

B.Sc. (Honours) Botany

Subject Prerequisites: To study this subject a student must have had the subject Biology/Biotechnology at 10+2 or intermediate level.

Course Structure: The courses will be based on Choice Based Credit System (CBCS) structure developed by the University. There will be four compulsory or elective core courses (3 credits each) of Botany in each semester of BSc first year. Apart from these, in each semester one **Minor Generic Elective Course (4 credits)** is to be chosen by a student in the first year of BSc honors (Botany) in each semester. In addition to this one Ability Enhancement course (AEC), Skill Enhancement course (SEC) & one Value Addition Course (VAC) will be taken in each semester of BSc first year. All these AEC, SEC & VAC will be of 2 credits each.

In this way each semester of BSc Botany First year (honors) will be of 22 credits. One credit is equal to 15 lectures.

Vocational Course/ Internship/Apprenticeship/ Project/ Community Outreach/ Workshop (VIAPCW) of 4 credits is mandatory for exiting after first year and will be awarded certificate in Botany

Thus, Total Credits after One-Year (BSc First year) = $44+4=48$ (mandatory for Certificate in Botany)

Programme (BSc Honours Botany) Objectives:

This programme has been designed to train and enable students to understand the relationship between plant science and society as well as logical, scientific and ethical issues related to plant science. In addition to this, the students will be able to think critically for the formulation of hypotheses and experimental designing based on the scientific method, which will make the students readily employable in various streams of teaching, research, civil services and in industries.

Programme Specific Outcomes (PSOs): After completing BSc honours (Botany), the following will be the PSOs

PSO-1: It is expected that after successfully completing BSc honors (Botany), students will develop deeper theoretical & Practical knowledge of various branches of Botany.

PSO-2: This program has a strong theoretical basis that will help students in evolutionary relationships of lower and higher plants by using the key characters which is expected from a student of Botany to support the other branches of knowledge related to plants.

SO-3: Many of the courses in the programme have been carefully designed that will help the students for qualifying competitive exams like IAS, IFS, CSIR NET, SET, TGT, PGT and to write research proposals for grants.

PSO-4: Continuous internal assessment provides ample opportunity to the students for interaction with teachers and improvement after every evaluation. Seminars and field visits will groom the personality of students and enable them to present themselves with confidence. Assignments enable the students to compile and present the solutions of the given problems with optimal discussion.

PSO 5. A student completing the programme will be capable of executing research projects.

Subject : B.Sc. Botany (Honours) I semester		
Course Code :	Core Course I: Microbiology	
Course Objectives: The objective of this course is to make students aware about microbial world and its diversity along with their skill enhancement in microbial application for human welfare and development.		
Course outcomes: After the completion of the course the students will be able to:		
1. Develop understanding about the classification and diversity of different microbes & their economic importance.		
2. Develop conceptual skill about identifying microbes, pathogens, biofertilizers & lichens.		
3. Gain knowledge about developing commercial enterprise of microbial products.		
4. Learn host -pathogen relationship and disease management.		
5. Learn Presentation skills (oral & writing) in life sciences by usage of computer & multimedia.		
6. Gain Knowledge about uses of microbes in various fields.		
7. Understand the structure and reproduction of certain selected bacteria.		
8. Gain Knowledge about the economic values of this lower group of living world.		
Credits : 3	Core Compulsory Theory	
Max Marks :	Min. Passing Marks :	
Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0		
Unit	Topic	No. of Lectures (45 hrs)
I	Introduction to microbial world, microbial nutrition, growth and metabolism	5
II	Microbial Techniques & instrumentation Microscopy – Elementary knowledge of Light, phase contrast, electron, scanning and transmission electron microscopy, staining techniques for light microscopy, sample preparation for electron microscopy. Common equipment of microbiology lab and principle of their working – autoclave, oven, laminar air flow, centrifuge. Colorimetry and spectrophotometry, immobilization methods, fermentation and fermenters.	10
III	Microbial World I: Viruses, general characteristics, viral culture, Structure of viruses, TMV and retro viruses, Bacteriophages, Structure of T4 & λ -phage; Lytic and Lysogenic cycles, mycophages, viroid, Prions & mycoplasma & phytoplasma, Actinomycetes (Actinobacteria) and economic uses of microbes	10
IV	Microbial World II: Cell structure of Eukaryotic and prokaryotic cells, Gram positive and Gram-negative bacteria, Structure of a bacteria and plasmids; Bacterial Chemotaxis and Quorum sensing, Bacterial Growth curve, factors affecting growth of microbes; measurement of growth; Batch culture, fed batch culture and continuous culture; Synchronous growth of microbes; Sporulation and reproduction and recombination in bacteria	10

V	Applied Microbiology: Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases. Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine).	10
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Suggested Readings

1. Prescott, L.M., Harley J.P., Klein D. A. (2005). Microbiology, McGraw Hill, India. 6th edition.
2. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
3. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.

