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	**Field work** (techniques of specimen collection, preservation and curation – 2 times each of 7 days) and **seminar**	2	50
Total		**17**	**425**

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	**Field work** (techniques of ecological sampling, vegetation and floristic study – 1 time of at least 15 days duration) and **seminar**	2	50
Total		**18**	**450**

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
Total		**3+3**	**150**

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

Course No	Title	Credit	FM
	Group A		
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
	Group 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
	Group C		
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
	Group D		
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
Total		**6 + 2**	**200**

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
Total		**3+1**	**100**

** 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

Course No.	Title	Credit	FM
BOT 651	Dissertation**	8	200
Total		**8**	**200**

*** 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	**Field work** (techniques of specimen collection, preservation and curation – 2 times each of 7 days) and **seminar**	2	50
Total		**17**	**425**

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 (Maxomyceties), Mastigomycotina (Chytridiomycetes) and Amastigomycotina (Zygomycetes, Ascomyceties, Basidiomyceties and Deutromycetes). **[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 pathogencity; 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; symtomatology 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**].

Course title: Diversity and Evolution of Fungi, Bacteria, Virus and Lichen	**Full marks:** 25
Course No.: BOT 502	**Pass marks:** 12.5
Nature of course: Practical	**Credits:** 1
Level: MSc, I Semester	**Credit hours:** 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 (Symtomatology: 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* (2nd 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, Arnhem, The Netherlands.

Thomas N.H. 2008. *Lichen Biology.* Cambridge University Press. Cambridge, UK.

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

Course title: Diversity and Evolution of Non-Vascular Plants: Algae and Bryophytes	**Full marks:** 75
Course No.: BOT 503	**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 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 pryophytes; 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, Bacillarophyceae, 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 phyco-remediation; 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; Sphaerocarpales 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**].

Course title: Diversity and Evolution of Non-Vascular Plants: Algae and Bryophytes	**Full marks:** 25
Course No.: BOT 504	**Pass marks:** 12.5
Nature of course: Practical	**Credits:** 1
Level: MSc, I Semester	**Credit hours:** 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 microphotograpy 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 Wyne 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 Netherland.

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 Publsher.

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

Course title: Diversity and Evolution of Vascular Plants I: Pteridophytes and Gymnosperms	**Full marks:** 75
Course No.: BOT 505	**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 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, Hyeniales, 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**].

Course title: Diversity and Evolution of Vascular Plants I: Pteridophytes and Gymnosperms	**Full marks:** 25
Course No.: BOT 506	**Pass marks:** 12.5
Nature of course: Practical	**Credits:** 1
Level: MSc, I Semester	**Credit hours:** 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: Lycopsida (*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.

Mehltreter, 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

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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.

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Shrestha T.B. and Dobremez J.F. 1974. *Gymnosperms of Nepal*. Cahiers Nepalais Doc. 3, Centre Natioanl de la Recherche Scientific, France.

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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

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

Course title: Diversity and Evolution of Vascular Plants II: Angiosperms	**Full marks:** 25
Course No.: BOT 508	**Pass marks:** 12.5
Nature of course: Practical	**Credits:** 1
Level: MSc, I Semester	**Credit hours:** 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	**Full marks:** 50
Course No.: BOT 509	**Pass marks:** 25
Nature of course: Field Work and Seminar	**Credits:** 2
Level: MSc, I Semester	**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.

Tribhuvan University

Institute of Science and Technology

Central Department of Botany

M.Sc. Botany Syllabus

Second Semester

2074

Course Outline

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	**Field work** (techniques of ecological sampling, vegetation and floristic study – 1 time of at least 15 days duration) and **seminar**	2	50
Total		**18**	**450**

Ecology

Course title: Ecology	**Full marks:** 75
Course No.: BOT 551	**Pass marks:** 37.5
Nature of course: Theory	**Credits:** 3
Level: MSc, II Semester	**Credit hours:** 48

Objectives

The general aim of this course is to impart fundamental knowledge about the structural and functional aspects of ecology. The specific objectives are to:

- Give an introduction to the basic ecological principles on population, community and ecosystem levels
- Make the students understand the problems, issues and challenges pertaining to environment

Course content

Unit 1. Population ecology: (i) Concept and characteristics. (ii) Population growth models and regulation; life history strategies; meta-population concept. (iii) Measurement and experimental design for population study. (iv) Factors controlling distribution pattern. (v) Major theories of geographical distribution patterns: Lotka-Voltiera, vicariance, isolation, and nunatak. [**12 h** (1+4+3+2+2)].

Unit 2. Community ecology: (i) Introduction and history. (ii) Hierarchical concept: species and speciation. (iii) Community pattern: community composition, species richness, and productivity. (iv) Methods in vegetation study; gradient analysis: regression, ordination, and classification (hierarchical, k-means and fuzzy clustering). (v) Major biological and environmental determinants of community pattern (scales, area, adaptations). (vi) Community dynamics: boundary concept; ecotone, conservatism and resilience, biological mechanism of ecological succession, changes in ecosystem properties during succession. (vii) Methods of measuring succession: lichenometry, dendrochronology, palaeoecology, radio carbon dating, long term ecological research (LTER). [**15 h** (1+1+2+4+2+3+2)].

Unit 3. Ecosystem ecology: (i) Forest ecology: introduction, forest biomes of the world, forest types and phytogeography in the Himalayas, community attributes (composition, profile structure, regeneration, phenology), ecosystem services, carbon dynamics, REDD (reducing emission from deforestation and degradation). (ii) Wetland ecology: introduction, global distribution of wetlands, types of wetlands with special reference to freshwater wetland ecosystem, service and function of wetlands, threats to wetlands, conservation and management, Ramsar sites of Nepal. (iii) Grassland ecology: introduction, types and global distribution, factors determining grassland development and distribution, productivity, grassland and climate change, grassland management. [**15 h** (5+5+5)].

Unit 4. Contemporary environmental issues: (i) Biodiversity loss. (ii) Pollution. (iii) Climate change. (iv) Biological invasion. [**6 h** (2+1+2+1)].

Course title: Ecology	**Full marks: 2**5
Course No.: BOT 552	**Pass marks:** 12.5
Nature of course: Practical	**Credits:** 1
Level: MSc, II Semester	**Credit hours:** 16×4

Course content

1. To determine the Importance Value Index (IVI) of plants in a community.
2. To measure species diversity (Simpson, and Shannon-Weiner indices) of a plant community.
3. To determine sticky point and water holding capacity of different soil samples.
4. To determine the water rising and percolation rate of different soil samples.
5. To estimate humus content in different soil samples.
6. To measure pH of soil samples.
7. To determine soil texture of different soil samples.
8. To summarize and analyze climatic data from different parts of Nepal.
9. To determine the age structure from population data of Nepal.
10. To determine dissolved oxygen (DO) in different water samples.
11. To estimate acidity of given water samples by titration.

Text and reference books

Begon M., Townsend C.R and Harper J. L. 2006. *Ecology: Individuals, Populations and Communities*. 4th edition. Blackwell Publishing Ltd.

Grime J.P. 2001. *Plant Strategies, Vegetation Processes, and Ecosystem Properties*. 2nd edition. Chichester (United Kingdom) and New York: John Wiley & Sons..

Krebs C.J. 1994. *Ecology: the Experimental Analysis of Distribution and Abundance*. 4th edition. Addison-Wesley Educational Publoishers, Inc., USA.

Odum E.P. 1996. *Fundamentals of Ecology*. Natraj Publishing, Dehradun, Inida.

Singh J.S., Singh S.P. and Gupta S.R. 2006. *Ecology, Environment and Resource Conservation*. Anamaya Publishers, New Delhi.

Suggested further readings

Barbour M.G., Burk J.H., Pitts W.D., Gilliam F.S. and Schwartz M.W. 1999. *Terrestrial Plant Ecology*. 3rd edition, Benjamin/Cummings.

Callaway R.M. 2007. *Positive Interactions and Interdependence in Plant Communities*. Springer.

Chase J.M. and Leibold M.A. 2003. *Ecological Niches: Linking Classical and Contemporary Approaches*. The University of Chicago Press.

Gaugh H.G. 1982. *Multivariate Analysis in Community Ecology*. Cambridge University Press, Cambridge.

Hill D., Fasham M., Tucker G., Shewry M. and Shaw P., eds. 2005. *Handbook of Biodiversity Methods: Survey, Evaluation and Monitoring*. Cambridge University Press, Cambridge.

Huston M.A. 1994. *Biological Diversity: The Coexistence of Species on Changing Landscapes*. Cambridge University Press.

Jonathan C. 2007. *Climate Change*. Cambridge University Press, Cambridge.

Korner C. 2003. *Alpine Plant Life: Functional Plant Ecology of High Mountain Ecosystems*. 2nd edition. Springer.

Kreshaw K.A. 1973. *Quantitative and Dynamic Plant Ecology*. English Language Book Society, London.

Larcher W. 1995. *Physiological Plant Ecology*. Springer

Myers J. H. and Bazely D. 2003. *Ecology and Control of Introduced Plants*. Cambridge University Press. Cambridge.

Nagy L. and Grabherr G. 2009. *The Biology of Alpine Habitats* . Oxford University Press, USA.

Perlman D.L. and Adelson G. 1997. *Biodiversity: Exploring Values and Priorities in Conservation.* Blackwell Science, Massachusetts, USA.

Silvertown J. 1987. *Introduction to Plant Population Ecology* . Longman Scientific & Technical, UK.

Singh J.S. and Singh S.P. 1992. *Forests of Himalaya: Structure, Functioning and Impact of Man*. Gyanodaya Prakashan, Nainital, India.

Stainton J.D.A. 1972. *Forest of Nepal*. John Murray, London.

Waltner-Toews D. 2004. *Ecosystem Sustainability and Health.* Cambridge University Press,

WCMC (World Conservation Monitoring Centre). 1992. *Global Biodiversity: Status of the Earth's Living Resources.* Chapman & Hall, London.

Wiens John A., Moss Michael R., eds. 2005. *Issues and Perspectives in Landscape Ecology*. Cambridge University Press, Cambridge.

Wilson E.O. 1988. *Biodiversity*. National Academic Press, Washington, D.C.

Woodward F.I. 1996. *Climate and Plant Distribution.* Cambridge University Press, UK.

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Gupta, P.K. 2000. *Methods in Environmental Analysis: Water, Soil and Air.* Agrobios (India), Jodhpur, India.

Kreshaw K.A. 1973. *Quantitative and Dynamic Plant Ecology.* English Language Book Society, London.

Zobel, D.B., Behan M.J., Jha, P.K. and Yadav, U.K.R. 1987. *A Practical Manual for Ecology*. Ratna Book Distributors, Kathmandu, Nepal

Cytology and Genetics

Course title: Cytology and Genetics	**Full marks:** 75
Course No.: BOT 553	**Pass marks:** 37.5
Nature of course: Theory	**Credits:** 3
Level: MSc, II Semester	**Credit hours:** 48

Objectives

The general aim of this course is to impart theoretical and practical knowledge about cytology, genetics and evolution. The specific objectives are to:

- Give the students fundamental knowledge about cell, cell organelles and principles of cell signaling
- Impart knowledge about the nature of gene and genome, and mechanism of gene expression
- Impart understanding of the theory of inheritance and evolution
- Make the students understand the recent aspects of plant breeding, genetic manipulations and their impact on human life

Course content

Unit 1. Cell: Structure and reproduction: (i) Major intracellular compartments of eukaryotic cells, endosymbiont hypothesis on the evolution of mitochondria and chloroplast. (ii) Biological membranes (chemical composition, structure and function of membrane). (iii) Cyto-skeleton: structure, assembly, disassembly and regulation of microfilaments, microtubules and intermediate filaments. (iv) Cell communication and cell signaling (general principles, signaling molecules and their receptors). (v) Cell cycle and regulation of cell division, chromosomal behavior during meiosis. [**8 h** (1+1+1+3+2)].

Unit 2. Structural organization of genome: (i) Genome organization in virus, prokaryotic genome (folded chromosome of *E. coli*), eukaryotic genome (organization of nuclear and organellar genomes). (ii) Chromosome structure: eukaryotic chromatin and chromosomes; histones and non-histone proteins, nucleosomal organization of chromatin, higher levels of chromatin structure, chromosomal packing and structure of metaphase chromosome, structure and function of centromere and telomere, special chromosomes. (iii) Chromosome banding patterns and their use in cytogenetics. [**8 h** (3+4+1)].

Unit 3. Structure, expression and regulation of gene: (i) Nucleic acids: structure, chemistry and types, replication of DNA in prokaryotes and eukaryotes. (ii) Concept of gene: molecular structure of prokaryotic and eukaryotic genes, genetic code. (iii) Changes in gene structure and correction mechanism. (iv) Gene expression and its regulation. [**10 h** (3+2+2+3)].

Unit IV. Genetics and plant breeding: (i) Theory of inheritance: overview of Mendel's laws, interaction of genes (allelic and non-allelic); linkage and chromosome mapping; cytoplasmic inheritance, sex determination in plants, influence of environment on heredity. (ii) Population genetics: introduction to population genetics, the Hardy-Weinberg Equilibrium and its significance; describing genetic variation and diversity, relationship between species traits and population genetic diversity. (iii) Genetics and evolution: sources of genetic variation (mutation, gene flow, selection and drift); migration, speciation and genetic variation, inbreeding and heterosis; macro- versus micro-evolution. (iv) Human genetics: blood group inheritance, human chromosomes and sex-linked diseases, in-born error of metabolism,

cancer genetics, genetic counseling. (v) Genetics and human affairs: introduction to genetic engineering, transgenic plants (problems and solutions). (vi) Plant breeding: overview of plant breeding methods; conventional and mutation breeding. [**22 h** (7+5+4+3+1+2)].

Course title: Cytology and Genetics	**Full marks:** 25
Course No.: BOT 554	**Pass marks:** 12.5
Nature of course: Practical	**Credits:** 1
Level: MSc, II Semester	**Credit hours:** 16×4

Course content

1. Preparation of different types of solutions for cytological study:
   a. 8-Hydroxyquinoline and Colchicine
   b. Carnoy's Solutions
   c. Aceto-Carmine
2. Study of cytological techniques:
   a. Collection of roots
   b. Pretreatment of roots
   c. Fixation and
   d. Staining of chromosomes
3. Study of chromosomal behavior of different phases of mitosis cell division of *Allium cepa/Triticum aestivum/Lens culinaris*.
4. Determination of mitotic index of *Allium cepa/Triticumaestivum/ Lens culinaris*root meristem
5. Determination of mitotic phase index in root meristem of *Allium cepa/Triticum aestivum/Lens culinaris*.
6. Preparation of permanent slide of mitotic cell division of *Allium cepa/ Triticumaestivum/ Lens culinaris*.root meristem.
7. Study of chromosomal behavior of different phases of meiosis cell division of *Allium cepa/Triticum aestivum/Lens culinaris*.
8. Study of giant chromosome.
9. Study of pollen fertility.
10. Study of plant breeding techniques.
11. Extraction of DNA from plant material.

Text and reference books

Briggs D. and Walter S.M. 1997. *Plant Variation and Evolution*. Cambridge University Press.

De Robertis E.D.P. and De Robertis E.M.F. (Jr.). 1995. *Cell and Molecular Biology*. Waverly Pvt. Ltd. New Delhi, India.

Sarin C. 1993. *Genetics*. Tata McGraw-Hill Publishing Co. Ltd., New Delhi, India.

Snustad, D.P. and Simmons, M.J. 1999. *Principles of Genetics*. 2nd edition. John Wiley & Sons.Inc.

Stebbin G.L. 1979. *Process of Organic Evolution*. Prentice-Hall of India Pvt. Ltd., New Delhi, India.

