GOVERNMENT COLLEGE (AUTONOMOUS), BHAWANIPATNA

(College with potential for excellence)

COURSES OF STUDIES

FOR THREE YEAR DEGREE COURSE IN

S C I E N C E

(UNDER CBCS)

SUB: BOTANY

Semester-I	**2017**	**Semester-II**	**2018**
Semester-III	**2018**	**Semester-IV**	**2019**
Semester-V	**2019**	**Semester-VI**	**2020**

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COURSE STRUCTURE

		Paper Code	Credit Points
Semester-I	1	AECC-1	02
	2	GE-1	06
	3	CORE-1	06
	4	CORE-2	06
		TOTAL	**20**
Semester-II	1	AECC-2	02
	2	GE-2	06
	3	CORE-3	06
	4	CORE-4	06
		TOTAL	**20**
Semester-III	1	SEC-1	02
	2	GE-3	06
	3	CORE-5	06
	4	CORE-6	06
	4	CORE-7	06
		TOTAL	**26**
Semester-IV	1	SEC-2	02
	2	GE-4	06
	3	CORE-8	06
	4	CORE-9	06
	4	CORE-10	06
		TOTAL	**26**
Semester-V	1	CORE-11	06
	2	CORE-12	06
	3	DSE-1	06
	4	DSE-2	06
		TOTAL	**24**
Semester-VI	1	CORE-13	06
	2	CORE-14	06
	3	DSE-3	06
	4	DSE-4	06
		TOTAL	**24**
		GRAND TOTAL	**140**

C O N T E N T

ABILITY ENHANCEMENT COMPULSORY COURSE (AECC)

SEMESTER–I

AECC-I : ENVIRONMENTAL STUDIES (ENVS)

(CREDITS: 2, Theory=2)
(Total Marks: 50, Mid Sem=10, Term End=40, Duration: 2 hrs)

MODULE-1: Introduction to environmental studies and Ecosystem [BOTANY Dept]

Multidisciplinary nature of environmental studies;
Scope and importance; Concept of sustainability and sustainable development.

Ecosystems : **[ZOOLOGY Dept]**

What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: Food chains, food webs and ecological succession. Case studies of the aquatic ecosystems (ponds) (8 lectures)

MODULE-2:

Natural Resources : Renewable and Non-renewable Resources [ZOOLOGY Dept]

- Land resources and land use change; Land degradation, soil erosion and desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, Biodiversity and tribal populations.
- Water : Use and over---exploitation of surface and ground water, floods, droughts, conflicts Over water (international & inter-state).
- Energy resources : Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies. (8 lectures)

MODULE-3: Biodiversity and Conservation [BOTANY Dept]

- Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zones Of India; Biodiversity patterns and global biodiversity hot spots
- India as a mega-biodiversity nation; Endangered and endemic species of India
- Threats to biodiversity : Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions;
- Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.
- Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value. (8 lectures) **[BOTANY Dept]**

MODULE-4: Environmental Pollution [CHEMISTRY Dept]

- Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution
- Nuclear hazards and human health risks
- Solid waste management: Control measures of urban and industrial waste.
- Global warming, ozone layer depletion. (8 lectures)

References:

1. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*. S.Chand Publishing, New Delhi.
2. Das and Mishra. Man and Environment.
3. S. Swain. Environmental Studies.
4. M C Dash. Fundamental of Ecology.
5. Shukla and Chandel. A Text Book of Plant Ecology.

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ABILITY ENHANCEMENT COMPULSORY COURSE (AECC)

SEMESTER-II

AECC-II : ENGLISH

(CREDITS: 2, Theory=2)
(Total Marks: 50, Mid Sem=10, Term End=40, Duration: 2 hrs)

This course aims at enhancing the English language proficiency of undergraduate students in humanity, science and commerce streams to prepare them for the academic, social and professional expectations during and after the course. The course will help develop academic and social English competencies in speaking, listening, pronunciation, reading and writing, grammar and usage, vocabulary, syntax, and rhetorical patterns.

Students, at the end of the course, should be able to use English appropriately and effectively for further studies or for work where English is used as the language of communication.