Subject : B.Sc. Botany (Honours) 1 semester		
Course Code :	Core Course II: Mycology and Phytopathology	
Objectives: 1. To understand the detailed structure of fungus 2. To study general characteristic, classification and Life cycle of different group of fungi. 3. To study structure of lichen & Mycorrhiza 5. To study General symptoms & etiology of different disease		
Course outcomes: After the completion of the course the students will be able to: 1. Learn Affinities with plants and animals; Thallus organization; Cell wall composition 2. understand the several aspects like general characteristics, classification & Life cycle of different fungi. 3. learn structure of lichen & Mycorrhiza 4. study General symptoms & etiology of different disease.		
Credits : 3		Core Compulsory Theory
Max Marks :		Min. Passing Marks :
Total no of Lectures-Tutorials- Practicals (in hours per week):4-0-0		
Unit	Topic	No. of Lectures (45 hrs)
I	Introduction to true fungi: Definition, General characteristics; Affinities with plants and animals; Thallus organization; Cell wall composition; Nutrition; Classification. Chytridiomycetes: General account	08
II	Zygomycota: General characteristics; Ecology; Thallus organisation; Life cycle with reference to Rhizopus. Ascomycota: General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; life cycle and classification with reference to <i>Saccharomyces</i> , <i>Aspergillus</i> , <i>Penicillium</i> , <i>Alternaria</i> and <i>Neurospora</i> , & <i>Peziza</i> .	11
III	Basidiomycota: General characteristics; Ecology; Life cycle and Classification with reference to black stem rust on wheat <i>Puccinia</i> (Physiological Specialization), loose and covered smut (symptoms only), <i>Agaricus</i> ; Bioluminescence, Fairy Rings and Mushroom Cultivation. Oomycota: General characteristic; Ecology; Life cycle and classification with reference to <i>Phytophthora</i> & <i>Albugo</i> .	12
IV	Symbiotic associations: Lichen Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction. Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance	04
V	Phytopathology: Terms and concepts; General symptoms; Geographical distribution of diseases; etiology; symptomology; Host- Pathogen relationships; disease cycle and environmental relation; prevention and control of plant diseases, and role of	10

quarantine. Bacterial diseases – Citrus canker and angular leaf spot disease of Cotton. Viral diseases – Tobacco Mosaic viruses, vein clearing. Fungal diseases – Early blight of potato, Black stem rust of wheat, white rust of crucifers.	
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Suggested Readings

1. Agrios, G.N. 1997 Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
5. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

Subject : B.Sc. Botany (Honours) 1semester		
Course Code :		Core Course III: Algae and Bryophytes
Objectives: To study general characteristics, ecology, thallus organization, and reproductive part of different Algae, & Bryophyta.		
Course outcomes: After the completion of the course the students will be able to learn		
<ol style="list-style-type: none"> 1. Contribution of different Phycologist 2. Ecology and occurrence, range of thallus organization, cell structure in different group of Algae 3. Life cycle pattern in different Algae 4. General characteristics, Classification, & Thallus organization in different group of Bryophytes 5. Reproduction and evolutionary trends in different Bryophytes 		
Credits : 3		Core Compulsory Theory
Max Marks :		Min. Passing Marks :
Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0		
Unit	Topic	No. of Lectures (45 hrs)
I	Algae: General characteristics, Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; and methods of reproduction, classification; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); significant contributions of important phycologists (F.E. Fritsch, G.M. Smith, R.N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P. Iyengar).	07
II	Cyanophyta: Ecology and occurrence, range of thallus organization, cell structure, heterocyst, reproduction, Economic importance; Morphology and life-cycle of <i>Nostoc</i> . Chlorophyta: General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles of <i>Volvox</i> and <i>Oedogonium</i> . Charophyta: General characteristics; occurrence, morphology, cell structure and life-cycle of <i>Chara</i> evolutionary significance.	08
III	Xanthophyta: General characteristics; range of thallus organization; Occurrence, morphology and life-cycle of <i>Vaucheria</i> . Phaeophyta: Characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles of <i>Ectocarpus</i> . Rhodophyta: General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycle of <i>Polysiphonia</i> .	10

IV	Bryophytes Introduction Unifying features of archegoniates; Transition to land habit; Alternation of generations.	02
V	Bryophytes General characteristics; Adaptations to land habit; Classification; Range of thallus organization. Classification (up to family). <i>Riccia</i> , <i>Marchantia</i> , <i>Pellia</i> , <i>Porella</i> , <i>Anthoceros</i> , <i>Sphagnum</i> and <i>Funaria</i> ; Reproduction and evolutionary trends in <i>Riccia</i> , <i>Marchantia</i> , <i>Anthoceros</i> and <i>Funaria</i> (developmental stages not included). Ecological and economic importance of bryophytes with special reference to <i>Sphagnum</i> .	18

Suggested Readings

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
2. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
3. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.
4. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
5. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.
6. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.
7. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
8. Vander-Poorteri 2009 Introduction to Bryophytes. COP.

Subject BSc Botany (Honours) I semester

Course Code : **Core Course IV: Practical I**

Objective: To performs at least 10 exercises/experiment from each part.