Strickberger M.W. 1996. *Genetics*. Prentice-Hall of India Pvt. Ltd. New Delhi, India.

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Czepulkowski B. 2001. *Analyzing Chromosomes* (Basics). BIOS Scientific Publishers, Oxford, UK.

Darlington C.D. 1964. *Chromosome Botany and the Origins of Cultivated Plants*. George Allen Unwin Ltd., the University Press, Aberdeen, UK

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de Jong Tom and Klinkhamer P. 2005. *Evolutionary Ecology of Plant Reproductive Strategies.* Cambridge University Press. Cambridge, UK.

Frankham R., Ballou J. and Briscoe D. 2009.*Introduction to Conservation Genetics*. Cambridge University Press, Cambridge, UK.

Freifelder D. 1986. *Molecular Biology*. Jones &Barriet Publishing Inc., Boston, Portola Valley.

Futuyma D.J. 1998. *Evolutionary Biology*. 3rd ed. Sinauer Associates, Sunderland, Massachusetts.

Gomperts B.D. 1976. *The Plasma Membrane: Models for its Structure and Function*. Academic Press.

Gunning B.E.S. and Steer M.W. 1975. *Ultrastructure and the Biology of Cells*. Edward Arnold.

Gupta P.K. 1998. *Genetics*. Rastogi Publications, Shivaji Road, Meerut.

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Hartman P.E. and Suskind S.R. 1972.*Gene Action*. Prentice-Hall of India Pvt. Ltd., New Delhi, India.

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Levin B. 1998. *Genes VI* .Oxford University Press, London.

Niklas Karl J. 1997. *The Evolutionary Biology of Plants*. The University of Chicago Press, Chicago, USA.

Packer L. 1976.*Mitochondria: Bioenergetics, Biogenesis and Membrane Structure*. Academic Press, NY, USA.

Pigliucci M. and Kaplan J. 2006. *Making Sense of Evolution: The Conceptual Foundations of Evolutionary Biology*. The University of Chicago Press, Chicago, USA.

Risley M.S. 1986. *Chromosome Structure and Function*. Van Nostrand, Reinholt.

Roger B., Bridle J. and Schluter D. 2009. *Speciation and Patterns of Diversity*. Cambridge University Press, Cambridge, UK.

Rost T.L. Gifford, Jr. and Ernest M. 1977. *Mechanism and Control of Cell Division*. Academic Press, NY, USA.

Rothwell N.V. 1983. *Genetics*. Oxford University Press, UK.

Sharma A.K. and Sharma A. 1985. *Advances in Chromosome and Cell Genetics*. Oxford & IBH Publishing Co., India.

Sharma AK and Sharma A. 1990. *Chromosome Techniques: Theory and Practice*. Butterworth & Co. Ltd., New Delhi, India.

Singh R.J. 2002.*Plant Cytogenetics*. 2nd edition. CRC Press, Florida, USA.

Sinha U. and Sinha S. 1997. *Cytogenetics, Plant Breeding and Evolution*. Vikas Pvt. Ltd., India.

Sinnot E.W., Dunn L.E. and Dobshansky T. 1973. *Principles of Genetics*. TMH Edn.

Stebbin (Jr.) G.L. 1968.*Variation and Evolution in Plants*. Oxford & IBH Publishing Co., Delhi, India.

Willis K. J. and McElwain J.C. 2002.*The Evolution of Plants*. Oxford University Press, USA.

Winchester A.M. 1979.*Genetics*: *A Survey of the Principles of Heredity*. Oxford & IBH Publishing Co., New Delhi, India.

Plant Physiology

Course title: Plant Physiology	**Full marks:** 75
Course No.: BOT 555	**Pass marks:** 37.5
Nature of course: Theory	**Credits:** 3
Level: MSc, II Semester	**Credit hours:** 48

Objectives

The general aim of this course is to impart theoretical and practical knowledge about various physiological phenomena occurring in plant life in relation to changing environment. The specific objectives are to:

- Advance the knowledge of students on various metabolic processes
- Impart understanding of physiological processes in relation to plant growth and development
- Make the students understand the physiological processes in relation to environment change

Course content

Unit 1. Mineral nutrition and solute transport in plants: Mineral nutrition of plants an overview; acquisition and transport of mineral ions by plants; factors affecting availability and absorption of mineral ions. [**3 h**].

Unit 2. Nitrogen assimilation: Uptake and utilization of nitrogen in plants, biological nitrogen fixation (symbiotic and asymbiotic). [**3 h**].

Unit 3. Bioenergetics and ATP synthesis: Laws of thermodynamics and energy transformation in living systems, energy transformation and coupling, energy transduction and chemiosmotic synthesis of ATP in chloroplast and mitochondria. [**4 h**].

Unit 4. Photosynthesis: An overview of photosynthesis (photosynthetic apparatus, photosynthetic electron transport system, photosynthetic carbon assimilation – comparative account of C_3, C_4 and CAM pathways); allocation, partitioning and translocation of photosynthate; photorespiration and its effect on plant productivity; law of limiting factors with reference to climate change. [**5 h**].

Unit 5. Respiration: Overview of plant respiration, structural organization of mitochondria, electron transport and terminal oxidation, oxidative pentose phosphate pathway. [**4 h**].

Unit 6. Lipid metabolism: Properties and function of lipids, mechanism of synthesis of saturated and unsaturated fatty acids, oxidation of fat and fatty acid, gluconeogenesis. [**5 h**].

Unit 7. Secondary metabolites: Introduction, secondary metabolites and plant defense (metabolism and significance of terpenes, phenolic compounds and nitrogen-containing compounds). [**5 h**].

Unit 8. Environmental physiology: Functional adaptation of plants in terrestrial and aquatic environments, plant water relations; physiological responses to biotic and abiotic (water, minerals, temperature, oxygen) stresses; mechanism of stress injury and resistance; concept of allelopathy and phytoalexin; stress induced gene expression. [**8 h**].

Unit 9. Developmental physiology: Plant growth and development; the analysis of plant growth; phytochrome and light control of plant development; hormonal control of growth, plant growth regulators (biosynthesis, translocation, bioassay, physiological effects, and cellular and molecular mechanisms of action: hormone receptors and signal transduction); seed physiology; physiology of senescence and ageing; physiology of fruit ripening. [**11 h**].

Course title: Plant Physiology	**Full marks:** 25
Course No.: BOT 556	**Pass marks:** 12.5
Nature of course: Practical	**Credits:** 1
Level: MSc, II Semester	**Credit hours:** 16×4

Course content

1. Visit to the nearby field to study the deficiency syndromes of different minerals
2. Determination of absorption spectrum of chlorophyll pigments
3. Demonstration of Hill reaction
4. Document the C_3 and C_4 plants from nearby locality on anatomical basis
5. Study the diurnal fluctuation in acidity of cell sap in succulent plants
6. Isolation and separation of different photosynthetic pigments
7. Localization of fats in germinating mustard/soybean cotyledons
8. Extraction and qualitative test of secondary metabolites present in plants
9. Determination of water potential of plant tissues
10. Effect of different plant hormones on seed germination and seedling growth
11. Effect of different hormones on plant senescence (chlorophyll retention)
12. Effect of different hormones in breaking seed dormancy
13. Bioassay of phytohormones (auxins, cytokinins, Gibberellins)

Text books

Bhattarai, T. 2005. *Plant Physiology*. Bhundipuran Prakashan, Kathmandu.

Hopkins, W.G. and Huner, N.P.A. 2010. *Introduction to Plant Physiology*. 4th edition. John Wiley and Sons Inc.

Mukerjee, S. and Ghosh, S.K. 2012. *Plant Physiology*. New Central Book Agency, New Delhi, India

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Reference Books

Bajracharya, D. 1999. *Experiments in Plant Physiology*. Narosa Publishing House, New Delhi.

Bard J. 1990. *Morphogenesis*. Cambridge University Press, London.

Baskin C.C. and Baskin J.M., 1998. *Seeds: Ecology, Biogeography, and Evolution of Dormancy and Germination*. Academic Press, San Diego, USA.

Bieleski R.L., A.R. Ferguson and Creswell M.M., eds. 1974. *Mechanisms of Regulation of Plant Growth*. The Royal Society of New Zealand, Wellington.

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Mayer A.M. and Poljakoff-Mayber A. 1989. *The Germination of Seeds*. Pergamon Press, Oxford.

Murphy T.M. and Thompson W.F. 1988. *Molecular Plant Development*. Prentice Hall, New Jersey.

Mussell H. and Staples R. 1979. *Stress Physiology in Crop Plants*. Wiley-Interscience, NY, USA.

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Steward F.C. 1971. *Plant growth and Development*. Academic Press, NY, USA.

Turner N.C. and Kramer P.J. 1980. *Adaptation of Plants to Water and High Temperature Stress*. John Wiley and Sons, NY, USA.

Wardlaw C.W. 1968. *Morphogenesis in Plants*. Metheum & Co., London.

Plant Systematics

Course title: Plant Systematics	**Full marks:** 75
Course No.: BOT 557	**Pass marks:** 37.5
Nature of course: Theory	**Credits:** 3
Level: MSc, II Semester	**Credit hours:** 48

Objectives

The general aim of this course is to impart theoretical and practical knowledge on taxonomy of angiosperms. The specific objectives are to:

- Advance the knowledge of students on principles of angiosperm taxonomy, nomenclature and classification systems
- Impart understanding of the systematics and evolutionary trends in different taxa
- Impart understanding of the history and recent developments in Flora of Nepal
- Make the students understand the role of taxonomy in plant conservation.

Course content

Unit 1. Nature and concept of taxa: (i) Basic terminologies, taxonomic characters. (ii) Taxonomic hierarchy and concepts of categories: concept of species, types of species, intraspecific categories (subspecies, variety and forms), genus and higher categories. [**6 h** (2+4)].

Unit 2. Principles and approaches of classification: (i) Introduction: brief overview of the principles and background of biological classification. (ii) Pre-Darwinian systems: overview of Theophrastus, Linnaean, and Bentham and Hooker systems. (iii) Post-Darwinian and phyletic systems: overview of Engler and Prantl, Bessey, Hutchinson, Takhatajan and Cronquist systems. (iv) Phenetic (numerical taxonomy) and cladistic approaches: introduction to phylogeny and phylogenetic systematics, introduction to phenetic and cladistic approaches, nature and sources of information, assumptions, methodological steps, dendrograpm and cladogram construction and analysis. (v) Angiosperm Phylogeny Group (APG) classification: principles and ranks with major angiosperm clades, with updated version. [**15 h** (1+2+3+6+3)].

Unit 3. Botanical nomenclature: International Code of Botanic Nomenclature (history, principles, rules, important articles); typification; rules of effective and valid publications; retention, rejection, and choice of names. [**4 h**].

Unit 4. Systematic studies and evolutionary trends of major Angiospermic clades: basal order (Nymphaeales), Magnoliids (Magnoliales), Monocotyledones (Liliales), Commelinoides (Poales), Eudicots (Ranunculales), Core Eudicots (Caryophyllales), Rosids (Geraniales), Euroides- I (Rosales), Euroids –II (Sapindales), Asterids (Ericales), Euasterids –I (Lamiales), Euasterids-II (Asterales). [**12 h**].

Unit 5. Herbarium taxonomy, and taxonomic tools: surveys and monitoring, plant collection and herbarium technique, curation of living material, herbaria and taxonomic libraries, plant identification techniques. [**3 h**].

Unit 6. Botanical exploration and Flora of Nepal: History of botanical exploration in Nepal, Flora of Nepal. [**2 h**].

Unit 7. Taxonomy and plant conservation: Taxonomy and species conservation – introduction; taxonomy and the implementation of conventions and global strategies – Convention on Biological Diversity (CBD), Global Strategy for Plant Conservation (GSPC), Global Taxonomy Initiative (GTI), Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); IUCN Red List categories and threatened species conservation. [**6 h**].

Course title: Plant Systematics	**Full marks:** 25
Course No.: BOT 558	**Pass marks:** 12.5
Nature of course: Practical	**Credits:** 1
Level: MSc, II Semester	**Credit hours:** 16×4

Objectives

The general aim of this course is to impart practical knowledge on taxonomy of angiosperms. The specific objectives are

- to impart basic techniques on collection, herbarium preparation, identification, preservation and documentation of specimens of angiosperms.
- to impart basic knowledge on using keys for plant identification.

Course content

1. Plant description and identification

- Identification of selected groups of angiosperms up to species level using keys and literature.
- Description of plants by using semi-technical taxonomic terminology representing the families (minimum 10 families) mentioned in unit 4, based on macro- and micro-morphological studies.

2. Interrelationships and phylogeny

- *Phenetic approach*: data correlation, data coding, analysis (cluster analysis, PCA), construction of dendrogram/phenogram
- *Cladistic approach*: data correlation, data coding, construction of cladogram, and tracing phylogenetic relationships

3. Field work

- Field trips to learn collection of specimens and herbarium techniques (refer to Course Bot. 559).

Text and reference books

Judd W.S., Campbell C.S., Kellogg E.A., Stevens P.F., Donoghue M.J. 2015. *Plant Systematics: A Phylogenetic Approach*. Fourth edition. Sinauer Associates, Inc.

Simpson M.G. 2010. *Plant Systematics*. Second edition. Academic Press, USA.

Stuessy T.F. 2009. *Plant Taxonomy: The Systematic Evaluation of Comparative Data*, 2nd edition. Columbia University Press, NY, USA.

Woodland D.W. 2009. *Contemporary Plant Systematics*. Fourth edition. Andrews University Press, Berrien Springs, MI, USA.

References for practical

Bridson D. and Forman L 1999. *The Herbarium Handbook*. Third edition. Royal Botanic Gardens, Kew, UK.

Davis P.H. and Cullen J. 1965. *The Identification of Flowering Plant Families*. Oliver & Boyd, Edinburgh & London, UK.

Long D.J. 1999. *Flora of Bhutan*. Volumes 1, 2, 3 parts 1, 2, 3. Royal Botanic Gardens, Edinburgh, UK.

Malla S.B., Rajbhandary S.B., Shrestha T.B., Adhikari P.M., Adhikari S.R. and Shakya P.R. (eds). 1986. *Flora of Kathmandu Valley*. Department of Medicinal Plants, Thapathali, Kathmandu.

Watson M.F., Akiyama S., Ikeda H., Pendry C.A., Rajbhandari K.R. and Shrestha K.K. 2011. *Flora of Nepal. Volume 3*. Royal Botanic Garden Edinburgh.

Suggested further readings

Chaudhary R.P. 1998. *Biodiversity in Nepal: Status and Conservation*. S. Devi, Saharanpur, India and Tecpress Books, Bangkok, Thailand.

Cronquist A. 1988. *The Evolution and Classification of Flowering Plants*. Nelson, NY, USA.

Cullen J. 2004. *The Identification of Flowering Plant Families*. Oliver & Boyd, UK.

Dahlgren R. 1984. *The Families of Monocotyledons: Structure, Evolution and Taxonomy*. Springer Verlag.

Davis P.H. and Cullen J. 1965. *The Identification of Flowering Plant Families*. Oliver & Boyd, Edinburgh & London, UK.

Davis P.H. and Heywood V.H. 1963. *Principles of Angiosperm Taxonomy*. Oliver & Boyd, Edinburgh & London, UK.

Faegri K and Iverson J. 1989. *Textbook of Pollen Analysis*. John Wiley & Sons.

Greuter W. et.al., eds., 1988. *International Code of Botanical Nomenclature*. Intl. Ass. Plant Tax. Leiden.

Herzberg F.O., Brown A.H.D., Burdon J.J. 1995. *The Conservation of Plant Biodiversity*. Cambridge University Press. Cambridge, UK.

Heywood V.H., ed. 1968. *Modern Methods in Plant Taxonomy*. Academic Press, NY, USA.

