mode of reproduction; symptomatology and transmission of plant viruses; phylogeny and economic importance. (iii) *Lichens*: an overview of lichen structure and reproduction; role of lichen in environmental monitoring; ecology and distribution of lichens in Nepal; origin of lichens; economic importance of lichens. [6 h].

<b>Course title:</b> Diversity and Evolution of Fungi, Bacteria, Virus and Lichen	<b>Full marks:</b> 25
<b>Course No.:</b> BOT 502	<b>Pass marks:</b> 12.5
<b>Nature of course:</b> Practical	<b>Credits:</b> 1
<b>Level:</b> MSc, I Semester	<b>Credit hours:</b> 16×4

### List of experiments

1. Techniques of sterilization (including equipments handling procedures)
2. Preperation of culture media and techniques
3. Tools and techniques for studying and identifying bacteria and fungi (inoculation, incubation and observation)
4. Survey of plant diseases using herbarium specimens (Symptomatology: fungal, bacterial and viral diseases)
5. Morphological and reproductive structure of selected mushrooms (including slide preperation)
6. Morphological and reproductive structure of selected pathogenic fungi (*Rhizopus*, *Mucor*, *Aspergillus*, *Penicillium*, *Trichoderma*, *Puccinia* – different stages, *Erysiphae*, *Physoderma*, *Melampsora* and available other fungi).
7. Baiting and identification of aquatic fungi
8. Identification of mycorrhizal funig by staining method
9. Staining of Gram + ve and Gram - ve Bacteria
10. General survey of lichens and anatomy/reproductive structures of lichens
11. Field visit and report preparation on mushroom, lichens and plant diseases

### Text books

#### Fungi

- Ainsworth G.C., Sparrow F.K. and Sussman A.F. 1973. *The Fungi: An Advanced Treatise I-IV*. Academic Press, N.Y. and London.
- Alexopoulos C.J. 1962. *Introductory Mycology*. John Wiley & Sons, NY, USA.
- Alexopoulos C.J. and Mims C.W. 1993. *Introductory Mycology*. Wiley Eastern Limited.
- Bessey E.A. 1979. *Morphology and Taxonomy of Fungi*. Vikas Publishing House Pvt., Ltd., New Delhi.

#### Bacteria

- Lehninger A.L., David L.N. and Cox M.M. 1993. *Principles of Biochemistry*. CBS Publishers and Distributers, New Delhi, India.
- Stewart F.S. 1962. *Bigger's Handbook of Bacteriology*. Willoame & Wilkiesali, Beltimore.

#### Virus

- Cooper J.I. 1995. *Viruses and the environment* (2<sup>nd</sup> ed.). Chapman & Hall, London.
- Luria S.E. and Darnell E.J. 1967. *General Virology*. Wiley International Edition.
- Smith K.M. 1996. *A text Book of Plant Virus Diseases*. J & A Chauachall, London.

#### Lichens

- Ahmadjian V. and Hale M.E., eds. 1973. *The Lichens*. New York: Academic Press.
- Hale M.E. 1983. *The Biology of Lichen*. Edward Arnold Publication, Maryland.



## References

### **Fungi**

- Adhikari M.K. and Manandhar V. 1997. *Fungi of Nepal Part II. Phycomycotina, Mastigomycotina and Zygomycotina*. Department of Plant Resources Bull. No. 16, Kathmandu, Nepal.
- Burnet J.H. 1971. *The Fundamentals of Mycology*. ELBS Publications, London.
- Deacon J.W. 1996. *Introduction to Modern Mycology I & II*. Blackwell Scientific Publication, London.
- Deacon J.W. 2006. *Fungal Biology*. Blackwell Publishing, UK.
- Fungi of Nepal, Part I: Historical Review and Myxomycotina*. Department of Plant Resources Bull. No. 13, Kathmandu, Nepal.
- Gray W.D. 1959. *The Relation of Fungi to Human Affairs*. Hery Holt & Co., Inc.
- Paracer S. and Ahmadjian V. 2000. *Symbiosis, an Introduction to Biological Associations*. Second Edition. Oxford University Press
- Smith G.M. 1955. *Cryptogamic Botany* Vol. I. Tata Mcgraw Hill Publishing Co., Ltd., New Delhi, India.
- Smith S.E. and Reed D.J. 2008. *Mycorrhiza Symbiosis*. Third Edition. Academic Press.
- Stamets P. 2005. *Mycelium Running: How Mushrooms Can Help Save the World*. Ten Speed Press, California, USA.
- Webster J. 1989. *Introduction to Fungi*. Cambridge University Press, London.