Course outcomes: After performing eperiment from each unit, the students will be able to perform

1. 10 experiments from microbiology
2. 10 experiments from Mycology and Phytopathology
3. 10 experiments from Algae & Bryophytes

Credits : 3

Core Course Practical

Max Marks :

Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):0-0-4

Unit	Topic	No. of Lectures (45 hrs)
I	Microbiology <ol style="list-style-type: none"> 1. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle. 2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule. 3. Gram staining. 4. Endospore staining with malachite green using the (endospores taken from soil bacteria). 	15
II	Mycology and Phytopathology <ol style="list-style-type: none"> 1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, asocarps & basidiocarps). 2. <i>Rhizopus</i>: study of asexual stage from temporary mounts and sexual structures through permanent slides. 3. <i>Aspergillus</i>: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs. 4. <i>Alternaria</i>: Specimens/photographs and temporary mounts. 5. <i>Puccinia</i>: Herbarium specimens of Black Stem Rust of Wheat and infected Barberryleaves; sections/ mounts of spores on wheat and permanent slides of both the hosts. 6. <i>Agaricus</i>: Specimens of button stage and full grown mushroom; sectioning of gills of Agaricus, fairy rings and bioluminescent mushrooms to be shown. 7. <i>Albugo</i>: Study of symptoms of plants infected with Albugo; asexual phase study throughsection/ temporary mounts and sexual structures through permanent slides. 8. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endo mycorrhiza (Photographs) 	15

	9. Phytopathology: Herbarium specimens of any bacterial diseases; Viral diseases: TMV, Vein clearing, Fungal diseases: Early blight of potato, Black stem rust of wheat and White rust of crucifers.	
III	Algae and Bryophytes Phycology: Study of vegetative and reproductive structures of <i>Nostoc</i> , <i>Volvox</i> , <i>Oedogonium</i> , <i>Chara</i> , <i>Vaucheria</i> , <i>Ectocarpus</i> , and <i>Polysiphonia</i> , temporary preparations and permanent slides. Bryophytes 1. <i>Riccia</i> – Morphology of thallus. 2. <i>Marchantia</i> - Morphology of thallus, whole mount of rhizoids & Scales, vertical section of thallus through Gemma cup, whole mount of Gemmae (all temporary slides), vertical section of Antheridiophore, Archegoniophore, longitudinal section of Sporophyte (all permanent slides). 3. <i>Anthoceros</i> - Morphology of thallus, dissection of sporophyte (to show stomata, spores, pseudoelaters, columella) (temporary slide), vertical section of thallus (permanent slide). 4. <i>Funaria</i> - Morphology, whole mount of leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, longitudinal section of capsule and protonema.	15

Subject : B.Sc. Botany (Honours) 1 semester		
Course Code :	Minor Generic Elective Course I: Biodiversity (Microbes, Algae, Fungi and Archegoniatae)	
Objective: To study Biodiversity including Microbes, Algae, Fungi and Archegoniatae		
Course outcomes: After the completion of the course the students will be able to:		
1. Learn diversity of microbes, their reproduction & Economic importance		
2. Learn diversity of Algae, life-cycles of some Algae & their Economic importance		
3. Learn diversity of fungi, life-cycles of some Algae & their Economic importance		
4. Learn diversity of Bryophytes, life-cycles of some Bryophytes & their Economic importance		
5. Learn diversity of Pteridophytes & Gymnosperms, reproductive stages of some Pteridophytes & Gymnosperms & their Economic importance		
Credits : 4		Core Elective
Max Marks :		Min. Passing Marks :
Total no of Lectures-Tutorials- Practical's (in hours per week):4-0-0		
Unit	Topic	No. of Lectures (60 hrs)
I	Microbes & Viruses: Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.	10
II	Algae: General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: <i>Nostoc</i> , <i>Chlamydomonas</i> , <i>Oedogonium</i> , <i>Vaucheria</i> , <i>Fucus</i> , <i>Polysiphonia</i> . Economic importance of algae.	12
III	Fungi: Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition , nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of <i>Rhizopus</i> (Zygomycota) <i>Penicillium</i> , <i>Alternaria</i> (Ascomycota), <i>Puccinia</i> , <i>Agaricus</i> (Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.	12

IV	Bryophytes: General characteristics, adaptations to land habit, Classification. Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of <i>Marchantia</i> and <i>Funaria</i> (Developmental details not to be included) .Ecology and economic importance of bryophytes with special mention of <i>Sphagnum</i>	12
V	Pteridophytes: General characteristics, classification, Early land plants (<i>Cooksonia</i> <i>Agloophyton</i> , and <i>Rhynia</i>). Classification (up to family), morphology, anatomy and reproduction of <i>Selaginella</i> , <i>Equisetum</i> and <i>Pteris</i> (Developmental details not to be included). Heterospory and seed habit, stelar evolution. Ecological and economical importance of Pteridophytes. Gymnosperms: General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of <i>Cycas</i> and <i>Pinus</i> (Developmental details not to be included). Ecological and economical importance.	14

Suggested Readings

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
2. Tortora, G.J., Funke, B.R. & Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