Jones S.B. and Luchsinger A.E. 1979. *Plant Systematics*. McGraw-Hill Book Company, NY, USA.

Lawrence G.H.M. 1951. *Taxonomy of Vascular Plants*. Oxford & IBH, New Delhi, India.

Leadlay E. and Jury S. 2006. *Taxonomy and Plant Conservation*. Cambridge University Press.

Naik V.N. 1984. *Taxonomy of Angiosperms*. Tata McGraw hill Publishers, New Delhi, India.

Perlman, D.L. and Adelson, G. 1997. *Biodiversity: Exploring Values and Priorities in Conservation*. Blackwell Science, Massachusetts, USA.

Roger B., Bridle J. and Schluter D.. 2009. *Speciation and Patterns of Diversity*. Cambridge University Press, Cambridge, UK.

Shivarajan V.V. 1991. *Introduction to the Principles of Plant Taxonomy*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India.

Shrestha T.B. and Joshi R.M. 1996. *Rare, Endemic and Endangered Plants of Nepal*. WWF Nepal Program, Kathmandu, Nepal.

Siwakoti M. and Rajbhandary S., eds. 2015. Taxonomic Tools and Flora Writing. Department of Plant Resources, Ministry of Forests and Soil Conservation and Central Department of Botany, Tribhuvan University, Kathmandu, Nepal.

Sporne K.R. 1974. *The Morphology of Angiosperms*. Hutchinson and Co. Ltd., London.

Stace C.A. 1980. *Plant Taxonomy and Biosystematics*. Edward Arnold, London.

Takhtajan A.L. 1980. Outline classification of flowering plants and Magnoliophytes. *The Botanical Review*, 46(3): 225-359.

Takhtajan A.L. 1991. *Evolutionary Trends in Flowering Plants*. Colombia University Press, NY, USA.

UNEP 2002. Global Strategy for Plant Conservation. Decision V1/9, UNEP/CBD/COP/6/20. Secretariat of the Convention on Biological Diversity, Montreal, Quebec, Canada.

UNEP 2002. Global Taxonomy Initiative (GTI). Decision V1/8, UNEP/CBD/COP/6/20. Secretariat of the Convention on Biological Diversity, Montreal, Quebec, Canada. www.bidiv.org/programmes/cross-cutting/taxonomy/default.asp.

Willis K.J. and McElwain J.C. 2002. *The Evolution of Plants.* Oxford University Press, USA.

Important Journals

- *Annals of the Missouri Botanical Garden*
- *Australian Systematic Botany*
- *Blumea*
- *Botanical Journal of the Linnean Society*
- *Curtis's Botanical Magazine*
- *Edinburgh Journal of Botany*
- *European Journal of Taxonomy*
- *Harvard Papers in Botany*
- *Journal of Japanese Botany*
- *Journal of Systematics and Evolution*
- *Nordic Journal of Botany*
- *Novon*
- *Phytokeys*
- *Phytotaxa*
- *Plant Systematics and Evolution*
- *Systematic Botany*

Fieldwork and Seminar

Course title: Fieldwork and Seminar	**Full marks:** 50
Course No.: BOT 559	**Pass marks:** 25
Nature of course: Fieldwork and seminar (**Practical**)	**Credits:** 2
Level: MSc, II Semester	**Credit hours:** 32×4

Objectives

- Familiarize student with techniques of ecological sampling, vegetation and floristic study (1 time of at least 15 days duration).
- Enable students to prepare report based on field work and present their finding
- Develop skill to review scientific literatures, their synthesis, critical analysis, and presentation

Tribhuvan University

Institute of Science and Technology

Central Department of Botany

M.Sc. Botany Syllabus

Third Semester

2074

Course Outline

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
BOT603	Dissertation Proposal and Seminar	1	25
Total		**3+3**	**150**

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

Course No	Title	Credit	FM
	Group A		
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
	Group 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
	Group C		
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
	Group D		
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
Total		**6 + 2**	**200**

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
Total		**3+1**	**100**

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

COMPULSORY PAPERS (6 credits)

Research Design and Biological Data Analysis

Course title: Research Design and Biological Data Analysis	**Full marks:** 75
Course No.: BOT 601	**Pass marks:** 37.5
Nature of course: Theory	**Credits:** 3
Level: MSc, III Semester	**Credit hours:** 48

Objectives

The overall aim is to develop basic skills in original research in plant science and provide basic training in methods of data analysis. The specific objectives are to provide/develop (i) understanding on research design, (ii) computational and analytical understanding necessary for processing and analyzing biological data, and (iii) basic understanding of the theory and practice of geographical information systems (GIS) and remote sensing techniques within the field of application in biodiversity conservation.

Course content

Unit 1: Research design and hypothesis testing: (i) Research design: introduction, types of research design. (ii) Populations, samples and observations; types of variables – scale and measurement. (iii) Designing experiments: types of experiments, replication, controls, randomization, independence. (iv) Hypothesis testing: biological and statistical hypotheses, deductive and inductive reasoning, the hypothetico-deductive method. (v) Research ethics, risk and safety measures. [**9 h** (1+1+2+3+2)].

Unit 2. Biological data analysis – an introduction: (i) Variations and statistical inference, managing and curating data; overview of the approaches in biological data analysis: descriptive and inferential statistical analysis, univariate and multivariate analysis. (ii) Descriptive analysis: introduction, measures of central tendency, frequency tables and histograms, stem and leaf plots, measures of dispersion, box-plots and outliers. (iii) Inferential statistical analysis: hypothesis testing and inferential statistics, sampling and inferential statistics, parametric and non-parametric statistics, testing basic assumptions of parametric tests, data transformation methods. [**7 h** (1+3+3)].

Unit 3. Basic analysis: (i) Tests for nominal variables: Chi square test. (ii) Tests for one measurement variable: parametric methods (t-tests and ANOVAs), non-parametric methods. (iii) Tests for multiple measurement variables: correlation and regression analyses. [**10 h** (1+5+4)].

Unit 4. Multivariate analysis: (i) Introduction, aims, nature of multivariate data, concept of similarity, distance measures, multivariate normality. (ii) Ordination and gradient analysis: introduction and concepts, data matrix, constrained and unconstrained analyses, main techniques (DCA, PCA, CA, CCA, RDA, NMDS). (iii) Classification: Hierarchical and K-means clustering, discriminant analysis. [**10 h** (2+6+2)].

Unit 5. Geographical information systems (GIS) and remote sensing (RS): (i) Fundamentals of GIS and remote sensing: introduction, aims and approaches, components and tools, computer system, applications for monitoring and conservation of biodiversity. (ii) Spatial data and database system. (iii) Map features and properties, coordinate system, map projection, coordinate transformation, digital terrain model, digital mapping and visualization of geospatial data. (iv) Introduction to spatial analysis. (v) Satellite imagery and digital image processing. [**12 h** (2+2+3+2+3)].

Course title: Research Design and Biological Data Analysis	**Full marks:** 50
Course No.: BOT 602	**Pass marks:** 25
Nature of course: Practical	**Credits:** 2
Level: MSc, III Semester	**Credit hours:** 32×4

Objectives

The overall aim of this course is to strengthen practical knowledge on biological data analysis, GIS and remote sensing.

Course content

1 Biological data analysis (20 practical)

1.1 Basics

1.1.1 Application of spreadsheets in managing, manipulating and analyzing raw data, displaying results in graphs and tables (1 practical)

1.1.2 Checking data for outliers, errors and missing value (1 practical)

1.1.3 Computer software for univariate and multivariate data analysis (1 practical)

1.2 Statistical methods and data analysis I

1.2.1 Descriptive statistics, testing basic assumptions of parametric tests, data transformation methods (1 practical)

1.2.2 Student's t-test, paired t-test and analysis of variance (3 practicals)

1.2.3 Non-parametric methods (1 practicals)

1.2.4 Correlation and regression analysis (3 practicals)

1.2.5 Categorical data: chi-squared test (1 practicals)

1.3 Statistical methods and data analysis II: multivariate analysis

1.3.1 *Ordination*: obtaining eigenvalue and length of gradient, explorative analysis (DCA), unconstrained analyses (PCA, CA), constrained analyses (CCA, RDA), NMDS (5 practicals)

1.3.2 Defining groups with multivariate data: cluster analysis (2 practicals)

1.3.3 Comparing groups: discriminant analysis (1 practical)

2 GIS and remote sensing (12 practical)

2.1 Working knowledge of GIS Software

2.2 Maps and images and their characteristics

2.3 Data acquisition sources and database concepts

2.4 Map preparation and map upgradation

2.5 Interpretation of satellite images and aerial photographs

2.6 Handling of GPS, using GPS with map and compass, data collection and integration of GPS data

2.7 Load digital data

2.8 File management- raster layer and layer information

2.9 Spatial database building and editing

2.10 Attribute data automation

2.11 Geographic Analysis

2.12 Thematic Maps – road networks, drainage, land etc

2.13 Fundamental of Digital Terrain Modeling (DTM)

2.14 Land use and land cover change identification

2.15 Network analysis

Text and reference books

Burrough P.A. and McDonnell R.A. 2003 *Principles of Geographic Information Systems- Spatial Information Systems and Geostatistics*. Oxford University Press.

Fowler J., Cohen L. and Jarvis P. 1998. *Practical Statistics for Field Biology*. John Wiley and Sons.

Laake P., Benestad H.B. and Olsen B.R. 2007. *Research Methodology in the Medical and Biological Sciences*. Academic Press, CA, USA.

Lepš J. and Šmilauer P. 1999. *Multivariate Analysis of Ecological Data*. Faculty of Biological Sciences, University of South Bohemia, Ceské Budejovice

Muaz J.M. 2013. *Practical Guidelines for Conducting Research. Summarizing Good Research Practice in Line with the DCED Standard*. http://www.enterprise-development.org/page/download?id=2133

Sokal R.R. and Rohlf F.J. 1995. *Biometry* (3rd edition). W.H. Freeman & Company, NY, USA.

Gorard S. 2013. *Research Design: Creating Robust Approaches for the Social Sciences*. SAGE Publications Ltd.

Lilles R.M. and Kiefer R.W. 2002. *Remote Sensing and Image Interpretaion*. 4th Edition. WSE Wiley.

Suggested further readings

Bailey N.T.J. 1994. *Statistical Methods in Biology*. Cambridge University Press, Cambridge.

Crawley M.J. 2007. *The R Book*. John Wiley & Sons Ltd, England, UK.

Crawley M.J. 2012. *Statistical Computing: An Introduction to Data Analysis Using R*.

Gauch H.G. 1982. *Multivariate Analysis in Community Ecology*. Cambridge University Press, Cambridge, UK.

Gotelli N.J. and Ellison A.M. 2004. *A Primer of Ecological Statistics*. Sinauer Associates, Inc. Publishers, Sunderland, MA, USA.

Heywood I., Cornelius S. and Carver S. 2005. *An Introduction to Geographical Information System*. Pearson Education.

ICIMOD 2010. *Basics of Geographic Information Systems and Remote Sensing*. Training course. ICIMOD, Kathmandu.

Jenson J.R. 2003. *Remote Sensing of the Environment- An Earth resources Perspective*. Pearson Education.

Jha P.K., Shakya D.D., Joshi S.D., Chaudhary R.P. and Sakya S.R. 2004. *Research Methods and Practice*. Buddha Academic Publishers and Distributers Pvt. Ltd., Kathmandu, Nepal.

Legendre P. and Gallagher E.D. 2001. Ecologically meaningful transformations for ordination of species data. *Oecologia*, 129: 271–280.

Legendre P. and Legendre L. 2012. *Numerical Ecology*. 3rd English edition. Elsevier Science BV, Amsterdam.

Lo C.P. and Yeung A.KW. 2003. *Concepts and Techniques of Geographic Information System. Prentice*-Hall India.

McCullagh P. and Nelder J.A. 1989: *Generalised Linear Models*. Second Edition. Chapman and Hall, London.

McCune B. and Grace J.B. 2002. *Analysis of Ecological Communities*. MjM Software Design, Oregon, USA.

Quinn P.G. and Keough J.M. 2002. *Experimental Design and Data Analysis for Biologists*. The press Syndicate of the University of Cambridge, Cambridge, UK.

Silbershatz A., Korth H., Sudarshan S. 2005. *Database Systems Concepts*, 5th ed., McGraw-Hill.

Venables W.N., Smith D.M. and the R Development Core Team. 1999–2006. *An Introduction to R*. R Development Core Team.

Dissertation Proposal and Seminar

Course title: Dissertation Proposal and Seminar	**Full marks:** 25
Course No.: BOT 603	**Pass marks:** 12.5
Nature of course: Seminar	**Credits:** 1
Level: MSc, III Semester	**Credit hours:** 16×4

Objectives

The general aim of this course is to provide training in essential scientific communication skills such as dissertation proposal writing and oral presentations.

Course content

Unit 1: Scientific writing and communication: (i) Writing research proposal, report and article: general processes, steps and approaches, grant application. (ii) Literature review: sources and basic approaches. (iii) Poster preparation. (iv) Methods of effective oral presentation. [**7 h** (3+2+1+1)].

Unit 2: Term paper and seminar: Guided work and assignments in literature research in the area of interest and proposal writing for original research project (M.Sc. thesis to be conducted in 4th semester), seminar presentation. [**9 h**].

Text and reference books

Kothari C.R. 1993. *Research Methodology*. Wiley Eastern Ltd., New Delhi, India.

Muaz J.M. 2013. *Practical Guidelines for Conducting Research. Summarizing Good Research Practice in Line with the DCED Standard*. http://www.enterprise-development.org/page/download?id=2133

Stuart C. 2005. *Speak for Yourself: How to Give Persuasive Presentations and Entertaining Talks - with Confidence*. Piatkus, London.

SPECIAL PAPER [any one group] (8 credits)

Group A

BOT. 611, 612. Functional Plant Ecology

BOT. 613, 614. Landscape and Global Change Ecology

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Functional Plant Ecology

Course title: Functional Plant Ecology	**Full marks:** 75
Course No.: BOT 611	**Pass marks:** 37.5
Nature of course: Theory	**Credits:** 3
Level: MSc, III Semester	**Credit hours:** 48

Objectives

The general objective of this paper is to discuss functional aspects from individual plants to ecosystems. The specific objectives are:

- To impart knowledge on nutrient cycles and productivity at various levels of ecological hierarchy
- To provide physiological bases for plant-environment interactions
- To understand plants' responses to varying levels of resources such as water and minerals
- To understand physiological mechanisms of adaptation/defense of plants to varying environmental conditions/stress.
- To discuss functional significance of plant-microbe interactions

Course content

Unit 1. Nutrient cycles and productivity: (i) Biogeochemical cycles: plant nutrients and nutrient use efficiency; quantitative study of biogeochemical cycles (C, N, P, S, hydrologic); cycling of non-essential elements; cycling of organic nutrients; nutrients cycling in different climatic regions; recycle pathways; litter removal and deforestation. (ii) Nutrient budget: nutrient dynamics in grassland, natural forest and converted ecosystems; hydrologic response to forest with particular reference to nutrients, nitrogen relations in population of certain tree species. (iii) Productivity: world distribution and comparison of primary production and biomass; environmental factors and productivity; productivity-diversity relation. [**16 h** (7+5+4)].