### **Lichens**

- Ahmadjian V. 1993. *The Lichen Symbiosis*. John Willey and Sons, Inc., New York.
- Paracer S. and Ahmadjian V. 2000. *Symbiosis, an Introduction to Biological Associations*. Second Edition. Oxford University Press
- Seaward M.R.D. 1977. *Lichen Ecology*. Academic Press.
- Sharma L.R. 1995. *Enumeration of the Lichens of Nepal*. Biodiversity Profile Project Publication No. 3. Department of National Parks and Wildlife Conservation, Government of Nepal/Directorate General International Cooperation, Government of the Netherlands, Euroconsult, Amhem, The Netherlands.
- Thomas N.H. 2008. *Lichen Biology*. Cambridge University Press. Cambridge, UK.

## Diversity and Evolution of Non-Vascular Plants: Algae and Bryophytes

<b>Course title:</b> Diversity and Evolution of Non-Vascular Plants: Algae and Bryophytes	<b>Full marks:</b> 75
<b>Course No.:</b> BOT 503	<b>Pass marks:</b> 37.5
<b>Nature of course:</b> Theory	<b>Credits:</b> 3
<b>Level:</b> MSc, I Semester	<b>Credit hours:</b> 48

### Objectives

The general aim of this course is to provide theoretical and practical knowledge on biology and diversity of algae and bryophytes. The specific objectives are to (i) develop understanding on the structural and reproductive diversities, and phylogeny of non-flowering plants (algae and bryophytes); (ii) provide basic knowledge on ecology and human affairs of algae and bryophytes; and (iii) impart knowledge on their distribution, conservation status and economic importance in the context of Nepal.

### Course content

#### I. Algae (Total credit: 1.5; Lecture: 24)

**Unit 1. Taxonomy:** Classification of algae (Fritsch and recent). [2 h].

**Unit 2. Structural and reproductive diversity:** Comparative account of structural and reproductive diversities in Cyanophyceae, Chlorophyceae, Bacillariophyceae, Xanthophyceae, Phaeophyceae and Rhodophyceae. [11 h].

**Unit 3. Phylogeny:** Origin and phylogenetic relationships of algae. [2 h].

**Unit 4. Ecology and human affairs:** Distribution and present status of algae in Nepal. Algae sampling and culture techniques. Algae as bioindicator: water pollution and phycoremediation; water quality monitoring and climate change, algal blooms and phycotoxins; Commercial and local utilization of algae (algal biodiesel, algal bio-fertilizers, nutritional and medicinal uses; use of diatoms in forensic science and nanotechnology). [9 h].

#### II. Bryophytes (Total credit: 1.5; Lecture: 24 hrs)

**Unit 1. Taxonomy:** General classification of Bryophytes. [2 h].

**Unit 2. Structural and reproductive diversity:** Comparative account of structural and reproductive diversities in Bryophytes: (i) Anthocerotae [Anthocerotales]; (ii) Hepaticae [Marchantiales; Jungermaniales; Metzgeriales; Sphaerocarpaceae and Takakiales] and (iii) Musci [Sphagniales; Funariales; Polytrichales]. Peristome and its significance in classification of mosses. [12 h].

**Unit 3. Phylogeny:** Origin and phylogenetic relationships of bryophytes; sporophyte evolution in Bryophytes. [3 h].

**Unit 4. Physiology:** Conducting system and water relations; stress tolerance. [2 h].

**Unit 5. Ecology and human affairs:** Distribution, present status and conservation of bryophytes with reference to Nepal; resilience of bryophyte communities to human impact and climate change; commercial and local uses of Bryophytes. [5 h].

<b>Course title:</b> Diversity and Evolution of Non-Vascular Plants: Algae and Bryophytes	<b>Full marks:</b> 25
<b>Course No.:</b> BOT 504	<b>Pass marks:</b> 12.5
<b>Nature of course:</b> Practical	<b>Credits:</b> 1
<b>Level:</b> MSc, I Semester	<b>Credit hours:</b> 16×4

## List of experiments

### A. Algae

1. Algae collection, preservation and slide preparation (including diatom's frustules cleaning) techniques.
2. Identification of algae using microphotography techniques.
3. Isolation and culture of algae.
4. Extraction of algal lipid for biodiesel production.
5. Extraction of algal pigments and their separation by paper chromatography.
6. Survey of algae products (industrial and local products like food, fodder, medicine, chemicals, cosmetics etc.) available in the market.