Subject : B.Sc. Botany(Honours) II semester		
Course Code :	Core Course V: Pteridophytes and Gymnosperms	
Objective: To study general characteristics, Classification, Morphology, Anatomy and Reproduction in different Pteridophytes and Gymnosperms		
Course outcomes: After the completion of the course the students will be able to:		
1. Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms		
2.		
3. Understand morphology, anatomy, reproduction in different Pteridophytes and Gymnosperms		
4. understand different group of fossils plants		
1.		
Credits : 3	Core Elective	
Max Marks :	Min. Passing Marks :	
Total no of Lectures-Tutorials- Practical's (in hours per week):4-0-0		
Unit	Topic	No. of Lectures (45 hrs)
I	Pteridophytes: General characteristics, Classification (up to family), Comparative study of morphology, anatomy and reproduction of <i>Psilotum</i> , <i>Selaginella</i> , <i>Equisetum</i> , <i>Azolla</i> , <i>Marsilea</i> and <i>Pteris</i> (Developmental details not to be included).	15
II	Apogamy, and apospory, heterospory and seed habit, telome theory, stelar evolution. Ecological and economic importance	05
III	Gymnosperms: General characteristics, recent classification, morphology, anatomy and reproduction of <i>Cycas</i> , <i>Pinus</i> and <i>Ephedra</i> (Developmental details not to be included), Ecological and economic importance.	15
IV	Palaeobotany Early fossil land plants (<i>Cooksonia</i> , <i>Agloophyton</i> and <i>Rhynia</i>). General account of Cycadofilicales, Bennettitales, Pentoxylales and Cordaitales.	05
V	Geological time scale; Brief account of process of fossilization & types of fossils and study techniques.	05

Suggested Readings

1. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.
2. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
3. Gangulee H. S. and K. Kar 1992. College Botany Vol. I and II. (New Central Book Agency)
4. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
5. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
6. Rashid A (1999) An Introduction to Pteridophyta, Vikas Publishing House Pvt. Ltd. New Delhi.
7. Sharma OP (1990) Textbook of Pteridophyta. MacMillan India Ltd. Delhi.
8. Vashishtha BR, Sinha AK and Kumar A (2010) Botany for Degree Students – Pteridophyta, S. Chand and Company.
9. Vashishtha BR, Sinha AK and Kumar A (2010) Botany for Degree Students – Gymnosperms, S. Chand and company.

Subject : B.Sc. Botany (Honours) II semester		
Course Code :	Core Course VI: Cell Biology and Biomolecules	
Objective: To study structure & function of cell organelle including structural and functional role of different Biomolecules		
Course outcomes: After the completion of the course the students will be able to:		
1. structural & functional organization of cell & cell organelle.		
2. different stages of Mitosis & Meiosis		
3. structure, classification and role of carbohydrate, lipid & protein		
4. To gain knowledge on enzyme structure, function and kinetics.		
Credits : 3	Core Elective	
Max Marks :	Min. Passing Marks :	
Total no of Lectures-Tutorials- Practical's (in hours per week):4-0-0		
Unit	Topic	No. of Lectures (45 hrs)
I	The cell: Cell as a unit of structure and function; Cell wall and plasma membrane Chemistry, structure and function of Plant Cell Wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis.	04
II	Cell organelles: Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus. Cytoskeleton: role and structure of microtubules, microfilaments and intermediary filament. Structure and function of Chloroplast, mitochondria and peroxisomes. Endomembrane system: Structure and function of Endoplasmic Reticulum, Golgi Apparatus and Lysosomes. Cell division: Eukaryotic cell cycle, mitosis and meiosis.	14
III	Carbohydrates: Nomenclature and classification; Role of monosaccharides (glucose, fructose, sugar alcohols – mannitol and sorbitol); Disaccharides (sucrose, maltose, lactose), Oligosaccharides and polysaccharides (structural-cellulose, storage – starch,)	05

IV	Lipids: Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties. Saponification. Structural lipids.	05
V	Proteins: Structure of amino acids; Peptide bonds; Levels of protein structure-primary, secondary, tertiary and quarternary; Isoelectric point; Protein denaturation and biological roles of proteins. Enzymes: Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced - fit theory), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.	17

Suggested Readings

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
6. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
7. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
8. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
9. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco

Subject : B.Sc. Botany(Honours) II semester		
Course Code :	Core Course VII: Plant Anatomy and Embryology	
Objectives: To study plant tissue, internal structure of different plant parts, & different aspects of plant embryology		
Course outcomes: After the completion of the course the students will be able to:		
1. Root & Shoot apex organization		
2. Structure of root, stem & leaf of dicot and monocot leaf		
3. Structure of wood and periderm		
4. Structure and development of male gametophyte, female gametophyte & development of embryo		
Credits : 3	Core Elective	
Max Marks :	Min. Passing Marks :	
Total no of Lectures-Tutorials- Practical's (in hours per week):4-0-0		
Unit	Topic	No. of Lectures (45 hrs)
I	Tissues: Classification of tissues; Simple and complex tissues; Pits and plasmodesmata	5
II	Stem: Organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, cytohistological zonation); Types of vascular bundles; Structure of dicot and monocot stem. Root: Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root	15
III	Structure of root, stem & leaf of dicot and monocot leaf. Vascular Cambium: Structure, function and seasonal activity of cambium; Secondary growth in root and stem.	05
IV	Wood: Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology. Periderm: Development and composition of periderm, rhytidome and lenticels.	05
V	Plant Embryology: Structure of microsporangium, microsporogenesis, Pollen structure, pollen morphology, Structure of megasporangium and its types, megasporogenesis, Structure and types of female gametophyte, Types of pollination, Methods of pollination, Germination of pollen grain, Structure of male gametophyte, Fertilization, Structure of dicot	15

and monocot embryo, Endosperm, Double fertilization, Apomixis and Polyembryony. Palynology: pollen allergy, Applied Palynology: Basic concepts, Palaeopalynology, Aeropalynology, Forensic palynology, Role of palynology in taxonomic evidences.	
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Suggested Readings