Unit 2. Plant physiological ecology: (i) The environment of plants: Atmosphere, hydrosphere, lithosphere, phytosphere, radiation and climate. (ii) Plant water relations: water relations parameters, water availability in soil, water relations of cell, water relations of whole plant (root, stem and leaf), water use efficiency, drought resistance. (iii) Mineral nutrition: mineral nutrients in soil, uptake of mineral nutrients, nutrient acquisition from extreme soil and habitats (acidic soil, calcareous soil, soil with high levels of heavy metals, saline soil, epiphytic habitat). (iv) Growth and allocation: physiological basis of variation of growth, allocation to storage, environmental influences (irradiance, temperature, water potential and salinity, nutrient supply, soil compaction, flooding, elevated CO_2). (v) Physiological adaptation: functional adaptation of plants to extreme environments (alpine and tundra, metal contaminated soil, desert, epiphytic habitat, saline habitat, flooded lands). (vi) Phenology: concept and significance, methods of phenological studies, phenology and climate change. [**18 h** (2+5+3+3+3+2)].

Unit 3. Ecological biochemistry and plant defense: General introduction; cutin, suberin and waxes (introduction and their ecological role); secondary metabolites: principal groups (terpenes, phenolic compounds and nitrogen containing secondary products), site of synthesis and accumulation, role of secondary metabolites in plant defense (herbivory, microbial attack and others); essential oils and their ecological roles; plant defense against pathogens; allelopathy; optimal defense hypothesis. [**8 h**].

Unit 4. Microbial ecology: Scope and history; microbial diversity; interaction between micro-organisms and plants: rhizosphere; mycorrhizae; phyllosphere: microbial abundance, sources of microbes, leaf attributes and environmental factors controlling microbial populations, leaves as islands for colonization; ice nucleation activity and frost injury. [**6 h**].

Course title: Functional Plant Ecology	**Full marks:** 25
Course No.: BOT 612	**Pass marks:** 12.5
Nature of course: Practical	**Credits:** 1
Level: MSc, III Semester	**Credit hours:** 16×4

Course content

I. Experiment

1. To determine organic carbon and organic matter contents of different soil samples.
2. To estimate the available phosphorus content in grassland, cropland and forest soil samples.
3. To estimate the total nitrogen content in different soil samples.
4. To compare litter decomposition rate of different species.
5. To measure the relative growth rate (RGR) and net assimilation rate (NAR).
6. To compare specific leaf area (SLA) of evergreen and deciduous species.
7. To estimate the productivity of aquatic ecosystem by light and dark bottle method.
8. To determine water potential of tree species by pressure chamber.
9. To determine the relative water content (RWC) and bound water content (BWC) in the leaf of different species.
10. To estimate bacterial population of phyllosphere/rhizosphere.
11. To study allelopathic impact of invasive alien plants on seed germination of native plant species.
12. To estimate essential oil content in different plant species.

II. Term paper/bibliographic review of the topics provided in the class/case study

Text books and references

Atlas RM and R Bartha. 2005. *Microbial Ecology: Fundamentals and applications.* Pearson Education, Singapore.

Bailey MJ. AK Lilley, TM Timms-Wilson, PTN Spencer-Philips. (Eds.) 2006. *Microbial Ecology of Aerial Plant Surfaces.* CAB International, UK.

Barbour MG, JH Burk, WD Pitts, FS Gilliam and MW Schwartz. 1999. *Terrestrial Plant Ecology*. 3rd edition. California (USA): Benjamin/Cummings.

Begon M, CR Townsend and JL Harper. 2006. *Ecology: from Individuals to Ecosystems*. Blackwell Publishing Ltd.

Callaway RM. 2007. *Positive Interactions and Interdependence in Plant Communities*. Springer.

Chapman JL and MJ Reiss. 1999. *Ecology: Principles and Applications*. Cambridge University Press.

Crawley MJ (Ed). 1997. *Plant Ecology* (2nd ed.). Blackwell Science Ltd.

Fokkema NJ and JE van den Heuval (eds.). 1986. *Microbiology of the Phylloplane*. Cambridge: Cambridge University Press.

Grime JP. 2001. *Plant Strategies, Vegetation Processes and Ecosystem Properties*. John Wiley & Sons, Chichester.

Gurevitch J, SM Scheiner and GA Fox. 2006. *The Ecology of Plants*. The Sinauer Associates, Inc.

Harborne JB. 1993. *Introduction to Ecological Biochemistry*. Academic Press, New York.

Jonathan C. 2007. *Climate Change*. Cambridge University Press, Cambridge.

Körner C. 2003. *Alpine Plant Life: Functional Plant Ecology of High Mountain Ecosystems* (2nd edition). Springer.

Lambers H, FS Chapin III and TL Pons. 2008. *Plant Physiological Ecology*. 2nd edition. Springer.

Larcher W. 1995. *Physiological Plant Ecology*. Springer

Laszlo N and G Georg. 2009. *The Biology of Alpine Habitats*. Oxford University Press, USA.

Odum EP and GW Barrett. 2005. *Fundamentals of Ecology*. Brooks/Cole, Thompson Asia Pte Ltd. Singapoor.

Singh JS, SP Singh and SR Gupta. 2006. *Ecology, Environment and Resource Conservation*. Anamaya Publishers, New Delhi

Taiz L and E Zeiger. 1998. *Plant Physiology*. Sinauer Associates, Inc., Sunderland, Massachusetts.

Wilson E.O. 1988. *Biodiversity*. National Academic Press, Washington, D.C.

References for practical

Cornelissen JHC, S Lavorel, E Garnier, S Diaz, et al. 2003. A hand book of protocols for standardized and easy measurement of plant functional traits worldwide. *Australian Journal of Botany* 51:335-380.

Gupta, P.K. 2000. *Methods in Environmental Analysis: Water, Soil and Air*. Agrobios (India), Jodhpur, India.

Pearcy RW, J Ehleinger, HA Mooney and PW Rundel (eds.). 1989. *Plant Physiological Ecology: Field Methods and Instrumentation*. Chapman and Hall, New York.

Zobel DB, PK Jha, MJ Behan and UKR Yadav. 1987. *Practical Manual for Ecology*. Ratna Book Distributors, Kathmandu.

Landscape and Global Change Ecology

Course title: Landscape and Global Change Ecology	**Full marks:** 75
Course No.: BOT 613	**Pass marks:** 37.5
Nature of course: Theory	**Credits:** 3
Level: MSc, III Semester	**Credit hours:** 48

Objectives

The general objective of this paper is to impart knowledge of macroecology which includes landscape ecology and components of global changes. The specific objectives are:

- To introduce the concept of landscape approaches in ecological studies and conservation
- To understand structural and functional aspects of mountain ecosystem.
- To discuss various components of global changes such as land use change, biodiversity loss, climate change and biological invasion.

Course content

Unit 1. Landscape ecology: (i) Principles and applications: concepts of landscape ecology, causes of landscape pattern, organisms and landscape patterns, metapopulation dynamics (concept and application), ecosystem process in the landscape, landscape approaches for conservation in Nepal. (ii) Land use and land cover change: types, spatial and temporal patterns (national and global), causes of land use and land cover change, impacts (on local climate, hydrology, carbon emission, biodiversity, agriculture productivity). [**10 h** (6 + 4)].

Unit 2. Fire ecology: Concept and principle, fire in the earth system, human dimension of fire, ecological impact (including impacts of fire suppression), fire for ecosystem-based management (practical implication of fire), fire and global environmental changes, wildfire prediction, prevention and preparedness, wildfire in Nepal. [**8 h**].

Unit 3. Mountain ecology: Delimitation, origin, type and global distribution of mountains; key environmental features; altitudinal pattern of biodiversity; treeline (species composition, structure, factors determining treeline); impact of climate change on mountains (treeline position, species range shift, endemic species, phenological changes, glacier retreat); human impact on mountain environments (pollution, developmental activities, grazing and deforestation); Himalayan environmental degradation: myth and evidences; mountain hazards; ecosystem services of mountains. [**10 h**].

Unit 4. Climate change: Introduction (climate vs. weather, climate change vs. climate variability, historical account of climate change research, climate change denialism); components and causes of climate change (natural and anthropogenic); patterns of climate change (global and regional patterns of changes in temperature, precipitation, extreme events); climate change impacts (on biodiversity and ecosystem, agriculture and food security, water resources, and human health); plant response to rising atmospheric CO_2; tools to study climate change; mitigation and adaptation. [**10 h**].

Unit 5. Invasion ecology: Introduction and terminology; invasion process (dispersal, establishment, persistence and spread, and evolution); life history traits of IAS (Invasive Alien Species); theories related to biological invasion (enemy release hypothesis, Darwin's naturalization hypothesis, Evolution of increased competitive ability hypothesis, novel weapons hypothesis, fluctuating resources hypothesis,

biotic resistance hypothesis, invasional meltdown); impacts (ecological, evolutionary, economic/health); management of IAS; overview of IAS in Nepal (diversity, major invasive alien plant species, modes of introduction and spread, impacts, management efforts, policy review). [**10 h**].

Course title: Landscape and Global Change Ecology	**Full marks:** 25
Course No.: BOT 614	**Pass marks:** 12.5
Nature of course: Practical	**Credits:** 1
Level: MSc, III Semester	**Credit hours:** 16 × 4

Course content

I. Experiments

1. To record phenological patterns of plant species in a community
2. To study the relationship between biomass and species richness in grassland.
3. To analyze changes in community traits along elevation gradient
4. To analyze climate data of Nepal for climate change trends.
5. To estimate age of tree with the help of annual rings.
6. To estimate carbon stock of different forest stands.
7. To document invasive alien plant species of a locality.
8. To study the impact of invasive plant species on plant species diversity of a community.

II. Term paper/bibliographic review of the topics provided in the class/case study

Text books and references

Bowman DMJS, J Balch, P Artaxo, WJ Bond, et al. 2009. Fire on the earth system. *Science* 324: 481-484.

Bowman DMJS, J Balch, P Artaxo, WJ Bond, et al. 2011. Human dimension of fire regime on earth. *Journal of Biogeography* 38:2223-2236.

Burroughs WJ. 2001. *Climate Change: A Multidisciplinary Approach*. Cambridge University Press

Chapin FS III, ES Zavaleta, VT Eviner, RL Naylor, et al. 2000. Consequences of changing biodiversity. *Nature* 405: 234-242.

Clout MN and PA Williams. 2010. *Invasive Species Management*. Oxford University Press.

Cochrane MA. 2009. *Tropical Fire Ecology: Climate Change, Landuse and Ecosystem Dynamics*. Springer + Paxis Publishing, Chichester, UK.

Cowie J. 2013. *Climate Change*: Biological and Human Aspects. 2nd edition. Cambridge University Press, Cambridge.

Davis MA. 2009. *Invasion Biology*. Oxford University Press, UK

De Blois S, G Domon and A Bouchard. 2002. Landscape issues in plant ecology. *Ecography* 25: 244-256.

Groombridge B and MD Jenkins. 2000. *Global Biodiversity: Status of the Earth's Living Resources in 21st Century*. World Conservation Press, Cambridge, UK.

IPCC 2013. Summary for Policymakers. In: *Climate Change 2013: The Physical Science Basis*. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Ives JD. 2006. *Himalayan Perceptions*. Himalayan Association for Advancement of Sciences, Kathmandu, Nepal

Körner C. 2003. *Alpine Plant Life: Functional Plant Ecology of High Mountain Ecosystems* (2nd edition). Springer.

Körner C. 2012. *Alpine Treeline*. Springer

Laszlo N and G Georg. 2009. *The Biology of Alpine Habitats*. Oxford University Press, USA.

Manel S, MK Schwartz, G Luikart and P Taberlet. 2003. Landscape genetics: combining landscape ecology and population genetics. *Trends in Ecology and Evolution* 18 (4): 189-197.

McKenzie D, C Miller and DA Falk. 2011. *The Landscape Ecology of Fire*. Springer

Morison JIL and MD Morecroft. 2006. *Plant Growth and Climate Change*. Blackwell Publishing Ltd.

Parmesan C. 2006. Ecological and evolutionary responses to recent climate changes. *Annual Review of Ecology, Evolution and Systematics* 37: 637-669.

Simberloff D and von Holle B. 1999. Positive interaction of non-indigenous species: invasional meltdown? *Biological Invasion* 1: 21-32.

Spehn EM, M Liberman and C Korner (eds.). 2006. *Land Use Change and Mountain Biodiversity*. Taylor and Francis, Boca Raton, FL, USA.

Tiwari S, M Siwakoti, B Adhikari and K Subedi. 2005. *An Inventory and Assessment of Invasive Alien Plant Species of Nepal*. IUCN - The World Conservation Union, Nepal.

Turner MG. 2001. *Landscape Ecology in Theory and Practice: Pattern and Process*. Springer.

Turner MG. 2005. Landscape ecology: what is the state of the science. *Annual Review of Ecology, Evolution and Systematics* 36: 319-344.

Valdia KS. 1998. *Dynamic Himalaya*. University Press, Hyderabad, India.

Wiens JA, MR Moss (eds.). 2005. *Issues and Perspectives in Landscape Ecology*. Cambridge University Press, Cambridge.

Williamson M. 1996. *Biological Invasion*. Chapman and Hall, London, UK.

Wilson EO (Ed.). 1988. *Biodiversity*. National Academic Press, Washington, D.C.

Group B

BOT. 615, 616. Applied Systematics
BOT. 617, 618. Biodiversity and Biogeography

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Applied Systematics

Course title: Applied Systematics	**Full marks:** 75
Course No.: BOT 615	**Pass marks:** 37.5
Nature of course: Theory	**Credits:** 3
Level: MSc, III Semester	**Credit hours:** 48

Objectives

The overall aim of this course is to provide students critical understanding of the applied aspects of plant systematics. The specific objectives are:

(i) to train students on the application of modern methods and tools for identification and analyzing taxonomic data and elucidating phylogenetic relationships;
(ii) to train them with the knowledge on documentation, management and publication of taxonomic data.

Course content

Unit 1. Contemporary methods in plant systematics: (i) Biosystematics: definition, scope and significance, sources of information, biosystematic categories, principles and procedures, applications. (ii) Application of external and internal morphology, embryology, palynology, cytogenetics, phytochemistry and reprodictive biology in plant systematics. [**12 h** (3+9)].

Unit 2. Approaches of biological classification and phylogeny: (i) Overview of biological classification. (ii) Molecular systematics: plant genomes, allozyme and isozyme, PCR techniques and DNA sequencing, DNA markers, acquisition and analysis of molecular data, concept of molecular clock. (iii) Phylogenetic systematics: introduction to phylogeny, approaches and methods of phylogenetic analysis, phylogenetic trees – types, construction and analysis. [**14 h** (2+7+5)].

Unit 3. Flowering plant identification, description, and documentation of taxonomic data: (i) Taxonomic literature, databases, herbaria and botanical gardens. (ii) Identification and naming of flowering plants: methods and approaches. (iii) Identification keys: types, key design principles, common problems in key usage. (iv) Methods and approaches of taxonomic revision and Flora writing. (v) Drawing and illustrations, basic photography techniques. (vi) Management and documentation of taxonomic data. [**18 h** (1+4+4+3+4+2)].

Unit 4. Flora and taxonomic accounts: (i) Floras and Monographs. (ii) Introduction to the major Flora of the world (Flora of India, Flora of Bhutan, Flora of China, Flora Malesiana, Pan-Himalayan Flora). [**4 h**].

Course title: Applied Systematics	**Full marks:** 25
Course No.: BOT 616	**Pass marks:** 12.5
Nature of course: Practical	**Credits:** 1
Level: MSc, III Semester	**Credit hours:** 15 × 4

Objectives

The overall aim of this course is to improve necessary expertise to perform taxonomic revision for better understanding of the evolutionary relationship and phylogenetic classification. The specific objectives are (i) to make the students able to understand the concept of different taxa in the light of recent principles; (ii) to enable them to understand the applied aspects systematics, and (iii) to enable them to manage and document taxonomic data.