### B. Bryophytes

1. General Survey of Bryophytes (2 Practical)
2. Comparative anatomical studies of *Riccia*, *Marchantia*, *Asterella*, *Plagiochasma*, *Targionia*, *Dumortiera*, *Jungermannia*, *Funaria* and *Polytrichum* or *Pogonatum* (4 Practicals)
3. Visit to nearest Herbarium / Museum (1 Practical)
4. Visit to field (Refer to course Bot 509)

## Text and reference books

### Algae

- Bold H.C. and Wynne M.J. 1978. *Introduction to Algae: Structure and Reproduction*. Prentice Hall, New Jersey.
- Fritsch F.E. 1979. *The Structure and Reproduction of Algae* (Vols I & II). Cambridge University Press, London, UK.
- Kumar H.D and Singh H.N. 1982. *A Text Book on Algae*. Affiliates East-West Press, Madras, India.
- Lee R.E. 2008. *Phycology*. Fourth Edition, Cambridge University Press. Cambridge, UK.

### Bryophytes

- Parihar N.S. 1965. *An Introduction to Embryophyta, vol. 1: Bryophyta*. Central Book Depot, Allahabad, India.
- Vashishta B.R. 1985. *Botany for Degree Students. Bryophyta Part III*. S. Chand and Co. Ltd., Ram Nagar, India.
- Watson E.V. 1971. *The Structure and Life of Bryophytes*. Hutchinson University Library, London.

## Suggested further reading

### Algae

- Baral S.R. 1995. *Enumeration of the Algae of Nepal*. Biodiversity Profile Project Publication No. 11. Department of National Parks and Wildlife Conservation, Government of Nepal/Directorate General International Cooperation, Government of the Netherlands, Euroconsult, Arnhem, The Netherlands.
- Bellinger E.G. and Sige D.C. 2010. *Freshwater Algae: Identification and Use as Bioindicator*. Wiley-Blackwell, UK.
- Borowitzka M.A. and Borowitzka L.J. (Eds.) 1988. *Micro-algal Biotechnology*. Cambridge University Press.
- Coesel P.F.M. and Meesters K.J. 2007. *Desmids of the lowlands – Mesotaeniaceae and Desmidiaceae of the European lowlands*. KNNV Publishing, The Netherlands.
- Darley W.M. 1982. *Algal Biology: A Physiological Approach*. Blackwell Scientific Publications, Oxford, London.
- Demirbas A. and Demirbas M.F. 2010. *Algae Energy: Algae as a New Source of Biodiesel*. Springer-Verlag London Limited.
- Graham L.E. and Wilcox L.W. 2000. *Algae*. Prentice-Hall, Upper Saddle River, NJ.
- Richmond A. 2004. *Handbook of Microalgal Culture: Biotechnology and Applied Phycology*. Blackwell Science.
- Round F.E. 1969. *The Biology of Algae*. Edward Arnold Ltd.
- Round F.E. 1981. *The Ecology of Algae*. Cambridge University Press, London.
- Round F.E., Crawford R.M. and Mann D.G. 1990. *The Diatoms: Biology and Morphology of the Genera*. Cambridge University Press, UK.
- Sharma O.P. 1986. *Text Book of Algae*. Tata McGraw-Hill, New Delhi.
- Smith G.M. 1955. *Cryptogamic Botany* Vol. I & II. Tata McGraw Hill Publishing Co., Ltd., New Delhi, India.
- Smol J.P. and Stoermer E.F. 2010. *The Diatoms Applications for the Environmental and Earth Sciences*. Second edition, Cambridge University Press, UK.
- South G.R. and Whittick A. 1987. *An Introduction to Phycology*. Blackwell Science Ltd.
- Sze P. 1998. *A Biology of the Algae*. Third Edition, McGraw-Hill, Boston.
- Trivedi P.C. 2001. *Algal Biotechnology*. Pointer Publisher.
- Van den Hoek C., Mann D.G. and Jahns H.M. 1995. *Algae: An Introduction to Phycology*. Cambridge University Press. Cambridge, UK.
- Venkataraman G.S. 1973. *Algal Biofertilizers and Rice Cultivation*. ICAR, New Delhi, India.
- Venkataraman G.S. et al. 1974. *Algae Form and Function*. Today & tomorrow Publishers, New Delhi, India.
- Wehr J.D. and Sheath R.G. (Eds.) 2003. *Freshwater Algae of North America: Ecology and Classification*. Academic Press, California, USA.