1. Maheswari, P. 1971. An Introduction to Embryology of Angiosperms. McGraw Hill Book Co., London
2. Bhattacharya et. al. 2007. A textbook of Palynology, Central, New Delhi.
3. Bhojwani, S.S. and S. P. Bhatnagar. 2000. The Embryology of Angiosperms (4th Ed.), Vikas Publishing House,.
4. P.K.K. Nair- A textbook of Palynology.
5. Johri, B. M. 1984. Embryology of Angiosperms. Springer-Verleg, Berlin.
6. Dutta A.C. 2016. Botany for Degree Students. Oxford University Press.
7. E.J.Eames . Morphology of Vascular Plants, Standard University Press.
8. Dickinson, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
9. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
10. Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc.

Subject : B.Sc. Botany(Honours) II semester

Course Code : **Core Course VIII: Practical II**

Objective: To performs at least 10 exercises/experiment from each part.

Course outcomes: After performing experiment from each unit, the students will be able to perform

1. 10 experiments from Pteriophytes and Gymnosperms
2. 10 experiments from Cell Biology and Biomolecules
3. 10 experiments from Plant Anatomy and Embryology

Credits : Practical-3 (Practical Lectures)

Core Practical

Max Marks :

Min. Passing Marks :

Total no of Lectures-Tutorials- Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (45 hrs)
I	Pteriophytes and Gymnosperms 1. <i>Selaginella</i> - morphology, W.M. leaf with ligule, T.S. stem, W.M. strobilus, W.M. microsporophyll and megasporophyll (temporary slides), L.S. strobilus (permanent slide). 2. <i>Equisetum</i> - morphology, T.S. internode, L.S. strobilus, T.S. strobilus, W.M. sporangiophore, W.M. spores (wet and dry)(temporary slides); T.S. rhizome (permanent slide). 3. <i>Pteris</i> - morphology, T.S. rachis, V.S. sporophyll, W.M. sporangium, W.M. spores(temporary slides), T.S. rhizome, W.M. prothallus with sex organs and young sporophyte (permanent slide). 4. <i>Cycas</i> - morphology (coralloid roots, bulbil, leaf), T.S. coralloid root, T.S. rachis, V.S. leaflet, V.S. microsporophyll, W.M. spores (temporary slides), L.S. ovule, T.S. root (permanent slide). 5. <i>Pinus</i> - morphology (long and dwarf shoots, W.M. dwarf shoot, male and female), W.M. dwarf shoot, T.S. needle, T.S. stem, , L.S./T.S. male cone, W.M. microsporophyll, W.M. microspores (temporary slides), L.S. female cone, T.L.S. & R.L.S. stem (permanent slide).	15
II	B. Cell Biology and Biomolecules 1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins. 2. Study of plant cell structure with the help of epidermal peel mount of Onion/Rhoeo/Crinum. 3. Demonstration of the phenomenon of protoplasmic streaming in Hydrilla leaf.	15

	<p>4. Measurement of cell size by the technique of micrometry.</p> <p>5. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).</p> <p>6. Study of cell and its organelles with the help of electron micrographs.</p> <p>7. Cytochemical staining of : DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique.</p> <p>8. Study the phenomenon of plasmolysis and deplasmolysis.</p> <p>9. Study the effect of organic solvent and temperature on membrane permeability.</p> <p>10. Study different stages of mitosis and meiosis.</p> <p>11. Camera Lucida drawing of cellular structures.</p>	
III	<p>C. Plant Anatomy and Embryology</p> <p>1. Study of anatomical details through permanent slides/temporary stain mounts/ macerations/ museum specimens with the help of suitable examples.</p> <p>2. Apical meristem of root, shoot and vascular cambium.</p> <p>3. Distribution and types of parenchyma, collenchyma and sclerenchyma.</p> <p>4. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.</p> <p>5. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood.</p> <p>6. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.</p> <p>7. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.</p> <p>8. Root: monocot, dicot, secondary growth.</p> <p>9. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.</p> <p>10. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).</p> <p>11. Adaptive Anatomy: xerophytes, hydrophytes.</p> <p>12. Secretory tissues: cavities, lithocysts and laticifers.</p> <p>13. Structure of anther, microsporogenesis and pollen grains.</p> <p>14. Structure of ovule and embryo sac development (through slides).</p> <p>15. Study of embryo development in monocots and dicots.</p> <p>16. Vegetative propagation by means of cutting, budding and grafting exercises.</p> <p>17. Study of seed germination.</p> <p>18. Study of pollen morphology of the following plants – <i>Hibiscus</i>, <i>Vinca</i>, <i>Balsam</i>, <i>Ixora</i>, <i>Crotalaria</i>, <i>Bougainvillea</i> by</p>	15

microscopic observation.