Course content

1 Systematic revision

1.1 Systematic study: macro- and micro-morphology, anatomy, palynology

1.2 Preparation of identification keys

1.3 Drawing and illustrations

1.4 Photographic techniques (macro-photography)

1.5 Taxonomic database (in MS ACCESS): based on data obtained from systematic revision

2 Molecular systematics

2.1 DNA extraction

2.2 Gel electrophoresis

2.3 PCR techniques

3 Herbarium management: visit to herbaria (TUCH, KATH)

4 Term paper and seminar

5* Report/*mini dissertation

Text and reference books

Erdtman G. 1986. *Pollen Morphology and Plant Taxonomy: Angiosperms.* E.J. Brill, Leiden, The Netherlands.

Hillis D.M., Moritz C. and Mable B.K. 1996. *Molecular Systematics.* Second Edition. Sinaur Associates, Inc.

Simpson M.G. 2010. *Plant Systematics.* Elsevier Academy Press, USA.

Stace C.A. 1980 (reprint ed. 1984). *Plant Taxonomy and Biosystematics.* Edward Arnold, London

Stuessy T.F. 1990. *Plant Taxonomy, the Systematic Evaluation of Comparative Data.* Columbia University Press, New York.

Suggested further readings

Fageri K. and Iversen J. 1989. *Text Book of Pollen Analysis.* John Wiley & Sons Ltd.

Judd W.S., Campbell C.S., Kellogg E.A., Stevens P.F. and Donoghue M.J. 2010. *Plant Systematics: A Phylogenetic Approach.* Sinauer Associates Inc. Publishers, Sunderland, Massachusetts, USA

Shivarajan V.V. 1991. *Introduction to the Principles of Plant Taxonomy*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India.

Siwakoti M. and Rajbhandary S., eds. 2015. *Taxonomic Tools and Flora Writing*. Department of Plant Resources (DPR), Ministry of Forest and Soil Conservation, Government of Nepal and Central Department of Botany, Tribhuvan University, Kathmandu, Nepal.

Woodland D.W. 1997. *Contemporary Plant Systematics*. Barrien Springs, Michgian, USA.

Biodiversity and Biogeography

Course title: Biodiversity and Biogeography	**Full marks:** 75
Course No.: BOT 617	**Pass marks:** 37.5
Nature of course: Theory	**Credits:** 3
Level: MSc, III Semester	**Credit hours:** 48

Objectives

The overall aim of this course is to provide critical understanding of biodiversity and biogeography sciences. The specific objectives are to: (i) develop understanding of important biogeographical processes and patterns of biodiversity distribution; (ii) provide basic understanding of the status of biodiversity and of the methods in assessing species diversity; and (iii) develop understanding of the value of biodiversity and principles and approaches of biodiversity conservation.

Course content

Unit 1: The science of biogeography: (i) Introduction and scope of biogeography, overview of historical and ecological biogeography. (ii) History of earth: geological time scale, continental drift/plate tectonics and earth's history, glaciations and biogeographic dynamics. (iii) Fundamental biogeographic processes and geographic patterns: dispersal and immigration, vicariance, speciation and extinction, endemism and provincialism, disjunction, maintenance of biotas. (iv) Evolutionary processes and history of biota: basic concepts, fossil records and origin of life, major evolutionary processes, history of flowering plant diversity, history of biota, phylogeography. [**11 h** (1+2+4+4)].

Unit 2. Biodiversity – patterns and processes: (i) Components and levels of biodiversity, theory of species diversity, mechanisms regulating diversity in space and time, island biogeography theory and patterns of species distribution. (ii) Assessment of species diversity: diversity indices, analytical methods and approaches. (iii) Biodiversity gradients and their determinants: spatial patterns, altitudinal and latitudinal gradients; diversity in time – succession, factors causing diversity gradients. [**13 h** (4+3+6)].

Unit 3: Current biogeographic patterns and status of biodiversity: (i) Concept and classification of biomes. (ii) Phytogeographical regions of the world: introduction, basic characteristics (species diversity and endemism) of six floristic kingdoms. (iii) Biogeography of Himalayan plants: introduction, major phytogeographic divisions (with reference to Nepal), major floristic and vegetation elements and their affinities, endemism and disjunction in Himalayan flora. (iv) Threat and status: geography of extinction, major drivers of biodiversity loss/extinction, current status of global biodiversity, status of plant diversity in the Nepalese Himalaya, biodiversity hotspots, important plant areas. [**14h** (1+6+4+3)].

Unit 4. Value of biodiversity and conservation approaches: (i) Values of biodiversity: direct and indirect values, option value, existence value; biodiversity and livelihood/food security; methods and approaches of valuing biodiversity. (ii) Biodiversity and traditional knowledge: introduction and definitions, theoretical advancement, principles and assumptions, major components, bioprospecting and traditional knowledge. (iii) Biodiversity conservation: principles and approaches at population, ecosystem and landscape levels; traditional knowledge and biodiversity conservation. [**10 h** (2+3+5)].

Course title: Biodiversity and Biogeography	**Full marks:** 25
Course No.: BOT 618	**Pass marks:** 12.5
Nature of course: Practical	**Credits:** 1
Level: MSc, III Semester	**Credit hours:** 16 × 4

Objectives

The overall aim of this course is to provide practical and analytical knowledge related to biodiversity distribution in space and time. The specific objectives are to enable the students with the ability: (i) to document, manage and analyse biodiversity data at different spatial scale; (ii) to analyze biogeographic patterns of Himalayan flora; (iii) to monitor the change in biodiversity patterns.

Course content

1 Basics

- Qualitative and quantitative methods of biodiversity survey and analysis
- Applications of data analysis tools

2 Biogeography

- Biogeographic patterns of selected group of flowering plants of the Himalaya: chorology, endemism, disjunction
- Assessment of historic collection of plant specimens to compare changes in distribution patterns

3 Field Study: Biodiversity Survey

- Analysis of community structure and composition: classification, gradient analysis
- Assessment of species diversity and distribution pattern along environmental gradients
- Participatory survey to document resource utilization patterns and estimation of economic value of resource use
- Post field study: field data analysis and report writing

4 Term Paper and Seminar

5 Report/Mini Dissertation

Text and reference books

Huston M.A. 1994. *Biological Diversity: The Coexistence of Species on Changing Landscapes*. Cambridge University Press, UK.

Lomolino M.V., Riddle B.R. and Brown J.H. 2006. *Biogeography*. Sinauer Associates, Inc., Sunderland, Massachusetts, USA (Third edition).

Primack R.B. 2006. *Essentials of Conservation Biology*. Fourth Edition. Sinauer Associates, Inc. Publishers, Sunderland, MA, USA.

Takhtajan A. 1986. *Floristic Regions of the World*. University of California Press.

Suggested further readings

Banerji M.L. 1963. Outline of Nepal phytogeography. *Vegetatio* 11(5-6): 288-296. https://doi.org/10.1007/BF00303794.

Campbell B.M. and M.K. Luckert. 2002. *Uncovering the Hidden Harvest: Valuation Methods for Woodland and Forest Resources*. Earthscan, London.

Chaudhary R.P. 1998. *Biodiversity in Nepal - Status and Conservation*. S. Devi, Saharanpur, India and Tecpress Books, Bangkok, Thailand.

Cox B.C. and Moore P.D. 2010. *Biogeography: An Ecological and Evolutionary Approach*. John Willey & Sons, Inc., USA. (8th edition)

Cunningham A.B., 2001. *Applied Ethnobotany: People, Wild Plant Use and Conservation*. Earthscan, London, UK.

Futuyma D. 1997. *Evolutionary Biology*. Sinauer Associates, Sunderland, MA, USA.

Ghimire S.K., Sapkota I.B., Oli B.R. and Parajuli R.R. 2008. *Non-Timber Forest Products of Nepal Himalaya: Database of Some Important Species Found in the Mountain Protected Areas and Surrounding Regions*. WWF Nepal, Kathmandu.

GoN 2014. *Nepal National Biodiversity Strategy and Action Plan 2014-2020*. Government of Nepal Ministry of Forests and Soil Conservation, Kathmandu, Nepal.

Good R. 1974. *The Geography of Flowering Plants*. Longman, London.

Hill D., Fasham M., Tucker G., Shewry M. and Shaw P. (eds.) 2005. *Handbook of Biodiversity Methods: Survey, Evaluation and Monitoring*. Cambridge University Press, Cambridge, UK.

Hubel S.P. 2001. *The Unified Neutral Theory of Biodiversity and Biogeography*. Princeton University Press, Princeton and Oxford.

Kent M. and Coker P. 1994. *Vegetation Description and Analysis: a Practical Approach*. John Wiley, Chichester.

Krebs C.J. 2001. *Ecology: the Experimental Analysis of Distribution and Abundance*. Fourth Edition. Addison-Wesley Educational Publishers, Inc., USA.(Fifth edition).

Laird S. (ed.), 2002. *Biodiversity and Traditional Knowledge: Equitable Partnerships in Practice*. Earthscan, London, UK.

Magurran, A.E. 1988. *Ecological diversity and its measurement*. Princeton university press, Princeton

Mani M.S. 1978. *Ecology and Phytogeography of High Altitude Plants of the Northwest Himalaya: Introduction to High Altitude Botany*. Oxford and IBH Publishing Co., New Delhi, India.

Mani M.S. 1974. Biogeography of the Himalaya. In: *Ecology and Biogeography in India* (M.S. Mani, ed.), pp. 664-681. Monographiae Biologicae, vol 23. Springer, Dordrecht.

Martin G.J. 1995. *Ethnobotany: a Methods Manual*. Chapman & Hall, London, UK.

Miehe, G., Pendry, C. and Chaudhary, R.P., eds. *Nepal: An Introduction to the Natural History, Ecology and Human Environment of the Himalayas. A companion to the Flora of Nepal*. Royal Botanic Garden, Edinburgh, UK.

Myers A.A. and Giller P.S. (eds.). 1988. *Analytical Biogeography: an Integrated Approach to the Study of Animal and Plant Distributions*. Chapman & Hall, London, UK.

Rau M.A. 1974. Vegetation and phytogeography of the Himalaya. In: *Ecology and Biogeography in India* (M.S. Mani, ed.), pp. 247-280. Monographiae Biologicae, vol 23. Springer, Dordrecht.

Rao A.S. (1974) The vegetation and phytogeography of Assam-Burma. In: *Ecology and Biogeography in India* (M.S. Mani, ed.), pp 204-246. Monographiae Biologicae, vol 23. Springer, Dordrecht.

Shrestha T.B. 1982. *Ecology and Vegetation of North-West Nepal (Karnali Region)*. Royal Nepal Academy, Kathmandu, Nepal.

Shrestha T.B. and Joshi R.M. 1996. *Rare, Endemic and Endangered Plants of Nepal*. WWF Nepal Program, Kathmandu, Nepal.

Stainton J.D.A. 1972. *Forests of Nepal*. John Murray, London.

Takhtajan A. 1991. *Evolutionary Trends in Flowering Plants*. Colombia University Press.

Whittaker R.J., Araújo M.B., Jepson P., Ladle R.J., Watson J.E.M and Willis K.J. 2005. *Conservation Biogeography: Assessment and Prospect*. *Diversity and Distributions* 11: 3-23.

Whittaker, R.J. and Fernández-Palacios, J.M. 2007. *Island Biogeography: Ecology, Evolution, and Conservation*, 2nd ed. Oxford University Press, Oxford.

Wilson E.O. 1988. *Biodiversity*. National Academic Press, Washington, D.C.

Wilson E.O. 1992. *The Diversity of Life*. Harvard Belknap, Cambridge.

Important journals (selected)

- *American Journal of Botany*
- *Biodiversity and Conservation*
- *Biogeography and Macroecology*
- *Biological Conservation*
- *Conservation Biology*
- *Diversity and Distributions*
- *Ecography*
- *Global Ecology and Biogeography*
- *Journal of Applied Ecology*
- *Journal of Biodiversity*
- *Journal of Biogeography*
- *Nature Ecology & Evolution*

Group C

BOT. 619, 620. Plant Biotechnology
BOT. 621, 622. Genetic Engineering

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Plant Biotechnology

Course title: Plant Biotechnology	**Full marks:** 75
Course No.: BOT 619	**Pass marks:** 37.5
Nature of course: Theory	**Credits:** 3
Level: MSc, III Semester	**Credit hours:** 48

Objectives

The general aim of this course is to impart theoretical and practical knowledge on Plant Biotechnology. The specific objectives are to: (i) introduce tissue culture techniques and demonstrate the principles of tissue culture; (ii) provide knowledge on specialized cell culture techniques and their uses in plant science research and industry; (iii) understand how pharmaceuticals and phytochemicals can be produced in culture; (iv) make students be able to establish the commercial tissue culture industry in future as an entrepreneur; (v) describe various applications of plant biotechnology in environmental management; and (vi) understand the application of algal and fungal biotechnology.

Course content

Unit 1. Tools and techniques of tissue culture: (i) Overview of biotechnology, plant biotechnology achievements and current trends. (ii) Laboratory requirements for plant tissue culture, lab maintenance and fumigation, sterilization techniques. (iii) Media formulation and composition, plant growth regulators used in vitro, surface sterilization of explants, inoculation, sub-culturing and maintenance of culture. (iv) Indexing for plant pathogens: culture indexing for bacterial and fungal contaminant. [**8 h** (2+1+4+1)].

Unit 2. Culture types and techniques: (i) *In vitro* plant regeneration through explants culture. (ii) Callus formation, somatic embryogenesis, artificial seed production, suspension culture, types (batch, continuous and semi-continuous), techniques of single cell culture, embryo culture, anther and pollen culture, protoplast culture. (iii) Hardening of *in vitro*-raised plants. [**8 h** (3+4+1)].

Unit 3. Applications of plant tissue culture: (i) Micropropagation and its applications, production of virus free plants and micrografting. (ii) Somatic embryogenesis; artificial/synthetic seed: commercial production of artificial seed and its application. (iii) Callus and suspension culture and their application in production of secondary metabolites; factors affecting yield, immobilized cell systems, bioreactors, hairy root culture, methods of enhancement of secondary metabolite production in culture; biotransformation. (iv) Somaclonal variations and its application. (v) Haploid culture and its application. (vi) Protoplast culture and somatic hybridization: production of hybrid-cybrid. (vii) Embryo culture and its application in wide hybridization. [**14 h** (2+2+4+2+2+1+1)].

Unit 4. Commercialization of tissue culture technology: (i) Concept of commercialization and the need, design of commercial TC laboratory and management. (ii) Molecular farming: carbohydrate,

proteins, lipids, aromatic chemicals, enzymes, plant derived vaccines, pharmaceutical and biofules. (iii) Germplasm storage and cryopreservation: significance of short, medium and long term (cryopreservation) preservation, achievements and current trends of cryopreservation. [**7 h** (1+5+1)].

Unit 5. Algal/fungal/environmental biotechnology: (i) Algal biotechnology: algae and cyanobacteria as source of nitrogen-rich fertilizer and important plant products. (ii) Fungal biotechnology: *in vitro* establishment of mycorrhiza, mushroom culture. (iii) Environmental biotechnology: waste management, composting, bioremediation. (iv) Biofertilizer: isolation and identification of symbiotic and non-symbiotic nitrogen fixing bacteria, concept of cross inoculation, inoculation to leguminous seeds. [**11 h** (2+3+3+3)].

Course title: Plant Biotechnology	**Full marks:** 25
Course No.: BOT 620	**Pass marks:** 12.5
Nature of course: Practical	**Credits:** 1
Level: MSc, III Semester	**Credit hours:** 16 × 4

Course content

1. Preparation of media by direct method (MS medium).
2. Preparation of stock solutions for medium.
3. Preparation of medium supplemented with plant growth hormones.
4. Technique of isolation, surface sterilization and inoculation of different explants.
5. Surface sterilization and plant propagation by seed culture (orchids and other).
6. Callus culture and growth of callus.
7. Somatic embryogenesis from callus and preparation of synthetic seeds.
8. Micropropagation of plants by axillary bud/ single node culture proliferation.
9. Cytological and histological analysis of *in vitro* cells.
10. Production of virus free plants by meristem/shoot tip culture.
11. Anther/microspore culture of rice, wheat.
12. Protoplast culture and protoplast fusion of Pea or tobacco.
13. Technique of in vivo rooting from stem cuttings in some woody plants.
14. Technique of acclimatization of *in vitro* propagated plants.
15. Biological waste management/Vermicomposting.
16. Mushroom culture.