MODULE-1: Reading Comprehension [15]

- Locate and remember the most important points in the reading
- Interpret and evaluate events, ideas, and information
- Read "between the lines" to understand underlying meanings
- Connect information to what they already know

MODULE-2: Writing [15]

Expanding an Idea	Writing a Memo	Report Writing
Creative Writing	News Story	Setting in Creative Writing
Writing a Business Letter	Letters to the Editor	Précis Writing
CV & Resume Writing	Dialog writing	Covering Letter
Writing Formal Email	Elements of Story Writing	Note Making
Information Transfer	Interviewing for news papers	

MODULE-3: Language functions in listening and conversation [06]

1. Discussion on a given topic in pairs
2. Speaking on a given topic individually

(Practice to be given using speaking activities from the prescribed textbooks)

Grammar and Usage [14]

Simple and Compound Sentences; Complex Sentences; Noun Clause; Adjective Clause; Adverb Clause; The Conditionals in English; The Second Conditional; The Third Conditional; Words and their features; Phrasal Verbs; Collocation; Using Modals; Use of Passives; Use of Prepositions; Subject-verb Agreement; Sentence as a system; Common Errors in English Usage

Examination pattern

Each reading and writing question will invite a 200 word response.
Language function questions set in context will carry 01 mark per response. There will be 15 bit questions.

Midterm test:	Writing	: 1 question	04 x 01qn = 04 marks
	Speaking:	2 questions	03x02 qns = 06 marks
	Total		10 marks
Term End :	MODULE-1	Reading: 05 questions (3 prose and two poetry questions)	03x 05 qns= 15 marks
	MODULE-2	Writing: 03 questions	05 x 03 qns= 15 marks
	MODULE-3	Grammar & usage: 10 qns	01x 10 qns = 10 marks
	Total		40 marks

Grammar questions must be set in contexts; not as isolated sentences as used for practice in the prescribed textbook.

Book Prescribed

Vistas and Visions: An Anthology of Prose and Poetry. (Ed.)Kalyani Samantray, Himansu S. Mohapatra, Jatindra K. Nayak, Gopa Ranjan Mishra, Arun Kumar Mohanty. OBS
Texts to be studied : **Prose** (Decoding Newspapers, The Gold Frame, Of Truth, Lifestyle English)
Poetry (Lines Composed a few miles above Tintern Abbey; Sonnet 46 (Shakespeare); Pigeons)
All grammar and writing activities in the textbook

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AECC-II : ODIA
SEMESTER-II

ଆଭ୍ୟନ୍ତରୀଣ ମୂଲ୍ୟାଙ୍କ -୨, ମୋଟ୍ ଶ୍ରେଣୀ ପାଠଦାନ-୨୦ ଘଣ୍ଟା, ପୂର୍ଣ୍ଣସଂଖ୍ୟା -୫୦, ପରୀକ୍ଷା ସମୟ-୨ ଘଣ୍ଟା

<u>**ପାଠ୍ୟରୁ କୌଣସି ଗୋଟିଏ ପାଠ୍ୟକୁ ବାଛିବାକୁ ହେବ।**</u>

ପାଠ୍ୟ-୧ / Course-1 :

ଉପାଂଶ-୧: (ଗଳ୍ପବିଭାଗ) ଗଳ୍ପ ତରଂଗ-ପ୍ରକାଶକ ସମ୍ବଲପୁର ସାହିତ୍ୟ ସଂସଦ
ଭଗବାନ ମଲାପରେ-ମହାପାତ୍ର ନୀଳମଣି ସାହୁ
ବିଷକନ୍ୟାର କାହାଣୀ-ମନୋଜ ଦାସ
ଦ୍ବିତୀୟ ଶ୍ମଶାନ-ରାମଚନ୍ଦ୍ର ବେହେରା
ଦୁଇଟି ପ୍ରଶ୍ନରୁ ଗୋଟିଏ ପ୍ରଶ୍ନର ଉତ୍ତର ପାଞ୍ଚଶହ ଶବ୍ଦରେ ଲେଖିବାକୁହେବ। (୧୦)