19. Calculation of pollen viability percentage using in vitro pollen germination techniques.

20. Reproductive tissue processing, Block preparation and Microtomy technique

Subject : B.Sc. Botany(Honours) II semester	
Course Code :	Minor Generic Elective Course II: Flowering Plants Identification and Human Welfare

Objective: To study Identification, Classification of Angiosperms and Economic importance of plants

Course outcomes: After the completion of the course the students will be able to:

1. To gain an understanding of the history and concepts underlying various approaches to plant taxonomy and classification.
2. To learn the major patterns of diversity among plants, and the characters and types of data used to classify plants.
3. To compare the different approaches to classification with regard to the analysis of data.

4. Understand about the uses of plants
5. Understand phytochemical analysis related to medicinally important plants and economic products produced by the plants
6. know about the importance of Medicinal plants and its useful parts, economically important plants in our daily life.

Credits : 4	Core Elective
Max Marks :	Min. Passing Marks :

Total no of Lectures-Tutorials- Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	Taxonomic Resources & Nomenclature History of Plant Taxonomy; Components of taxonomy (identification, nomenclature, classification); Taxonomic resources: Herbarium- functions & important herbaria, Botanical gardens, Flora, Artificial Keys.	12
II	Nomenclature: Binomial Nomenclature: Principles and rules of Botanical Nomenclature according to ICN (ranks and taxa; principle of priority, type method, author citation, valid publication).	12
III	Types of classification & Evidences Artificial, natural and phylogenetic classification; Linnaeus, Bentham and Hooker, Hutchinson, Angiosperm Phylogeny Group (APG IV) classification. Introduction to taxonomic evidences from morphology, cytology, phytochemistry	12
IV	Origin and domestication of cultivated plants Centers of diversity of plants, origin of crop plants. Domestication and introduction of crop plants. Concepts of sustainable development; cultivation, production and uses of Cereals, legumes, Spices & beverages.	12

V	Botany of oils, Fibers, timber yielding plants & dyes Study of the plants with Botanical names, Family, part used, and economic uses yielding Edible & essential oils; Sugar, Starch; Fibers; Paper, Fumigatories & Masticatories, Rubber, Dyes, Timber, biofuel crops.	12
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Suggested Readings

1. Vijai Malik, Pranita Malik & Pavitra Dev (2022). Flowering Plant Identification & Aesthetic Characteristics, Pragati Publication Meerut
2. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
3. Sambamurthy, AVSS & Subrahmanyam, NS (2000). Economic Botany of Crop Plants. Asiatech Publishers. New Delhi
4. Vijai Malik & Pranita Malik (2023). Economic Botany, Ethnobotany, & Phytochemistry, Pragati Publication Meerut

Programme/Class: B.Sc. (Hons.)		Year: First	Semester: First
Subject: Botany			
CourseCode:-		Course Title: Ethnobotany	
Objectives: To study Ethnobotany & its methodology			
Course outcomes: After the completion of the course the students will be able to:			
1. Plants used by ethnic people in India			
2. Legal aspects of of Ethnobotany			
3. Methodology for ethnobotanical research			
Credits:02		Core: Skill Enhancement Paper (SEC-I)	
Max. Marks:		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week):4-0-0.			
Unit	Topic		No. of Lectures
I	Ethnobotany Introduction, concept, scope and objectives; History, Ethnobotanical Literature in India, Tribal knowledge towards disease diagnosis, treatment, medicinal plants, plant conservation and cultivation. Tribes, Difference between clan and tribe, Historian and Scientist Concepts, Characteristics of Tribes, Tribes in India, Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.		8
II	Methodology of Ethnobotanical studies Ethnobotanical survey and Field work, Problems occurs during ethnobotanical survey, Strategies to overcome the problems, Ethnobotany and Herbarium Resources (Voucher Specimen), Ancient Literature, Archaeological findings, temples and sacred places.		6
III	Role of Ethnobotany in modern Medicine Study of common plants used by tribes (<i>Aegle marmelos</i> , <i>Ficus religiosa</i> , <i>Embllica officinalis</i> , <i>Eclipta alba</i> , <i>Rauvolfia serpentina</i> , <i>Oxalis</i> and <i>Ocimum sanctum</i>) Ethnobotanical aspect of conservation and management of plant resources, Preservation of primeval forests in the form of sacred groves of individual species and Botanical uses depicted in our epics.		8
IV	Importance of Ethnobotany in Indian Medicine Importance of Ethnobotany in Indian System of Medicine (Siddha, Ayurveda &Unani), Ethnobotany andAyurveda,		8

Ethnobotany & Siddha system, Ethnobotany & Unani System, Uses of traditional medicinal plants in Indian system, System of Medicine under AYUSH, National Medicinal Plant Board, CIMAP, Tribal knowledge towards disease diagnosis, treatment