Text and reference books

Bhojwani S. S. 1990. *Plant Tissue Culture: Applications and Limitations*, Elsevier Science Publishers.

Bhojwani S.S. and M. K. Razdan. 1996. *Plant Tissue Culture: Theory and Practice*. Elsevier Science Publishers.

Chawala H.S. 2009. *Introduction to Plant Tissue Culture*. Third Edition. Oxford and IBH Publishing Co. Pvt. Ltd.

Cheremisinoff N.P. 1996. *Biotechnology for Waste and Waste Water Treatment*. Noyes Publications, USA.

Debergh P.C. and Zimmerman R.H. 1990. *Micropropagation*. Kluwer AcademicPubl. Dordrecht.

Evans G.M. and Furlong J.C. 2003. *Environmental Biotechnology: Theory and Application*. John Wiley and Sons Ltd.

Gamborg O.L. and Phillips G.C. 1995. *Plant Cell, Tissue and Organ Culture – Fundamental Methods* (Lab. Manual). Springer-Verlag.

Greene J.J. and Rao V.B. 1998. *Recombinant DNA Principles and Methodologies.* Marcel Dekker.

John H. Dodds, Roberts L.W. 1995. *Experiments in Plant Tissue Culture* (3rd Edition). Cambridge University Press. Cambridge, UK.

Lal R. and Lal S. 1995. *Genetic Engineering of Plants for Crop Improvement.* CRC Press.

Pierik R.L.M. *In vitro Culture of Higher Plants*. Kluwer Academic Publisher, Netherlands.

Punia M.S. 1999. *Plant Biotechnology and Molecular Biology*: *A Laboratory Manual*. Scientific Publishers, India.

Ramawat K.G. and Goyal S. 2014. *Comprehensive Biotechnology*. S. Chand Publishing, New Delhi.

Ramawat K.G. and Goyal S. 2014. *Molecular Biology and Biotechnology*. S. Chand Publishing, New Delhi.

Razdan M. K. 2003. *Introduction to Plant Tissue Culture*. Agritech Publications.

Satyanarayan U. 2005. *Biotechnology*. 1st ed. Arunabha Sen Books and Allied Pvt. Ltd.

Slater A, Scott N and Fowler M. 2003. *Plant Biotechnology: the Genetic Manipulation of Plants*. Oxford University Press.

Smith R. 2000. *Plant Tissue Culture: Techniques and Experiments.* Academic Press.

William G. H. 2006. *Plant Biotechnology (The Green World)*. Chelsea House Publications.

Text and reference books for practical

Bhattarai T. 2000. *Experimental Plant Biochemistry and Plant Biotechnology (Tissue culture)*. Bhudipuran Prakashan, Kathmandu.

Bregman A. 1990. *Laboratory Investigations in Cell and Molecular Biology*. John Wiley and Sons, New York.

Genetic Engineering

Course title: Genetic Engineering	**Full marks:** 75
Course No.: BOT 621	**Pass marks:** 37.5
Nature of course: Theory	**Credits:** 3
Level: MSc, III Semester	**Credit hours:** 48

Objectives

The general aim of this course is to impart theoretical and practical knowledge about various aspects of molecular biology and Genetic Engineering of plants. After the successful completion of the course, the students are expected to be able to: (i) know and make use of various tools and techniques used in genetic engineering; (ii) genetically manipulate microbes and plants; (iii) artificially induce mutations in plants; and (iv) explain the methods of screening of DNA libraries and sequencing techniques.

Course content

Unit 1. Introduction: History and importance of genetic engineering. [**1 h**].

Unit 2. Basic tools and techniques of genetic engineering: Restriction enzymes and other DNA modifying enzymes (nucleases, ligases and polymerases), PCR (basics, various components of PCR and their role), application of PCR in genetic engineering; types of PCR; gel electrophoresis, blotting. [**7 h**].

Unit 3. Cloning vectors: Plasmid, polylinker, lambda phage, cosmid, Artificial chromosomes (YAC, BAC), shuttle vectors, virus based vectors. [**5 h**].

Unit 4. cDNA and genomic library:** Genomic library, cDNA library, expression library, substraction library. [**3 h**].

Unit 5. Cloning strategies in prokaryotes and eukaryotes: Cloning in bacteria other than *E. coli*, cloning in yeast and other fungi, gene cloning in higher organisms (animals and plants), expression analysis of transgenes. [**4 h**].

Unit 6. Expression systems: Recombinant DNA technology, Synthesis of protein through expression vector, fusion protein; expression system in viruses (baculovirus), prokaryotes (*E. coli, Bacillus*) and eukaryotes (*Pichia,* insects and mammalian cells). [**5 h**].

Unit 7. Analysis and expression of cloned DNA: Restriction digestion, nucleic acid hybridization, Library screening by membrane hybridization, Western Blotting and immunoscreening for expression library, DNA sequencing, Microarray. [**7 h**].

Unit 8. Gene transfer methods: Marker and reporter genes, methods of gene transfer (direct, indirect), genetic transformation and selection of transformants in prokaryotes (*E. coli*, *Agrobacterium tumefaciens*); transformation and selection of transformants in eukaryotes (yeasts, higher plants). [**6 h**].

Unit 9. Engineering of plants for crop improvement: Application of plant genetic engineering for developing insect-resistance, disease-resistance and herbicide resistance in plants; developing stress and senescence-tolerance in plants; application of plant genetic engineering for quality: fruit ripening, flower pigmentation, shape and size, longer flowering, improved storage, terminator seed and terminator technology; molecular markers and marker assisted selection in plant breeding – RFLP, RAPD, AFLP. [**7 h**].

Unit 10. Biosafety and ethical issues in genetic engineering: Introduction, regulatory framework for release and marketing of genetically modified organisms (GMOs), biosafety protocol, handling of biotechnology (including terminator technology), sanitary and phytosanitary measures, impact of GMOs in biodiversity conservation in developing countries; ethics of genetic engineering. [**3 h**].

Course title: Genetic Engineering	**Full marks:** 25
Course No.: BOT 622	**Pass marks:** 12.5
Nature of course: Practical	**Credits:** 1
Level: MSc, III Semester	**Credit hours:** 16 × 4

Course content

1. Extraction of Plamid DNA and measurement of concentration and purity
2. Restriction digestion of Plasmid DNA and agarose gel electrophoresis of DNA
3. Construction of restriction map
4. Ligation reaction and construction of chimaeric plasmid
5. Production of competent E. coli cell and transformation
6. Selection of transformant
7. Labeling of nucleic acids and southern hybridisation
8. Amplification of particular DNA sequence by normal PCR
9. Extraction of Genomic DNA
10. Extraction of RNA and cDNA preparation by RT-PCR

Text and reference books

Ausubel F, Bent R. 2005. *Short Protocols in Molecular Biology*. Wiley

Brown, TA. 2006. *Gene Cloning and DNA analysis. An introduction*. Blackwell Publishing

Campbell, N.A. and Reece, J.B. 2002. *Biology*. Pearson Education/Benjamin Cummings

Carson, S and Robertson, D. 2006. *Manipulation and Expression of Recombinant DNA*. Academic Press.

Glick, B.R. and Pasternak, J.J (recent edition). *Molecular Biotechnology*. American Society of Microbiology Press

Griffiths A J F., Gelbart, W. M., Miller, J.H., Leontin, R.C. 2002. *Modern Genetic Analysis*. Freeman

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Krenzer, H and Massey, Y. 2000. *A Recombinant DNA and Biotechnology*. American Society of Microbiology Press.

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Lehninger, A.L., Nelson, D.L. and Cox, M.M. (recent edition). *Principles of Biochemistry*. Worth Publishers, USA or CBS, India

Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D., Darnell, J. 2004. *Molecular Cell Biology*. Freeman and Co.

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Primrose S B, Twyman RM, Old RW. 2007. *Principle of Gene Manipulation and Genomics*. Blackwell science

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Sambrook, J. and Russel, D. 2003. *Molecular Cloning. A laboratory Manual*. Vol. I to III CHSL Press

Stryer, L. (recent edition). *Biochemistry*. Freemean and Co.

Trun N&Trempy J. 2004. *Fundamentals of Bacterial Genetics*. Blackwell

Turner P, McLennan A, Bates A and White M. 2007. *Instant note on Molecular Biology*. Taylor and Francis.

Watson JD, Gilman, M, Witkoski, J, Zoller, M (1993).Recombinant DNA. Freeman

Watson JD, Baker, TA, Bell, SP, Gann, A, Levine, M. Losick, R (2004) Molecular biology of gene. Pearson

Text and reference books for practical

Sambrook, J. et al. 2001. *Molecular Cloning: A Laboratory Manual*. Third Edition. Cold Spring Harbour Laboratory, USA

Szeberenyi, J. 2006. *Experiments in Molecular Cell Biology*. Schenk Verlag, Germany.

Group C

BOT. 623, 624. Applied Mycology
BOT. 625, 626. Advanced Plant Pathology

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Applied Mycology

Course title: Applied Mycology	**Full marks:** 75
Course No.: BOT 623	**Pass marks:** 37.5
Nature of course: Theory	**Credits:** 3
Level: MSc, III Semester	**Credit hours:** 48

Objectives

The general aim of this course is to provide theoretical and practical knowledge on significance and application of fungi and microbes. The specific objectives are to: (i) develop understanding on general aspects of mycology; (ii) elaborate knowledge on soil fungi and their importance in forest, soil and agriculture; and (iii) impart knowledge on fungal utilization through industrial and modern technology.

Course content

Unit 1. General aspects of mycology: (i) General introduction, historical development and advances in mycology, importance and significance of fungi and microbes, characteristics of pathogenic and non-pathogenic fungi, concept of modern techniques (serological and molecular) in mycology (ii) Fungi as saprophytes: decomposition of organic matter, coprophilous fungi, cellulolytic fungi, lignolytic fungi (iii) Fungi as parasites: parasitism; mycoparasites, fungal parasites on plants, humans, insects and nematodes (iv) Fungi as symbionts: mycorrhizae, types of mycorrhizae, fungi-algae and fungi-insect mutualism, significance of mycorrhizal and mutualistic interaction. [**9 h** (4+1+2+2)].

Unit 2. Soil and microbes: (i) Concept of soil and microbes, microbial population and diversity in soil, classification of microorganisms in different types of soil (ii) structure and development of microbial community in soil, factors affecting microbial community (influence of C and N, inhibitors and stimulators, influence of physical factors) (iii) techniques for studying fungi and bacteria (methods for culturing, isolation and identification) (iv) microbial role in biogeochemical cycling (carbon, nitrogen and sulphur cycles), effective microbes on soil nutrient dynamics (v) plant-soil microbe interaction, pathogenic and beneficial fungi/microbes associated in governing forest and agriculture ecosystems, biodegradation of soil organic matter and crop residue (vi) Plant growth promoting fungi/microbes and their application, microbial toxins in soil (vii) significance of microbes in wood decaying and litter decomposition, (viii) microbial/fungal allelopathy and its significance, impact of invasive plants and weeds on soil fungi/microbes in forest and agriculture ecosystems (ix) climate change impacts on microbial activities. [**18 h** (2+3+2+1+2+3+1+2+2)].

Unit 3. Industrial mycology: (i) Fermentation and microbial products: types, techniques and processes of fermentation; production of food, alcohol, organic acids, vitamins, antibiotics, toxins and enzymes, single cell protein, biofuels; secondary metabolites (fungal enzymes) and their industrial significance; (ii) Composting and bio-fertilizers: process and techniques of compost preparation and green manuring; process and techniques of biofertilizers, biopesticides and plantonics. [**9 h** (5+4)].

Unit 4. Mushrooms cultivation: (i) Overview of tools and techniques of mushroom cultivation: spawn preparation and extraction method of bio-active components of mushrooms (*Ganoderma, Lantinus, Grifolia, Termitomyces, Cordyceps* and *Morchella*). (ii) Mushroom disease management: mushroom disease symptoms and management: viral (La France disease), bacterial (wet spot, bacterial blotch and fungal diseases (green mold, blue green molds, black molds, dry bubbles, wet bubbles, cow-web molds, red bread molds), insect pests (slug, sciarid fly, cecid fly, mites), nematodes; (iii) Post harvest technology: short-term preservation (washing, packaging, conventional packing, storage of fresh mushrooms, transportation, steeping preservation), long-term preservation (canning, drying and pickle preparation). [**12 h** (5+5+2)].

Course title: Applied Mycology	**Full marks:** 25
Course No.: BOT 624	**Pass marks:** 12.5
Nature of course: Practical	**Credits:** 1
Level: MSc, III Semester	**Credit hours:** 16 × 4

List of practical

1. Isolation of soil microbes from rhizosphere and phyllosphere by serial dilution method
2. Isolation of economically important microbes (root nodule bacteria, *Trichoderma*)
3. Alcohol fermentation (preparation of wine)
4. Isolation, culture, staining and estimation of mycorrhizae
5. Determination of soil microbial biomass.
6. Estimation of sugars, proteins and amino acids in fungal mycelium and culture filtrate.
7. Cultivation of different mushrooms as prescribed in the theory.
8. Preparation of compost, biofertilizer (root nodule bacteria) and biopesticide
9. Isolation and pure culture of mushroom strains.
10. Preparation of mushroom spawn.
11. Study of mushrooms pathogens.

Text and reference books

Agrios, G.N. 1999. *Plant Pathology*. Academic Press

Annual Review of Phytopathology, 1999. Vol. 37, APS Press

Cairney, J.W.G. & Chambers, S.M. 1999. *Ectomycorrhizal Fungi*. Springer Publishers

Chandanwala, K. 1986. *Introduction to Plant Pathology*. Ammol Publishers and Distributors

Cheet,I. 1993. *Biotechnology in Plant Disease Control*. Wilen-Liss, Inc.

Dennis Allsopp and Seal, K.J. 1986. *Introduction to Biodeterioration*. E Edward Arnold Ltd.

Dix, N. J. (ed.). 2012. *Fungal Ecology*. Springer Science & Business Media.

Dix, N. J., & Webster, J. 1995. Colonization and decay of wood. In *Fungal Ecology* (pp. 145-171). Springer Netherlands.

Frisvad, J.C. Bridge, P.D. Arora, D.K. 1998. *Chemical Fungal Taxonomy*. Marcel and Dekker Inc.

Horsfall, J.G. & Cowelling. 1978. *Plant Diseases – An Advance Treatise* Vol. II& IV Academic Press.

Ignacimuthu, S.J. 1996. *Applied Plant Biotechnology*. Tata McGraw–Hill Publ. Company Ltd.

Mahadevan, A. 1991. *Post Infectional Defense Mechanisms*. Today and Tomorrow's Printers.

Mehrotra, R.S. 1991. *Plant Pathology*. Tata McGraw–Hill Publ. Company Ltd.

Miles, P.G. and Chang, S.T. 1997. *Mushroom Biology*. World Scientific Publ. Company

Natish, S. Chopra, V.L. & Ramachandra, S. 1994. *Biotechnology in Agriculture*. Oxford and IBH

Rajak, R. 2000. *Microbial Biotechnology for Sustainable Development and Productivity*. Scientific pub

Roberts, S. Fritz & Elien. I. Simms. 1992. *Plant Resistance to Herbivores and Pathogens* (Ecology, Evolution and Genetics). University of Chicago Press.