ଉପାଂଶ-୨: (କବିତାଶ୍ରୀ) ଅନୁଭବାଚ -ଗୁରୁପ୍ରସାଦ ମହାନ୍ତି
ଲଣ୍ଡନ-ରମାକାନ୍ତ ରଥ
କୁରୁପତିସଭାସ୍ଥଳେ -ପ୍ରତିଭା ଶତପଥୀ
ଦୁଇଟି ପ୍ରଶ୍ନରୁ ଗୋଟିଏ ପ୍ରଶ୍ନର ଉତ୍ତର ପାଞ୍ଚଶହ ଶବ୍ଦରେ ଲେଖିବାକୁ ହେବ। (୧୦)

ଉପାଂଶ-୩: (ଅବବୋଧ) ଏକଶହପଚାଶ ଶବ୍ଦର ଏକ ଅନୁଚ୍ଛେଦ ପ୍ରଦାନ କରାଯିବ।
୫ଟି ପ୍ରଶ୍ନ ପଡିବ ଏବଂ ପ୍ରତ୍ୟେକ ପ୍ରଶ୍ନର ମୂଲ୍ୟ ୨। (୫X୨=୧୦)

ଉପାଂଶ-୪: (ଭାବ ସଂପ୍ରସାରଣ) କୌଣସି ଏକ ଉକ୍ତିକୁ ପ୍ରଶ୍ନଭାବରେ ପ୍ରଦାନ କରାଯିବ। (୧୦)

ଉପାଂଶ-୫: (ବିଭକ୍ତି) ବ୍ୟାକରଣ। ଆଠଟିରୁ ପାଞ୍ଚଟି ପ୍ରଶ୍ନର ଉତ୍ତର ଦେବାକୁ ହେବ। ପ୍ରତ୍ୟେକ ପ୍ରଶ୍ନର ମୂଲ୍ୟ ୨ ନମ୍ବର। (୫X୨=୧୦)

ପାଠ୍ୟ-୨ / Course-2 : ସଂପର୍କ ଅନୁବିଧି

ଉପାଂଶ-୧: ସଂପର୍କର ଭିତ୍ତି, ପରିଭାଷା, ଅନୁବିଧି ଓ ପରିସର

ଉପାଂଶ-୨: ସଂପର୍କର ପ୍ରକାରଭେଦ: କଥିତ-ଲିଖିତ, ବ୍ୟକ୍ତିଗତ-ସାମାଜିକ-ସାଂସ୍କୃତିକ-ବ୍ୟାବସାୟିକ-ସାହିତ୍ୟିକ

ଉପାଂଶ-୩: ସଂପର୍କର ବାଧକ ଓ ସଫଳସାଧନର ଦିଗ

ଉପାଂଶ-୪: ସଂପର୍କରେ ସାହିତ୍ୟର ଭୂମିକା

ଉପାଂଶ-୫: ସଫଳ ସଂପର୍କର ଭାଷା

ପାଠ୍ୟ-୩ / Course-3 : ସଂପର୍କର ରୀତି / ଭଙ୍ଗୀ ଓ ମାଧ୍ୟମ

ଉପାଂଶ-୧: ସ୍ବଗତକଥନ ଓ ସାଂଳାପିକ ଭଙ୍ଗୀ / ସାହିତ୍ୟ-ମାଧ୍ୟମ ଓ ଯୋଗାଯୋଗ

ଉପାଂଶ-୨: ଦଳଗତ ଆଲୋଚନା ଓ ବିତର୍କ

ଉପାଂଶ-୩: ସାକ୍ଷାତ୍କାର

ଉପାଂଶ-୪: ପତ୍ରଲିଖନ ପଦ୍ଧତି / ବିବରଣି ଲିଖନ

ଉପାଂଶ-୫: ବୈଦ୍ୟୁତିକ ପଦ୍ଧତି ଓ ସଂପର୍କର ଭାଷା (ଦୂରଭାଷ , ସଂକ୍ଷିପ୍ତ ସୂଚନା ପ୍ରେରଣ, ଦୃଶ୍ୟଶ୍ରାବ୍ୟ ସଂଚାର ବିଧାନ, ୱେବ୍‌ସାଇଟ୍, ଆନ୍ତର୍ଜାତିକ ପଦ୍ଧତି / ଇଣ୍ଟରନେଟ୍)