Suggested Readings:

- 1) S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
- 2) S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981.
- 3). Vijai Malik & Pranita Malik (2023). Economic Botany, Ethnobotany, & Phytochemistry, Pragati Publication Meerut
- 4) S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
- 5) S.K. Jain, 1990. Contributions of Indian ethnobotny. Scientific publishers, Jodhpur.
- 6) Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons- Chichester

Programme/Class: B.Sc. (Hons.)	Year: First	Semester: Second
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Subject: **Botany**

Course Code:-	Course Title: Intellectual Property Rights
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Objectives: To learn IPR, Patent, trademark & Traditional Knowledge

Course outcomes: After the completion of the course the students will be able to:

1. Concept of IPR in India and across the world
2. Procedure of obtaining patents & Working of patents
3. Copyright & Infringement
4. Trademarks & Geographical Indications
- Protection of Traditional Knowledge & Plant Varieties

Credits: 02	Core: Skill Enhancement Paper (SEC-II)
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Max. Marks:	Min. Passing Marks:
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Total No. of Lectures-Tutorials-Practical(in hours per week): **4-0-0**.

Unit	Topic	No. of Lectures
I	Introduction to intellectual property right (IPR) Concept and kinds, IPR in India and world: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO).	2
II	Patents & Copyrights	6

	Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, Working of patents. Infringement. Works protected under copyright law, Rights, Transfer of Copyright, Infringement.	
III	Trademarks & Geographical Indications Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defences, Domain name. Geographical Indications: Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position.	6
IV	Protection of Traditional Knowledge TKDL, Objectives of TKDL, International Patent Classification (IPC) system, Traditional Knowledge (TK), threats to Indian Traditional Knowledge, Protection of Traditional Knowledge, Indian Legislations to Protect Traditional Knowledge, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library.	6
V	Industrial Designs & Protection of Plant Varieties Objectives, Rights, Assignments, Infringements, Defences of Design Infringement. Plant Varieties Protection-Objectives, Justification, International Position, Plant varieties protection in India. Rights of farmers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.	6
VI	Biotechnology and Intellectual Property Rights. Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues	4

Suggested Readings:

1. Vijai Malik & Pranita Malik (2023). Economic Botany, Ethnobotany, & Phytochemistry, Pragati Publication Meerut
2. P. Ganguli (2001) Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill.
3. Arthur Raphael Miller, Micheal H. Davis; (2000). Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers.
4. Jayashree Watal, Intellectual property rights in the WTO and developing countries, Oxford University Press, Oxford

VAC Courses framed by the department

Course Name	Mushroom Cultivation		
Programme	UG	Credits	2
Pre-requisite of Course	Basic knowledge of Fungi		
Course Objectives	Course objectives: To study types of mushroom and Their production		
Course Outcomes	Course outcomes: After the completion of the course the students will be able to: <ol style="list-style-type: none"> 1. Understand the instruments, techniques, lab etiquettes and good lab practices for working in a microbiology laboratory. 2. Develop skills for cultivating and identifying mushrooms, using them for commercial purposes. 3. Understand the pathology associated with mushrooms and their pre-harvest & post- harvest management. 4. Start own enterprise on mushrooms 		
Units	Topics		
I	Introduction to mushrooms and their significance, What are mushroom? How many species of mushrooms exist?, How mushrooms survive in nature?, History of mushroom cultivation and present status, Why to grow mushrooms?, Why to eat mushrooms?, Medicinal mushrooms,		
II	Mushroom spawn (seed) production/ procurement. <ol style="list-style-type: none"> 1. Button mushroom 2. Pearl mushroom 3. Oyster mushroom 4. Paddy straw mushroom. 5. Milky mushroom 		
III	<ol style="list-style-type: none"> 1. Cultivation of other economically and medicinally important mushrooms 2. Mushroom; Sectioning of gills of Agaricus. 3. Insect pest management in cultivated mushrooms 4. Disease management in cultivated mushrooms 		
IV	<ol style="list-style-type: none"> 1. Value addition to mushrooms (nutrient quality improvement) 2. Mushroom growing unit/ house 		

V	1. Entrepreneurial skills and economics for small enterprise 2. Management of spent substrates and waste disposal of various mushroom 3. Health and Safety at workplace
References	1. S.G. Borkar and Nisha Patil (2020) Mushroom: A Nutritive Food & its Cultivation. Dya Publishing House A Division of Astral International Pvt. Ltd. New Delhi. 2. B.C. Suman and V.P. Sharma (2021) Mushroom Cultivation in India. Dya Publishing House A Division of Astral International Pvt. Ltd. New Delhi.