### Bryophytes

- Cavers F. 1917. *The Interrelationship of Bryophytes*. New Phytol Inc.
- Eddy A. 1988, 1990 and 1996. *A Handbook of Malesian Mosses Vol. I-III*. Nat. Hist. Mus., London.
- Gangulee H.S. 1969-1980. *Mosses of Eastern India and Adjacent Regions*. Fasc. 1-8: 1-2145. Pubs. by the Author, Kolkata, India.
- Ghimire S.K. 2001. An overview if the Bryophytes of Nepal: Diversity and distribution in Nepal Himalayas. *Botanica Orientalis* 2(1): 74-81.
- Goffinet B. and Jonathan Shaw A. (eds.) 2008. *Bryophyte Biology* (second edition). Cambridge University Press. Cambridge, UK.
- Kashyap S.R. 1929. *The Liverworts of Western Himalayas and Punjab Plains I & II*.
- Kattel L.P. and Adhikari M.K. 1992. *Mosses of Nepal (list and references)*. Natural History Society of Nepal, Kathmandu, Nepal.

- Pradhan N. 2000. *Materials for a Checklist of Bryophytes of Nepal*. The Natural History Museum, London.
- Pradhan N. 2013. Biodiversity: bryophyta in biological diversity and conservation. In: *Nepalpedia Series 2* (eds. P.K. Jha, F.P. Naupane, M.L. Shrestha and I.P. Khanal), pp. 113-117. Nepal Academy of Science and Technology (NAST), Lalitpur, Nepal.
- Pradhan N. and Joshi S.D. 2009. *Liverworts and Hornworts of Nepal: A Synopsis*. *Botanica Orientalis*, 6 (6): 69-75.
- Puri P. 1973. *Bryophytes: A Broad Perspective*. Atma Ram & Sons, New Delhi.
- Ron Porley and Nick Hodgetts 2005. *Mosses and Liverworts*. Harper Collins Publishers Limited.
- Schofield W.B. 1985. *Introduction to Bryology*. Macmillan Publishing Company, New York.
- Smith G.M. 1955. *Cryptogamic Botany Vol. II*. McGraw Hill Book Co., NY, USA.
- Uder R. 1976. *Bryology in India*. *Annales Cryptogamici et Phytopathologici Vol. 4*. The ChronicaBotanica Co., New Delhi, India.
- Vanderpoorten A. and Goffinet B. 2009. *Introduction to Bryophytes*. Cambridge University.
- Watanabe M. and Hagiwara H., eds. *Cryptogams of the Himalayas, Vol 3*, Nepal and Pakistan. Department of Botany, National Science Museum, Tsukuba, Japan.
- Watanabe M. and Malla S.B., eds. *Cryptogams of the Himalayas Vol. 2*. Central and eastern Nepal. Department of Botany, National Science Museum, Tsukuba, Japan.

## Diversity and Evolution of Vascular Plants I: Pteridophytes and Gymnosperms

<b>Course title:</b> Diversity and Evolution of Vascular Plants I: Pteridophytes and Gymnosperms	<b>Full marks:</b> 75
<b>Course No.:</b> BOT 505	<b>Pass marks:</b> 37.5
<b>Nature of course:</b> Theory	<b>Credits:</b> 3
<b>Level:</b> MSc, I Semester	<b>Credit hours:</b> 48

### Objectives

The general aim of this course is to provide theoretical and practical knowledge on biology and diversity of Pteridophytes and Gymnosperms. The specific objectives are to (i) develop understanding on the structural and reproductive diversities, and phylogeny of flowering plants (Pteridophytes and Gymnosperms); (ii) provide basic knowledge on ecological interactions of Pteridophytes and Gymnosperms; (iii) impart knowledge on their distribution, conservation status and economic importance in the context of Nepal.