<u>**ଗ୍ରନ୍ଥ ତାଲିକା**</u>

୧- ଗଳ୍ପତରଂଗ- ପ୍ରକାଶକ ସମ୍ବଲପୁର ସାହିତ୍ୟ ସଂସଦ।

୨- ସଂଯୋଗ ଅନୁବିଧି /ବ୍ୟାବହାରିକ ଓଡିଆ ଭାଷା ଓ ପ୍ରୟୋଗାତ୍ମକ ବ୍ୟାକରଣ, ସନ୍ତୋଷ ତ୍ରିପାଠୀ, ନାଳନ୍ଦା, କଟକ।

୩- ପ୍ରାୟୋଗିକ ଓଡିଆ ଭାଷା- ଓଡିଶା ରାଜ୍ୟ ପାଠ୍ୟପୁସ୍ତକ ପ୍ରଣୟନ ଓ ପ୍ରକାଶନ ସଂସ୍ଥା।

୪- ସମ୍ବାଦ ଓ ସାମ୍ବାଦିକତା- ଚନ୍ଦ୍ରଶେଖର ମହାପାତ୍ର, ଓଡିଶା ରାଜ୍ୟ ପାଠ୍ୟପୁସ୍ତକ ପ୍ରଣୟନ ଓ ପ୍ରକାଶନ ସଂସ୍ଥା।

୫- ଆଧୁନିକ ଓଡିଆ ବ୍ୟାକରଣ – ଧନେଶ୍ବର ମହାପାତ୍ର।

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AECC-II : HINDI

SEMESTER-II

(CREDITS: 2, Theory=2)

(Total Marks: 50, Mid Sem=10, Term End=40, Duration: 2 hrs)

MODULE-1: **कविता**

(i) कबीर - साखी : १ से १०

(ii) तुलसी - विनयपत्रिका - पद १ और २

(iii) प्रसाद - मधुमय देश

(iv) निराला - भिक्षुक

(v) अज्ञेय - हिरोशिमा

MODULE-2: **गद्य**

(i) रामचन्द्र शुक्ल - उत्साह

(ii) हजारी प्रसाद द्विवेदी - कुटज

(iii) हरिशंकर परसाई - सदाचार का तावीज

MODULE-3: **शब्द ज्ञान**

(i) शब्द सुद्धि

(ii) बाक्य सुद्धि

(iii) पयायिवाची शब्द

(iv) विलोम शब्द

MODULE-4: **सामान्य ज्ञान**

(i) निबंध लेखन

अंक विभाजन:

विभाग - (क)	अपर्युक्त इकाइयो ६, ६६ और ६७ से ०३ प्रश्न पूछे जाएँगे। उनमें से ०२ के उत्तर लिखने होंगे। (प्रत्येक उत्तर ७००-१००० शब्दों के बिच)	10X2=20
विभाग - (ख)	अपर्युक्त इकाइयों ६ और ६६ से ०४ पद्यांश / गद्यांश पूछे जाएँगे। जिनमें से ०२ के उत्तर लिखने होंगे। (प्रत्येक उत्तर ४००-५०० शब्दों के बिच)	05X2=10
विभाग - (ग)	युनिट ६६६ से अति संक्षीत्प प्रश्न पूछे जाएँगे।	02X5=10
	End Semester	40
	Internal	10
	Total	50

पाठ्य पुस्तक:

हिन्दी प्रसून - सं डॉ अंजुमन आरा, प्लानेट भी, कटक

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SKILL ENHANCEMENT COURSE (SEC)

SEMESTER-III

SEC-1: BASIC COMPUTER APPLICATION (BCA)

(CREDITS: 2, Theory=2)
(Total Marks: 50, Mid Sem=10, Term End=40, Duration: 2 hrs)

MODULE-1: **4 classes**

Introduction: Introduction to computer system: Computer, Hardware, Software, Types of software, Types of Computer, uses of computer**.**

MODULE-2: **6 Classes**

Human Computer Interface: Operating system as user interface, utility programs**,** Input and output devices: Keyboard, Mouse, Joystick, Scanner (OCR, OBR, OMR, MICR), Digital Camera, Touch Screen. Monitor, Printer, Plotter,

Windows-Introduction, functions, properties and different versions, Working with Start Menu, Control Panel, Explorer, Desktop and Icons, My computer, Recycle bin, My Document, Good practices to make the windows run efficiently.