Semester -II (Two VAC Courses from SWAYAM)

Plant Biochemistry and Biotechnology

Course layout

Week 1

- Lecture: 1 Plant and animal cell
Lecture: 2 Photosynthesis: Significance of Photosynthesis
Lecture: 3 Ultrastructure of Chloroplast and photosynthetic pigments
Lecture: 4 Photosynthesis in C3 and C4 plants

Week 2

- Lecture: 1 Photosynthetic light and dark reactions
Lecture: 2 Photophosphorylation and Photorespiration
Lecture: 3 Plant genome organization
Lecture: 4 Molecular biology of biotic and abiotic stresses

Week 3

- Lecture: 1 Plant growth and development
Lecture: 2 Biological nitrogen fixation
Lecture: 3 Nitrate and sulphate reduction and their incorporation into amino acids
Lecture: 4 Secondary metabolites

Week 4

- Lecture: 1 Secondary metabolites II
Lecture: 2 Plant hormones I: Introduction, biochemistry and mode of action of auxins
Lecture: 3 Plant hormones II: Gibberellins and Cytokinins
Lecture: 4 Plant hormones III: Ethylene and Absciscic Acid

Week 5

- Lecture: 1 Concept of Plant Biotechnology
Lecture: 2 Totipotency and morphogenesis
Lecture: 3 Growth media, environmental factors and explants source

Lecture: 4 Micropropagation

Week 6

Lecture: 1 Embryo culture and plant organ culture
Lecture: 2 Callus culture and somatic embryogenesis
Lecture: 3 Single cell and cell suspension culture
Lecture: 4 Protoplast isolation, purification, culture and fusion

Week 7

Lecture: 1 Factors Affecting in vitro Secondary Metabolite Production
Lecture: 2 Hairy Root Culture
Lecture: 3 Somaclonal Variation
Lecture: 4 Synthetic seed technology

Week 8

Lecture: 1 Germplasm Conservation
Lecture: 2 Direct and indirect methods of gene transfer
Lecture: 3 Transgenic plants and their applications
Lecture: 4 Morphological, Biochemical and DNA – based markers

Books and references

1. Taiz, L. and Zeiger, E. (2010) Plant Physiology. 5th Edition, Sinauer Associates, Inc., Sunderland.
2. Razdan, M. K. (2003). Introduction to plant tissue culture (2. ed. ed.). Enfield, NH [u.a.]: oxford Publishers. ISBN 1-57808-237-4.
3. Chawla, H.S. (2002). Introduction to plant biotechnology (2nd ed. ed.). Enfield, N.H.: Science Publishers. ISBN 1-57808-228-5.
4. Bhojwani, S.S. and Rajdan, Plant Tissue Culture: Theory and Practice, Amsterdam, Elsevier.
5. Roberta Smith, (2012) Plant Tissue Culture: Techniques and Experiments, Academic Press
6. Agriculture: Role of Genetic Engineering. Kluwer Academic Publishers, The Netherlands.
7. Basra, A.S. (1994). Stress-induced Gene Expression in Plants. Taylor and Francis, London.
8. Basra, A.S. and Basra, R.K. (eds) (1997). Mechanism of Environmental Stress Resistance in Plants. Harwood Academic Publishers. The Netherlands.

General Microbiology

Course layout

Week 1:

- Lecture1. Microbiology: Introduction
- Lecture2. Microscopy
- Lecture3. Cells
- Lecture4. Prokaryotic and Eukaryotic cells

Week 2:

- Lecture5. Structural organization of nucleic acids
- Lecture6. Nucleic acid as genetic information carrier
- Lecture7. Semiconservative replication of prokaryotes
- Lecture8. Classification of microorganisms-I

Week 3:

- Lecture9. Classification of microorganisms-II
- Lecture10. Gram positive bacteria
- Lecture11. Gram negative bacteria
- Lecture12. Yeast

Week 4:

- Lecture13. Virus – Introduction
- Lecture14. Virus- host interaction
- Lecture15. Lytic cycle of viruses
- Lecture16. Lysogenic cycle of viruses

Week 5:

- Lecture17. Control of microorganism
- Lecture18. Stains and staining techniques
- Lecture19. Nutritional requirements and growth media
- Lecture20. Bacterial fermentation I & II

Week 6:

- Lecture21. Bacterial photosynthesis
- Lecture22. Bacterial genetics I: genetic elements, Sex types, conjugation and protoplast fusion
- Lecture23. Bacterial genetics II
- Lecture24. Restriction endonucleases and cloning vectors

Week 7:

- Lecture25. Application of recombinant DNA technology
- Lecture26. Introduction to immune system
- Lecture27. Organs of immune system

Lecture28. Cells of immune system

Week 8:

Lecture29. Antigen presenting cells - macrophages and dendritic cells

Lecture30. Antigens and immunogens

Lecture31. Structure of immunoglobulins

Lecture32. Antigen antibody interactions

Books and references

REFERENCES:

- Pelczar, M.J., Chan, E.C.S. and Krieg, N.R. 1998. *Microbiology*. Tata, McGraw-Hill.
Prescott, L.M., Harley, J.P. and Klein, D.A. 1999. *Microbiology*. 4th Edition, McGraw-Hill.
Schlegel, H.G. 2006. *General Microbiology*. 7th edition, Cambridge University Press.
Slonczewski, J.L. and Foster, J.W. 2009. *Microbiology: An evolving Science*. Library of Congress Cataloguing-in-Publication Data.

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www.nos.org/media/documents/dmlt/microbiology
www.columbia.edu/itc/hs/medical/pathophys/id/2009