### Course content

#### I. Pteridophytes (Total credit: 1.5; Lecture hrs: 24)

**Unit 1. Taxonomy:** General account and classification of Pteridophytes (Eames 1936 and Smith *et. al.* 2006). [2 h].

**Unit 2. Structural and reproductive diversity:** Comparative account of morphology, anatomy of vegetative and reproductive organs of different orders of extinct (Psilophytales, Lepidodendrales, Hyaniales, Calamitales, Sphenophyllales) and extant (Psilotopsida; Equisetopsida; Marattiopsida; Polypodiopsida) pteridophytes (Follow Smith *et. al.* 2006). [14 h].

**Unit 3. Phylogeny:** Origin and evolution of pteridophytes; soral organization and evolution in ferns; heterospory and seed habit. [4 h].

**Unit 4. Ecology and human affairs:** Ecology and distribution of pteridophyte flora in Nepal; disturbance and resilience of pteridophyte communities; economic importance of pteridophytes. [4 h].

#### II. Gymnosperms (Total credits 1.5; Lecture hrs = 24)

**Unit 1. Taxonomy:** General account and classification of Gymnosperms. [2 h].

**Unit 2. Structural and reproductive diversity:** comparative account of structural and reproductive diversities of major groups of extinct (Pteridospermales, Cycadeoidales, Cordaitales) and extant (Cycadales, Ginkgoales, Coniferales, Taxales and Gnetales) gymnosperms. [17 h].

**Unit 3. Phylogeny:** Origin and phylogenetic relationship; Biogeography of gymnosperms. [3 h].

**Unit 4. Ecology and human affairs:** Diversity, distribution, and conservation status of Gymnosperm in Nepal; uses of Gymnosperm. [2 h].

<b>Course title:</b> Diversity and Evolution of Vascular Plants I: Pteridophytes and Gymnosperms	<b>Full marks:</b> 25
<b>Course No.:</b> BOT 506	<b>Pass marks:</b> 12.5
<b>Nature of course:</b> Practical	<b>Credits:</b> 1
<b>Level:</b> MSc, I Semester	<b>Credit hours:</b> 16×4

## List of experiments

### A. Pteridophytes

1. General survey of Pteridophytes of Nepal with reference to their habit/habitat, morphology, distribution, economic importance based on herbarium specimens (2 Practicals).
2. Variation and evolution of stellar structures among pteridophytes (1 Practical).
3. Variation in soral structure among ferns (1 Practical).
4. Anatomy, vegetative and reproductive parts of: Lycopsidea (*Lycopodium*, *Selaginella*), Sphenopsida (*Equisetum*), Pteropsida (*Botryopteris*, *Adiantum*, *Lygodium*, *Pyrrosia*, *Diplazium*, *Tectaria*) (4 Practicals).
5. Field visits and study of the techniques in Pteridophyte collection, preservation and identification: Field visits to representative areas to study the taxonomy, distribution and ecology of Pteridophytes; taxonomic description of collected specimens (Refer to Bot 509).

### B. Gymnosperms

1. General Survey of Gymnosperms with reference to their habit/habitat, morphology, distribution, economic importance based on herbarium (2 Practical)
2. Anatomical study of vegetative and reproductive parts of *Ginkgo*, *Cedrus*, *Abies*, *Tsuga*, *Podocarpus*, *Ephedra*, *Taxus* (5 Practicals)
3. Study of important fossil gymnosperms from permanent slides (1 Practical)
4. Visit to field (Refer to course Bot 509)

## Text books

### *Pteridophytes*

- Parihar N.S. 1992. *The Biology and Morphology of Pteridophytes*. Central Book Depot, Allahabad.
- Sporne K.R. 1970. *The Morphology of Pteridophytes: the Structure of Ferns and Allied Plants* (3rd edition). Hutchinson University Library, London, UK.
- Vashishta P.C. 1990. *Pteridophyta*. S. Chand & Co. Ltd, New Delhi, India.
- Mehlreter, K. Walker, L.R., Sharpe, J.M. 2010. *Fern Ecology*. Cambridge University Press, UK.
- Willis, K.J., McElwain, J.C. 2002. *The evolution of plants*. Oxford University Press, UK.
- Gensel, P.G., Edwards, D. 2001. *Plants Invade the Land*. Columbia University Press, New York.
- Bell, P.R. Hemsley, A.R. 2000. *Green Plants: Their Origin and Diversity*. Cambridge University Press, UK.
- Ranker, T.A. and C.H. Haufler. 2008. *Biology and evolution of ferns and lycophytes*. Cambridge University Press.