MODULE-3: **6 classes**

Memory: Primary, secondary, auxiliary memory, RAM, ROM, cache memory, hard disks, optical disks, USB storage, Memory Card, C.P.U., registers, ALU, Control Unit, system bus, processors(only basic idea about function and type).

MODULE-4: **5 classes**

VIRUS –Meaning, function, characteristics and types, Uses of Firewall and Antivirus.

Electronic mail and its features- inbox, composing mails, sending mail, thrash, spam folder in email.

MODULE-5: **9 classes**

Introduction to Ms.Office:

Ms.Word: Creating a file, Page formatting, editing, printing, saving a file, bullet and numbering, spell check, indenting, paragraph formatting, find and replace.

Ms. Excel: Spread sheet and its uses, Setting column and row, Inserting formula and uses of various functions (AND, IF, NOT, OR, SUM, MAX, COUNT, COUNTA, COUNTIF, AVERAGE), use of Auto sum, Formatting cell, printing, copying and saving.

Ms.Power Point: Features, Uses, Menus, Tool bar, template and wizard, creating animation and effects, saving, deleting and opening a presentations. characteristics of a good presentation.

Reference Book:

1. Computer Fundamental by PK Sinha – BPB publication.
2. Ms.Office 2007 by Rutkoshy, Seguin – BPB publication.
3. Goel, Computer Fundamentals, Pearson Education, 2010.

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SEMESTER-IV

SEC-2: COMMUNICATIVE ENGLISH AND WRITING SKILL (CEWS)

(CREDITS: 2, Theory=2)
(Total Marks: 50, Mid Sem=10, Term End=40, Duration: 2 hrs)

MODULE-1: Communication Process 10 Marks (1 long question / 2 short questions)

- Process of Communication, Characteristics of Business Communication, Inter-personal, Intra-personal and Group communication
- Definition, Objectives, Process, Channels and importance of Communication
- Principles of effective communication and Barriers to effective Communication.
- Types of Communication – Written, Verbal, Non-verbal, informal and Formal and Grape-vine
- Written Communication – Writing letters for inquiries, orders, complaints and claims, Condolence, Complement letters.

MODULE-2: Analytical Grammar 10 Marks (1 x 10 = 10)

- **Vocabulary :** Phrasal Verbs, Synonyms, Antonyms, Idioms, Commercial Terms, Countable and uncountable Nouns, Tense Patterns, Modal Verbs, Prepositions and Phrasal Verbs, The Imperatives, Interrogative, The Passive, Direct and Reported Speech.

MODULE-3: WRITING SKILL: 10 Marks (1 long question/ 2 short questions)

- Writing paragraph**,** developing ideas into paragraphs**,** writing personal letters and notes**,** writing applications, official letters and business letters**,** writing curriculum vitae/resume**,** writing e-mails, sms, advertisement and short notes.

MODULE-4: Creative Skills 10 Marks (1 long question)

- Reporting (on issues, events and business matters), Note making and summarising, Description of objects/events/process, Writing and designing pamphlet/brochure, Writing Review/ comment.

Recommended reading:

1. Fluency in English – Part I & II, Oxford University Press.
2. A. J. Thomson & A. V. Matrinet, Practice English Grammar.
3. L. Garteside (ELBS) Modern Business Letters.
4. Business English, Pearson, 2008
5. Pradhan, Bhende and Thakur – Business Communication, Himalaya Publishing House.
6. U. S. Rai & M. S. Rai, Business Communication, Himalaya Publishing House, Bombay.
7. Language, Literature and Creativity, Orient Blackswan 2013

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GENERIC ELECTIVE (GE)

CHEMISTRY

SEMESTER-I

GE- 1: ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

SECTION A (INORGANIC CHEMISTRY-1)

MODULE-1: Atomic Structure

(a) Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

(b) What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms.

Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms). Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

MODULE-2: Chemical Bonding and Molecular Structure

(a) Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

(b) Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonalbipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic and organic compounds.

(c) MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO+.

SECTION B (ORGANIC CHEMISTRY-1)

MODULE-3: Fundamentals of Organic Chemistry

(a) Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

(b) Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

MODULE-4: Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans

nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

MODULE-5: Aliphatic Hydrocarbons

(a) Alkanes: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

(b) Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis.

(c) Alkynes: (Upto 5 Carbons) Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.

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CHEMISTRY

SEMESTER-II

GE-2: CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

Section A (Physical Chemistry-1)

MODULE-1: Chemical Energetics

(a) Review of thermodynamics and the Laws of Thermodynamics.

(b) Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.

(c) Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

MODULE-2:

(a) Chemical Equil ibrium: Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^o, Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases.

(b) Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Section B (Organic Chemistry-2)

MODULE-3: (Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure)

(a) Aromatic hydrocarbons (i) Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid

(ii) Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

(b) Alkyl and Aryl Halides: **Alkyl Halides** (Upto 5 Carbons) (i) Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions. (ii) Preparation: from alkenes and alcohols. (iii) Reactions: hydrolysis, nitrite & nitro formation, nitrile &isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

(c) Aryl Halides (i)Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer&Gattermann reactions. (ii) Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH2/NH3 (or NaNH2/NH3). (iii) Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

MODULE-4: Alcohols, Phenols and Ethers (Upto 5 Carbons)

(a) Alcohols: (i) Preparation: Preparation of 1^0 , 2^0 and 3^0 alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

(ii) Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

(b) Phenols: (Phenol case) Preparation: Cumenehydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. ReimerTiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction.

(c) Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

MODULE-5: Aldehydes and ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde);

(i) Preparation: from acid chlorides and from nitriles.

(ii) Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-PondorffVerley reduction.

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ZOOLOGY

SEMESTER-III

GE-3: ANIMAL DIVERSITY

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

LECTURES: 60

MODULE-1: Protista, Porifera, Radiata

General characters of Protozoa; Life cycle of Plasmodium, General characters and canal system in Porifera, General characters of Cnidarians and polymorphism

MODULE-2: Aceolomates, Pseudocoelomates, Coelomate Protostomes

General characters of Helminthes; Life cycle of Taenia solium, General characters of Nemethehelminthes; Parasitic adaptations, General characters of Annelida ; Metamerism.

MODULE-3: Arthropoda, Mollusca, Coelomate Deuterostomes

General characters of Arthropoda. Social life in insects; General characters of mollusca; Pearl Formation, General characters of Echinodermata, Water Vascular system in Starfish

MODULE-4: Protochordata, Pisces, Amphibia

Salient features of protochordata, Osmoregulation, Migration of Fishes, General characters, Adaptations for terrestrial life, Parental care in Amphibia.

MODULE-5: Amniotes, Aves, Mammalia

Amniotes; Origin of reptiles. Terrestrial adaptations in reptiles. The origin of birds; Flight adaptations, Early evolution of mammals; Primates; Dentition in mammals.

PRACTICAL: Mark 25 / Credit- 2

1. Study of following specimens:

Non Chordates: Euglena, Noctiluca, Paramecium, Sycon, , Physalia, Tubipora, Metridium, Taenia, Ascaris, Nereis, Aphrodite, Leech, Peripatus, Limulus, , Hermitcrab, Daphnia, Millipede, Centipede, Beetle, Chiton, Dentalium, Octopus, Asterias, and Antedon.

Chordates: Balanoglossus, Amphioxus, Petromyzon, Pristis, Hippocampus, Labeo, Icthyophis/Uraeotyphlus, Salamander, Rhacophorus Draco, Uromastix, Naja, Viper, model of Archaeopteryx, any three common birds-(Crow, duck, Owl), Squirrel and Bat.

2. Study of following Permanent Slides:

Cross section of Sycon, Sea anemone and Ascaris(male and female). T. S. of Earthworm passing through pharynx, gizzard, and typhlosolar intestine. Bipinnaria and Pluteus larva.