Rudra P. Singh, Uma S. Singh & Keiisuke Kohmoto (eds.) 1995. *Pathogenesis and Host Specificity in Plant Diseases*. Vol. III. Pergamon Press.

Scheffer, R.P. 199. *The Nature of Disease in Plants*. Cambridge University Press.

Tarr, S.A.J . 1987. *Principles of Plant Pathology*. Academic Press

Verma, A & Hock, B. 1999. *Mycorrhizae*. Springer Publishers

Advanced Plant Pathology

Course title: Advanced Plant Pathology	**Full marks:** 75
Course No.: BOT 625	**Pass marks:** 37.5
Nature of course: Theory	**Credits:** 3
Level: MSc, III Semester	**Credit hours:** 48

Objectives

The general aim of this course is to provide theoretical and practical knowledge on plant pathology. The specific objectives are to: (i) develop understanding on general aspects of plant pathology and factors affecting plant diseases; (ii) elaborate knowledge on agriculture and forest pathology; and (iii) impart knowledge on integrated pest management.

Course content

Unit 1. General aspect of plant pathology: (i) History of plant pathology; concept of pest, pathogen and weeds; nature and concept of plant diseases, classification of plant disease (ii) factors affecting plant diseases (temperature, light, moisture, wind, host plant nutrition, soil pH and soil structure) (iii) disease dissemination (through air, water, pollen, seed, animals, transplants and other vectors) (iv) plant disease clinic, climate change relation to crop disease development and weed and pest infestation. [**6 h** (3+1+1+1)].

Unit 2. Pathogenesis, physiology of diseased plant and defense mechanism: (i) Koch's postulate; process of disease development: specificity, recognition, pre-penetration; direct penetration and entry by pathogens through other routes (natural openings, wounds, root hairs, buds), pathogen development inside host tissue; plant disease forecasting. (ii) Mlecular basis of host pathogen interaction, enzymes and toxin in plant disease (classification of enzymes and toxins). (iii) Physiology of diseased plants. (iv) Biotic stress and defense mechanism in plants (morphological and structural defense, biochemical defense, synthesis of proteins and enzymes, toxin detoxification, altered respiration and hypersensitive reaction); abiotic stresses (heat and chilling stress, water and salt stress) in plants, resistance and ways to overcome stress effects. [**10 h** (3+1+2+4)].

Unit 3. Agriculture pathology – symptoms, etiology and control of crop diseases: (i) Cereal crops: rice (brown spot; foot rot; false smut and viral diseases); wheat (brown and yellow rust; flag smut; burnt; foot rot; powdery mildew; tundra and yellow); maize (head smut and rust). (ii) Cash crops: tea (blister blight, die back and brown blight); coffee (red blister, red root rot, rust disease); cardamom (chirkey diseases, foorkey disease and leaf blight). (iii) Vegetable crops: potato (early and late blight, brown rot, ring rot, potato leaf roll of virus, mild mosaic of potato); tomato (early and late blight); crucifers (club root of crucifers). (iv) Fruit plants: banana (leaf spot, bunchy top); mango (powdery mildew, die back, anthracnose, blotch); apple (*Alternaria* rot; Bull's eyes rot; apple scab); citrus (greening and gummosis). (v) Weed and pest infestation in agriculture, impacts and control measures. [**11 h (**3+2+3+2+1**)**].

Unit 4. Forest pathology: (i) Introduction and significance. (ii) Host, causal agents, symptoms and control measures of forest diseases: damping off; pine blister rust; *Atropellis* cankers of pine; die back and wilt disease, *Fomes* root rot and butt rot; leaf spot; tar spot; powdery mildew; concept of rot disease (white rot, brown rot, soft rot and bacterial rot). (iii) Pest infestation in forests: alien invasive pests in Nepalese forests, their impacts and control measures (application of biopesticides). **[8 h** (1+4+2+1)].

Unit V. Applied tools for disease management: (i) Tools for plant disease diagnosis: substrate metabolism, FAME analysis, protein analysis, ELISA, and PCR techniques. (ii) Control and management of plant diseases: cultural methods (pathogen avoidance, exclusion of inoculums and eradication of pathogens); physical methods (heat treatment, refrigeration and radiation); chemical methods (protectants, eradicants, therapeutants, inorganic and organic fungicides, antibiotics, fumigants and oils, and biocides (nomenclature and formulations, methodology of pesticide/fungicide/weedicide application, safeners; spreaders and stickers, pesticide resistance management, pesticide act in Nepal); Biological methods (suppressive soils, fungal and bacterial antagonists, biopesticides (essential oils, microorganisms and plant extract), improvement of biological control agents. (iii) Breeding for disease resistance: introduction, selection, hybridization, back cross, reversal dominance, modifier genes, extrachromosomal inheritance and other gene interaction; application of biotechnology for development of target specific pesticides; integrated pest management (IPM: principles, strategies and method). [**13 h** (3+5+5)].

Course title: Advanced Plant Pathology	**Full marks:** 25
Course No.: BOT 626	**Pass marks:** 12.5
Nature of course: Practical	**Credits:** 1
Level: MSc, III Semester	**Credit hours:** 16 × 4

List of practical

1. Symtomatology of crop and forest diseases (herbarium and field study).
2. Microscopic study of plant diseases (slide preparation and study of pathogens).
3. Demonstrate Kotch's postulate.
4. Isolation, culture, subculture and identification of available plant diseases (crop and forest).
5. Study of viability of fungal spores.
6. Fungal characteristics in pure colonies (physico-chemical approach).
7. Measurement of fungal spores by the use of ocular micrometer.
8. Photography of fungal vegetative and reproductive parts through digital microscope.
9. Demonstration of induction of wilting by *Fusarium* toxins
10. Abiotic stress effect on plant growth and development.
11. Extraction of essential oil from selected aromatic plants.
12. A mini field project to study crop diseases from field and market specimens.

Text and reference books

Agrios, G.N. 2005. *Plant Pathology*, 5th ed. Elsevier Academic Press, London.

Aneja, K.R. 2003. *Experiments in Microbiology, Plant Pathology and Biotechnology*, 4th ed. New Age International Publishers, New Delhi.

Barnett, H.L. 1972. *Illustrated Genera of Imperfect Fungi*, 4th ed. Burgess Publishing Co. Ltd., Minneapolis.

Bilgrami, K.S. & R.S. Verma. 1948. *Physiology of Fungi.* Vikas Publishing House Pvt. Ltd., New Delhi.

Booth, C. 1971. *Methods in Microbiology*, vol IV. Academic Press Inc. (London) Ltd., London.

Dickinson, M. 2003. *Molecular Plant Pathology*. BIOS Scientific Publishers, Oxford.

Fry, W.E. 1982. *Principles of Plant Disease Management.* Academic Press, New York

Gilman, J.C. 1957. *A Manual of Soil Fungi*, 2nd ed. Iowa State College Press, Iowa.

Gupta, G.P. 2004. *Plant Pathology*. Discovery Publishing House, New Delhi.

Horsfall, J. G. & A. E. Diamond. 1959. *Plant Pathology: An Advanced Treatise*, Vol. I-III. Academic Press, New York.

Lucas, G.B., C.L. Campbell and L.T. Lucas. 2001. *Introduction to Plant Diseases: Identification and Management*, 2nd ed. Kluwer Academic Publishers, Masachussets.

Lucas, J.N. 2002. *Plant Pathology and Plant Pathogens*, 3rd ed. Blackwell Science Ltd., Malden.

Manners, J.G. 1993. *Principles of Plant Pathology*. University Press, Cambridge.

Mehrotra, R.S. 2003. *Plant Pathology*. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.

Miles, P.G. & S.T. Chang. 2004. *Mushroom: Cultivation, Nutritional Value, Medicinal Effects and Environmental Impacts*. CRC Press, Florida.

Negi, S. S. 1996. *An Introduction to Forest Pathology*. International Books Distributers, Dehradun.

Parry, D.W. 1990. *Plant Pathology in Agriculture*. University Press, Cambridge.

Rangaswami, R.S. 2005. *Diseases of Crop Plants of India*. Prentice Hall of India Pvt. Ltd., New Delhi.

Sambamurty, A.V.S.S. 2006. *Text Book of Plant Pathology*. I.K. International Pvt. Ltd., New Delhi.

Sharma, P. D. 1997. *Plant Pathology*. Rastogy Publications, New Delhi.

Singh, R.S. 1978. *Introduction to Principles of Plant Pathology*. Oxford & IBH Pub. Co. Ltd., New Delhi.

Strange, R.N. 2003. *Introduction to Plant Pathology*. John Wiley & Sons, New York.

Tar, S. A. J. 1972. *The Principle of Plant Pathology*. McMillan Press, London.

Trigiano, R.N., M.T. Windham and A.S. Windham. 2008. *Plant pathology: Concepts and Laboratory Exercises*. CRC Press, Florida.

APPLIED PAPER [any one of the following] (4 credits)

Natural Resources Management

Course title: Natural Resources Management	**Full marks:** 75
Course No.: BOT 631	**Pass marks:** 37.5
Nature of course: Theory	**Credits:** 3
Level: MSc, III Semester	**Credit hours:** 48

Objectives

The general objective is to provide an understanding of the multiple uses of natural resources and their management. The specific objectives are to (i) make the students familiar with comprehensive resource planning, resource management and conservation and environmental and socio-economic impacts of natural resources, and (ii) develop among the students an ability to evaluate the environmental effects of resource exploitation

Course content

Unit 1. Natural resources (30 h)

a. *Soil and water resources*: (i) Soil: the base of life, soil formation, soil structure and classification, soil nutrients and their management; soil types of Nepal, soil fertility; soil degradation; soil erosion; soil conservation; Mineral resources of Nepal. (ii) Water resource: source (surface and ground water); global supply and demand; methods of water conservation; watershed management approaches; water resources of Nepal. [**10 h** (5+5)].

b. *Energy resources*: Types and use**;** fossil fuels (oil, natural gas, coal); alternative energy (nuclear, hydro-energy, solar, biomass, geothermal); energy efficiency and conservation; energy use pattern in Nepal; energy use pattern and climate change. [**5 h**].

c. *Food resources*: Plant based food resources (global and national)**;** world food situation and food security; factors affecting food production; industrialized food production; organic agriculture and sustainability. [**5 h**].

d. *Biodiversity resources*: (i) Status and distribution of biodiversity (national and global); (ii) Ecosystem function of biodiversity (including diversity-stability debate)**;** (iii) Loss of biodiversity (trends, causes, and consequences); biodiversity hotspots; IUCN threat categories; rare and endangered plants and animals of Nepal; (iv) Strategy for biodiversity conservation (detail account of *in situ* and *ex situ* conservation); (v) Economics of biodiversity conservation. [**10 h** (1+1+4+3+1)].

Unit 2. Conservation and management of Natural Resources (18 h)

a. *Conservation policies*: (i) Social and cultural perspectives on Natural Resource Management (NRM), natural resources and knowledge systems for management: indigenous, traditional, and scientific; (ii) Environmental policies: environmental conventions; environmental legislation; environmental organizations; environmental education. [**8 h** (3+5)].

b. *Environmental impact assessment (EIA)*: (i) Concept and principles; EIA requirements and administrative procedures (baseline information, screening, scoping and TOR); (ii) EIA process: identification, prediction and evaluation of impacts; evaluation and comparison of alternatives;

mitigation measures; monitoring; auditing; compliance and enforcements; role of civil society; EIA guidelines for Nepal; drafting EIA reports. [**10 h** (4+6)].

Course title: Natural Resources Management	**Full marks:** 25
Course No.: BOT 632	**Pass marks:** 12.5
Nature of course: Practical	**Credits:** 1
Level: MSc, III Semester	**Credit hours:** 16 × 4

Course content

1. To determine bulk density of soil samples from different land uses.
2. To determine humus content of soils from different land uses.
   by De-Sigmoid's method.
3. To determine soil carbonates and bicarbonates of soil samples from different land uses.
4. To determine CO_2 released from soil microbial activity.
5. To determine free CO_2 present in different water samples.
6. To determine acidity of different water samples.
7. To determine alkalinity of different water samples.
8. To determine potability of drinking water.
9. To perform phytochemical screening of medicinal plants.
10. To prepare and submit Environmental Impact Assessment (EIA) report of developmental project.
11. Term Paper and Seminar
12. Report/Mini Dissertation

Text and references

Baland J.-M. and Platteau J.-P. 1996. *Halting Degradation of Natural Resources: Is there a Role for Rural Communities?*. Food and Agriculture Organization of the United Nations and Clarendon Press, Oxford.

Brady N.C. and Weil R.C. 2002. *The Nature and Properties of Soil*. Pearson Education Inc. and Dorling Kindersley Publishing, Inc. India.

Chaudhary R.P. 1998. *Biodiversity in Nepal - Status and Conservation*. S. Devi, Saharanpur, India & Tecpress Books,Bangkok, Thailand.

GoN/MFSC. 2014. *National Biodiversity Strategy and Action Plan (2014-2020)*. Ministry of Forest and Soil Conservation (MFSC), Government of Nepal (GoN), Kathmandu.

Huston M.A. 1994. *Biological Diversity: The Coexistence of Species on Changing Landscapes*. Cambridge University Press.

Jha P.K., Karmacharya S.B., Balla M.K., Chettri M.K. and Shrestha B.B., eds. 2010. *Sustainable Use of Biological Resources*. Ecological Society (ECOS), Kathmandu, Nepal.

Jha P.K., Karmacharya S.B., Chettri M.K., Thapa C.B. and Shrestha B.B., eds. 2008. *Medicinal Plants in Nepal: The Anthology of Contemporary Research*. Ecological Society (ECOS), Kathmandu, Nepal.

Jha S. 1990. *Conservation for Development in Nepal*. National Book Organization, Dew Delhi,

Jonathan C. 2007. *Climate Change*. Cambridge University Press, Cambridge.

Lekhak H.D. and Lekhak B. 2009. *Natural Resource Conservation and Sustainable Development in Nepal*. Kshitiz Publication, Kathmandu, Nepal.

McCann K.S. 2000. The diversity stability debate. *Nature* 405: 228-233

Miller G.T. 1997. Environmental Sciences. Wardsworth Publishing Company, USA.

Miller G.T. 2002. Living in the Environment. Wardsworth Publishing Company, Inc. USA.

Pickett S.T.A., Ostfeld R.S., Shachak M. and Likens G.E., eds. *The Ecological Basis of Conservation: Heterogeneity, Ecosystems, and Biodiversity*. Chapman and Hall.

Ramakrishnan P.S. 2001. *Ecology and Sustainable Development*. National Book Trust, India.

Savory A. 1988. *Holistic Resource Management*. Island Press, California, USA.

Sharma B.K. 2014. *Bioresources of Nepal*. Subidhya Sharma, Kathmandu, Nepal.

Singh J.S., Singh S.P. and Gupta S.R. 2006. *Ecology, Environment and Resource Conservation*. Anamaya Publishers, New Delhi.

Waltner-Toews D. 2004. *Ecosystem Sustainability and Health*. Cambridge University Press, Cambridge.

WCMC (World Conservation Monitoring Centre). 1992. *Global Biodiversity: Status of the Earth's Living Resources*.Chapman & Hall, London.

Wilson E.O. 1988. *Biodiversity*. National Academic Press, Washington, D.C.

Plant Conservation Biology

Course title: Plant Conservation Biology	**Full marks:** 75
Course No.: BOT 633	**Pass marks:** 37.5
Nature of course: Theory	**Credits:** 3
Level: MSc, III Semester	**Credit hours:** 48

Objectives

The overall aim of this course is to provide critical understanding of conservation biology science, and the processes and approaches of biodiversity conservation and management.