### *Gymnosperms*

- Arnold C.A. 1947. *An Introduction to Paleobotany*. McGraw-Hill Book Company, Inc., NY, USA.
- Bhatnagar S.P. and Moitra A. 1996. *Gymnosperms*. New Age International Limited, New Delhi, India.
- Chamberlain C. 1935. *Gymnosperm: Structure and Evolution*. Chicago University Press, USA.
- Coulter J.M. and Chamberlain C.J. 1917. *Morphology of Gymnosperms*. Chicago University Press, USA.

## Suggested further readings

### **Pteridohytes**

- Andrews H.N. 1961. *Studies in Paleobotany*. John Wiley & Sons, NY, USA. Arnold C.A. 1947. *An Introduction to Paleobotany*. McGraw-Hill Book Company, Inc., NY, USA.
- Bower F.O. 1939. *The Ferns*, Vols. I, II, III. Today & tomorrow's Printers, New Delhi
- Chandra S. and Srivastava M. 2003. *Pteridology in the New Millennium: NBRI Golden Jubilee Volume in Honour of Professor B.K. Nayar*. Kluwer Academic Publishers, The Netherlands.
- Bista, M. S., Adhikari, M. K. and Rajbhandari, K. R. (eds.), 2002. *Pteridophytes of Nepal*. Bull. Dept. Plant Resources No. 19, Department of Plant Resources, Kathmandu, Nepal, 175 pp.
- Fraser-Jenkins, C.R., Kandel, D.R. and Pariyar S. 2015. *Ferns and Fern-Allies of Nepal, Volume 1*. National Herbarium and Plant Laboratories, Department of Plant Resources, Ministry of Forests and Soil Conservation, Kathmandu, Nepal.

### **Gymnosperms**

- Andrews H.N. 1961. *Studies in Paleobotany*. John Wiley & Sons, NY, USA.
- Charles B.B. ed. 1988. *Origin and Evolution of Gymnosperms*. Columbia University Press, New York, USA. 10
- Christopher J. Cleal, Thomas B.A. 2009. *An Introduction to Plant Fossils*. Cambridge University Press. Cambridge, UK.
- Devkota A. 2013. Biodiversity: *Gymnosperms*. P. K. Jha, F. P. Neupane, M. L. Shrestha and I. P. Khanal (eds.); Biological Diversity and Conservation. *Nepalpedia Series no.2*, 127-134.
- Shrestha T.B. 1984. Indigenous Gymnosperms. In: Majupuria, T.C.(ed.), *Nepal Nature's Paradise*. Craftman Press, Bangkok, pp 252-260.
- Shrestha T.B. and Dobremez J.F. 1974. *Gymnosperms of Nepal*. Cahiers Nepalais Doc. 3, Centre National de la Recherche Scientific, France.
- Sporne K.R. 1971. *The morphology of Gymnosperm* (revised edition). Hutchinson & Co., London, UK.
- Vashita P.C. 1990. *Gymnosperms*. S. Chand & Co. Ltd., India.
- Vashita P.C., 2006 (Revised). *Gymnosperms*. S. Chand & Co. Ltd., India.



## Diversity and Evolution of Vascular Plants II: Angiosperms

<b>Course title:</b> Diversity and Evolution of Vascular Plants II: Angiosperms	<b>Full marks:</b> 50
<b>Course No.:</b> BOT 507	<b>Pass marks:</b> 25
<b>Nature of course:</b> Theory	<b>Credits:</b> 2
<b>Level:</b> MSc, I Semester	<b>Credit hours:</b> 32

### Objectives

The overall aim of this course is to provide critical understanding of diversity and evolution of angiosperms. The specific objectives are to: (i) develop understanding of important features that discriminate angiosperms with other groups of vascular plants, (ii) provide students understanding of the theory of evolutionary processes and dynamics, (iii) impart knowledge on the origin, early diversification and general evolutionary trends of angiosperms.

### Course content

**Unit 1. Angiosperms:** (i) Introduction and diversity. (ii) Angiosperm as a most successful group of land plants – structural, ecological and physiological peculiarities. (iii) Overview of the classification of angiosperms. (iv) Status and uses of angiosperms in the context of Nepal. [**6 h** (1+1+1+3)].