Course content

Unit 1. Science of conservation biology: Introduction and definitions, goals, history, philosophical roots, ethical and guiding principles, tools and approaches. [**2 h**].

Unit 2. Biodiversity: (i) components and levels, overview of patterns and processes of biodiversity distribution and their determinants. (ii) Current status of biodiversity, biodiversity hotspots, valuing biodiversity. [**5 h** (2+3)].

Unit 3. Threats and extinctions: (i) Overview of the drivers of biodiversity loss/extinction. (ii) Extinction: types, processes and rates of extinction, prediction of extinction rates, vulnerability to extinction (factors responsible for high extinction risk). (iii) Endemism: introduction, types of endemism, global pattern of endemism, endemism in the Himalaya. (iv) Rarity: concept and models of rarity, causes of rarity. (v) Threat assessments and priority setting: methods and approaches (IUCN threat categories, CAMP method, RVA method). [**11 h** (2+3+2+1+3)].

Unit 4. Conservation biology of small populations: (i) Population concept, causes and problems of small populations. (ii) Extinction forces and consequences: deterministic and stochastic forces; extinction vortices, minimum viable population and effective population size. (iii) Conservation approaches at population level: overview of *In-situ* and *ex-situ* conservation, solutions to small population problems. (iv) Demographic and genetic approaches: population modeling and predictions, population viability analysis (PVA)], metapopulation approach, conservation genetics. [**11 h** (1+2+2+6)].

Unit 5. Conservation approaches at ecosystem and landscape levels: (i) Ecosystem-level approaches: ecosystem resilience and stability, protected area (PA) systems (introduction, history, categories, importance, management planning), ecosystem approach as a conceptual framework. (ii) Shifting in the conservation paradigm (SLOSS debate), conservation outside PAs, ecological restoration. (iii) Landscape-level approaches: landscape ecology and spatial heterogeneity, corridors, landscape-based conservation (with reference to Nepal), trans-boundary conservation. (iv) Conservation instruments: laws, strategies, action plans, international conservation agreements. [**12 h** (4+2+4+2)].

Unit 6. Local society, TEK and biodiversity conservation: (i) Introduction and definitions, theoretical advancement, principles and assumptions, major components. (ii) TEK and biodiversity conservation: traditional resource management (TRM) system (with reference to Nepal), community institutions and conservation practices, application of integrating TEK in biodiversity assessment and conservation planning. (iii) Sustainable production and harvest of biological resources: concept, approaches and practices with reference to medicinal and aromatic plants and other NTFPs. [**7 h** (3+2+2)].

Course title: Plant Conservation Biology	**Full marks:** 25
Course No.: BOT 634	**Pass marks:** 12.5
Nature of course: Practical	**Credits:** 1
Level: MSc, III Semester	**Credit hours:** 16 × 4

Objectives

The overall aim of this course is to provide practical and analytical knowledge related to the principles and approaches of biodiversity conservation.

Course content

1. Biodiversity conservation: setting priority for action

1.1 Threat value and vulnerability indices

2. Population-level study

2.1 Population size and structure

2.2 Population modelling and analysis of population dynamics and viability/extinction risks through population models using secondary data

3. Project work (field-based study)

a. Ecosystem- and landscape-level studies

3.1 Assessment of habitat/landscape heterogeneity and status of biodiversity

3.2 Identification of important plant areas

3.3 Observe conservation action and review operation/management plan of a protected area or a community forest.

b. Participatory research for TEK and TRM

3.4 Documentation of TEK (structural, relational and utilitarian aspect) in relation to plant diversity

3.5 Traditional traditional resource management system (institutions and management practices)

3.6 Post field study: field data analysis and writing report/mini dissertation

4. Term paper and seminar

Text and reference books

Akçakaya H.R., Burgman M.A. and Ginzburg L.R. 1999. *Applied Population Ecology.* Sinauer Associates, Inc. Sunderland, MA, USA.

Primack R.B. 2014. *Essentials of Conservation Biology.* Sixth Edition. Sinauer Associates, Inc. Publishers, Sunderland, MA, USA.

Suggested Further Readings

Baland J.-M. and Platteau J.-P. 1996. *Halting Degradation of Natural Resources: Is there a Role for Rural Communities?.* Food and Agriculture Organization of the United Nations and Clarendon Press, Oxford.

Burroughs W.J. 2001. *Climate Change: A Multidisciplinary Approach.* Cambridge University Press.

Cunningham A.B. 2001. *Applied Ethnobotany: People, Wild Plant Use and Conservation*. Earthscan, London, UK.

Eiedler L.P. and Jain S.K., eds. 1992. *Conservation Biology: The Theory and Practice of Nature Conservation, Preservation and Management*. Chapman and Hall, NY, USA.

Frankham R., Ballou J.D., Briscoe D.A. and McInnes K.H. 2002. *Introduction to Conservation Genetics*. Cambridge University Press

Ghimire S.K. 2008. Medicinal plants in the Nepal Himalaya: Current issues, sustainable harvesting, knowledge gaps and research priorities. In: *Medicinal Plants in Nepal: The Anthology of Contemporary Research*. (P.K. Jha, S.B. Karmacharya, M.K. Chettri, C.B. Thapa and B.B. Shrestha, eds.), pp. 25-42. Ecological Society (ECOS), Kathmandu, Nepal.

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Whittaker, R.J. and Fernández-Palacios, J.M. 2007. *Island Biogeography: Ecology, Evolution, and Conservation*, 2nd edn. Oxford University Press, Oxford.

Zimmerer K.S. and Young K.R. 1998. *Nature's Geography: New Lessons for Conservation in Developing Countries.* The University of Wisconsin Press, Wisconsin, USA.

Important journals (selected)

- *Biodiversity and Conservation*
- *Biological Conservation*
- *Biotropica*
- *Conservation and Society*
- *Conservation Biology*
- *Ecology and Society*
- *Global Change Biology*
- *Journal of Applied Ecology*
- *The Journal of Wildlife Management*

Molecular Biology

Course title: Molecular Biology	**Full marks:** 75
Course No.: BOT 635	**Pass marks:** 37.5
Nature of course: Theory	**Credits:** 3
Level: MSc, III Semester	**Credit hours:** 48

Objectives

The main objectives of this course is to enable students to (i) describe the structure and organization of nucleic acids and their roles in living systems, (ii) explain the transfer of information within the cell and between the cell generations, (iii) explain the mechanism of regulation of gene expression inside a cell, and (iv) explain the synthesis, transport and roles of proteins within the cell.

Course content

Unit 1. Structure of genetic material at the molecular level: Nucleic acids: chemical and physical properties, molecular structure of eukaryoic chromosome; heterochromatin and euchromatin, satellite DNAs, nucleolar gene, repeated DNA sequence, mobile DNA. [**7 h** (2+1+1+1+2)].

Unit 2. Gene expression: Overview of gene expression in prokaryotes and eukaryotes; transcription and synthesis of different RNAs, processing of RNA transcript. Catalytic RNA, RNA splicing and Spliceosome. Transport of RNA through nuclear pore, translation and polypeptide synthesis, post-translational modification. Protein trafficking and degradation. Antibiotics and inhibition of protein synthesis. [**10 h** (3+2+3+1+1)].

Unit 3. Regulation of gene expression: Control of protein synthesis in prokaryotes and eukaryotes- an overview. Role of promoter; TBPs (TATA-binding proteins) structure/functions, TAFs (TBP-associated factors) structure and functions. Control in transcription level: structure and function of transcriptional activators and repressors. Signal transduction and the control of transcriptional regulators, RNA processing, RNA degradation; antisense RNA. Gene silencing, Gene regulation during development. [**12 h** (1+3+2+4+2)].

Unit 4. Molecular cytogenetics: Nuclear DNA content, C-value paradox, Cot curve and its significance. Restriction mapping: concept and techniques. Multigene families and their evolution. In situ hybridization and techniques. Chromosomes micro-dissection and micro-cloning, Flow cytometry, confocal microscopy and karyotype analysis. [**10 h** (2+1+2+1+4)].

Unit 5. Evolution of genome: Biological diversity, Genome evolution and genomes of higher organisms, Genome projects: Human genome project and other genome projects, Sequencing of Genome, application of genome sequencing; comparative genome analysis and its application. [**9 h**].

Course title: Molecular Biology	**Full marks:** 25
Course No.: BOT 636	**Pass marks:** 12.5
Nature of course: Practical	**Credits:** 1
Level: MSc, III Semester	**Credit hours:** 16 × 4

Course content

1. Laboratory safety
2. Isolation and purification of plasmid DNA from bacteria
3. Quantitative estimation of nucleic acid concentration and purity by spectrophotometer
4. Isolation of genomic DNA from bacteria
5. Restriction digestion and agarose gel-electrophoresis, and construction of restriction maps
6. Isolation of eukaryotic DNA from plants
7. Extraction of DNA fragment from gel
8. Isolation of RNA
9. Separation of RNA by formaldehyde agarose gel-electrophoresis.
10. Isolation of mRNA
11. *In vitro* amplification of DNA by polymerase chain reaction and agarose gel-electrophoresis of the amplified product.
12. Isolation of protein from plant tissues
13. Separation of protein by polyacrylamide gel-electrophoresis
14. Protein band recognition by coomassie blue or silver staining.

Text and reference books

Alberts B., Lewis J., Raff M., Johnson A. and Roberts K. 2004. *Molecular Biology of Cell*. Garland Publishing Inc.

Ausubel F.M., Brent R., Kingston R.E., Moore D.D., Seidman J.G., Smith J.A. and Struhl K. 2002. *Short Protocols in Molecular Biology*. Wiley.

Campbell N.A. and Reece J.B. 2002. *Biology*. Pearson Education/Benjamin Cummings.

Dale J.W. and Park S.F. 2010. *Molecular Genetics of Bacteria*. 5th edition. Wiley -Blackwell.

Glick B.R. and Pasternak J.J. (recent edition). *Molecular Biotechnology*. American Society of Microbiology press.

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Trun N. and Trempy J. 2004. *Fundamentals of Bacterial Genetics*. Blackwell.

Turner P.C., McLennan A.G., Bates A.D. and White M.R.H. 2007. *Instant Notes Molecular Biology*. Taylor and Francis

Watson J.D., Baker T.A., Bell S.P., Gann A., Levine M. and Losick R. 2004. *Molecular Biology of the Gene*. Pearson Education, Inc.

Food Security and Safety

Course title: Food Security and Safety	**Full marks:** 75
Course No.: BOT 637	**Pass marks:** 37.5
Nature of course: Theory	**Credits:** 3
Level: MSc, III Semester	**Credit hours:** 48

Objectives

The general aim of this course is to provide theoretical and practical knowledge on food security and safety. The specific objectives are to (i) develop understanding on food security concept, policy and programs; (ii) elaborate knowledge on food safety issue and strategies; and (iii) impart knowledge on food storage, post harvest management and plant quarantine.

Course content

Unit 1. Food security: (i) *Introduction:* concept and definition, conceptual framework of food security, key factors of food security, global; national; household and individual food and nutritional security, micro-economic analysis of food security, threats to food security; (ii) *Food aid policy and program*: concept and history, domestic and international food assistance policy and programs; mechanism to promote food security (economic and livelihood aspects); (iii) *Agriculture and forest for food security:* farming system, modern agriculture, green revolution and GM crops, sustainable agriculture and wild edible plants, undervalued and marginalized crops; food souverinity, food governance, sustainable development and food security; food security scenario in the different agro-ecological zones in Nepal. [**12 h** (4+4+4)].

Unit 2. Food safety: (i) *Food illness*: concept and history of food safety, unsafe sources, inadequate cooking, improper holding temperature, contaminated processing equipments, hygene; (ii) *Food hazards:* food borne infectious and microbiological agents, pesticide residues, misuse of food addititives, chemical contaminants including biological and food adulteration; environmental and health implication of food hazards, GM crops and food safety concern, (iii) *Food protection:* principles of food processing and preservation, concept of food protection, hygene, reduce microbial contamination and control growth (physical, chemical and biological methods), control chemical agents and toxins, food education and trainings. [**12 h** (3+4+5)].

Unit 3. Seed protection for food security and safety: (i) concept and history of seed protection, seed pathogens (bacterial, fungal and viral); (ii) method of detection of seed pathogens (examination without incubation: dry seeds, after softening, seed washing; incubation methods: blotter method, rolled paper towel method, 2,4-D method, deep-freezing method, agar plate method) (iii) seedling symptom test (Hiltner's brick stone method, sand method, standard soil method, test tube agar method); (iv) control of seed-borne pathogen; role of micro-organisms in seed quality and storage; seed certification; seed Act and regulation in Nepal. [**12 h** (1+5+3+3)].

Unit 4. Plant quarantines: (i) History, definition, certification, intra and inter-state movement of disease materials (ii) plant quarantine station and their function in Nepal, plant quarantine Act and Regulation of Nepal. [**3 h** (1+2)].

Unit 5. Post harvest management and safety: (i) concept of post harvest loss, post-harvest management technology and strategies, post harvest changes in seed and tubers biochemical

constituent's quality, effect of environmental factors on post harvest changes in seed and tubers. (ii) Biotechnological approaches to manipulate ethylene biosynthesis and action, alternate post-harvest methodology and quality attributes, scope for genetic modification of post-harvest life of flowers and fruits (iii) losses caused by plant diseases: reduction in quantity and quality of plant produce (iv) toxicity to humans and animals (v) bioterrorism, agro-terrorism, biological warfare (vi) traditional agricultural practices and agro-biodiversity in the management of plant diseases. [**9 h** (2+2+2+1+1+1)].

Course title: Food Security and Safety	**Full marks:** 25
Course No.: BOT 638	**Pass marks:** 12.5
Nature of course: Practical	**Credits:** 1
Level: MSc, III Semester	**Credit hours:** 16 × 4

Course content

1. Study of food security (field based) in nearby community.
2. Analysis of food security data (data obtained from different sources in Nepal).
3. Isolation and identification of microbes in different food stuffs.
4. Experiment on seed viability test of selected crops.
5. Study of seed-borne fungi by standard method.
6. Control of seed-borne pathogens by fungicide.
7. Isolation and identification of microbes in different food stuffs.
8. Survey on post harvest management practices
9. Survey on people's perception on impacts of climate change on food safety and security

Books and references

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Aneja, K.R. 2003. *Experiments in Microbiology, Plant Pathology and Biotechnology*. 4th ed. New Age International Publishers, New Delhi.

Asian Development Bank. 2012. *Agriculture, Food security and Rural Development*. Oxford University Press.

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Nyle C Brady and Ray R. Well. 2004. *The Nature and Property of Soil*. Pearson Education (Singapore) Pvt. Ltd.

Rangaswami, R.S. 2005. *Diseases of Crop Plants of India*. Prentice Hall of India Pvt. Ltd., New Delhi.

Sambamurty, A.V.S.S. 2006. *Text Book of Plant Pathology*. I.K. International Pvt. Ltd., New Delhi.

Tribhuvan University

Institute of Science and Technology

Central Department of Botany

M.Sc. Botany Syllabus

Fourth Semester

2074

Course Outline

SEMESTER IV: Compulsory Paper (Dissertation)

Credits: 8; Full marks: 200

Course No.	Title	Credit	FM
BOT 651	Dissertation	8	200
Total		**8**	**200**

Dissertation

Course title: Dissertation	**Full marks:** 200
Course No.: BOT 651	**Pass marks:** 100
Nature of course: Dissertation	**Credits:** 8
Level: MSc, IV Semester	**Credit hours:** 128

Objectives

The general aim of this course is to (i) enable students to design the experiment, collect primary data, analyze data using appropriate statistical method, and prepare a scientific research report; (ii) enable students to formulate hypothesis/research questions and test/answer them using primary data; and (iv) develop skill to present research finding in scientific meeting.

Evaluation

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*.