**Unit 2. Basic evolutionary processes:** (i) Basic evolutionary concepts: evolutionary biology an introduction, theoretical advancement and modern synthesis; theoretical considerations in angiosperm evolution. (ii) Population concept and evolutionary processes, variation in populations, infraspecific variation and ecotype, phenotypic plasticity. (iii) Population genetic structure and diversity. (iv) Isolation mechanisms, natural selection and speciation. [**11 h** (2+4+2+3)].

**Unit 3. Origin and early diversification of angiosperms:** (i) Fossil records of angiosperms. (ii) Origin and radiation of angiosperms: introduction, probable time of origin and diversification, probable ancestor, the early angiosperms. (iii) Processes in the origin and divergence: ecological and genetic bases of angiosperm evolution, neoteny, co-evolution of plants and insects. (iv) The cradle of angiosperm. [**7 h** (1+3+2+1)].

**Unit 4. Structural diversity and general evolutionary trends in angiosperms:** (i) Growth habit, leaf structure and stomatal apparatus. (ii) Vascular anatomy: xylem and phloem, nodal anatomy. (iii) Inflorescence, floral structure, floral anatomy. (iv) Embryology: male and female gametophyte, pollination and fertilization, endosperm, placentation, fruits and seeds. [**8 h** (1+2+2+3)].

<b>Course title:</b> Diversity and Evolution of Vascular Plants II: Angiosperms	<b>Full marks:</b> 25
<b>Course No.:</b> BOT 508	<b>Pass marks:</b> 12.5
<b>Nature of course:</b> Practical	<b>Credits:</b> 1
<b>Level:</b> MSc, I Semester	<b>Credit hours:</b> 16×4

## List of experiments

### 1 Diversity of angiosperm (10 practical)

- 1.1 General survey of Angiosperms of Nepal with reference to their habit/habitat, morphology, distribution, evolutionary trends and economic importance based on herbarium specimens
- 1.2 Macro- and micro-morphological studies of angiosperms (leaf, stem, flower and fruits) covering primitive to advanced plant families

### 2 Variation (4 practical)

- 2.1 Study of variations in plant populations

### 3 Study of fossil angiosperms (2 practical)

- 3.1 Study of fossil slides/photos/
- 3.2 Visit to study angiosperm fossils in museum (e.g., Central Department of Geology or Natural History Museum)

### 4 Field work (refer to course Bot 509)

- 4.1 Collection, identification and morphological characterization of important primitive and advanced families angiosperms
- 4.2 Post field study: preparation of field report

## Text and reference books

- Briggs D and Walters M. 1997. *Plant Variation and Evolution*. Third Edition. Cambridge University Press.
- Eldredge N and Craft J. 1980. *Phylogenetic Patterns and the Evolutionary Processes*. Columbia University Press, NW, USA.
- Takhtajan A.L. 1969. *Flowering Plants: Origin and Dispersal*. Oliver & Boyd, Edinburgh, UK.

## Suggested further readings

- Darwin C. 1859. *On the Origin of Species by Means of Natural Selection*. Murray, London, UK.
- Futuyma D. 1997. *Evolutionary Biology*. Sinauer Associates, Sunderland, MA, USA.
- Judd WS, Campbell CS, Kellogg EA, Stevens PF and Donoghue MJ. 2010. *Plant Systematics: A Phylogenetic Approach*. Sinauer Associates Inc. Publishers, Sunderland, MA, USA.
- Simpson, M.G. 2010. *Plant Systematics*. Elsevier Academy Press, USA.
- Soltis DE, Soltis PE, Endress PK and Chase MW. 2005. *Phylogeny and Evolution of Angiosperms*. Sinauer Associates Inc. Publishers, MA, USA.
- Stebbins GL. 1950. *Variation and Evolution in Plants*. Oxford University Press, London, UK.
- Takhtajan AL. 1980. *Outline classification of flowering plants and Magnoliophytes*. *The Botanical Review*, 46(3): 225-359.

## Field Work and Seminar

**Course title:** Field Work and Seminar

**Course No.:** BOT 509

**Nature of course:** Field Work and Seminar

**Level:** MSc, I Semester

**Full marks:** 50

**Pass marks:** 25

**Credits:** 2

**Credit hours:** 32

### Objectives

- Familiarize student with techniques of specimen collection, preservation and curation (field work for 2 times each of 7 days)
- Enable students to prepare report based on field work and present their finding
- Develop skill to review scientific literatures, their synthesis, and presentation.