3. Temporary mounts of

• Septal & pharyngeal nephridia of earthworm.
• Unstained mounts of Placoid, cycloid and ctenoid scales.

4. Dissections of

• Digestive and nervous system of Cockroach.
• Urinogenital system of Rat

SUGGESTED BOOKS

1. Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA.
2. Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary
3. Approach 7th Edition, Thomson Books/Cole
4. Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.
5. Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.
6. Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi.

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ZOOLOGY

SEMESTER – IV

GE-4: ANIMAL CELL BIOTECHNOLOGY

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

LECTURES: 60

MODULE-1: Introduction

Bio safety Physical and Biological containment, Concept and Scope of Biotechnology, Techniques in Gene manipulation, Outline process of genetic engineering and recombinant DNA technology, Isolation of genes, Concept of restriction and modification: Restriction endonucleases, DNA modifying enzymes

MODULE-2: Cloning Vectors, Transformation techniques

Cloning Vectors: Plasmids, Phage vectors, Cosmids, Phagemids, BAC, YAC, HAC. Shuttle and Expression Vectors. Construction of Genomic libraries and cDNA libraries Transformation techniques: microbial, plants and animals: Cloning in mammalian cells, Integration of DNA into mammalian genome- Electroporation and Calcium Phosphate Precipitation method.

MODULE-3: Animal cell Culture

Basic techniques in animal cell culture and organ culture, Primary Culture and Cell lines, Culture media-Natural and Synthetic, Stem cells, Cryopreservation of cultures. Agarose and Polyacrylamide Gel Electrophoresis, Southern, Northern and Western blotting, DNA sequencing: Sanger method, Polymerase chain reaction, DNA Fingerprinting and DNA microarrays.

MODULE-4: Fermentation

Different types of Fermentation: Submerged & Solid state; batch, Fed batch & Continuous; Stirred tank, Air Lift, Fixed Bed and Fluidized. Downstream Processing: Filtration, centrifugation, extraction, chromatography, spray drying and lyophilization.

MODULE-5: Transgenic Animal Technology, Application in Health

Production of transgenic animals: nuclear transplantation, Retroviral method, DNA microinjection method, Dolly and Polly. Development of recombinant Vaccines, Hybridoma technology, Gene Therapy. Production of recombinant Proteins: Insulin and growth hormones.

PRACTICAL: Mark 25 / Credit- 2

1. Packing and sterilization of glass and plastic wares for cell culture.
2. Preparation of culture media.
3. Preparation of genomic DNA from E. coli/animals/ human.
4. Plasmid DNA isolation (pUC 18/19) and DNA quantitation using agarose gel electrophoresis (by using lambda DNA as standard).

5. Restriction digestion of lambda (λ) DNA using EcoR1 and Hind III.
6. Preparation of competent cells and Transformation of E. coli with plasmid DNA using CaCl2, Selection of transformants on X-gal and IPTG (Optional).
7. Techniques: Western Blot, Southern Hybridization, DNA Fingerprinting, PCR, DNA Microarrays

SUGGESTED READINGS

1. Animal Cells Culture and Media, D.C. Darling and S.J. Morgan, 1994. BIOS Scientific Publishers Limited.
2. Methods in Cell Biology, Volume 57, Jennie P. Mathur and David Barnes, 1998. Animal Cell Culture Methods Academic Press.
3. P.K. Gupta: Biotechnology and Genomics, Rastogi publishers (2003).
4. B.D. Singh: Biotechnology, Kalyani publishers, 1998 (Reprint 2001).
5. T.A. Brown: Gene cloning and DNA analysis: An Introduction, Blackwell Science (2001).
6. Bernard R. Click & Jack J. Pasternak: Molecular Biotechnology, ASM Press, Washington (1998).
7. Methods in Gene Biotechnology, W. Wu, M.J. Welsh, P.B. Kaufman & H.H. Zhang, 1997, CRC Press, New York
8. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart,
9. W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA

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BOTANY

SEMESTER-I

CORE-1: MICROBIOLOGY AND PHYCOLOGY

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1:
Introduction to microbial world, microbial nutrition, growth and metabolism. **2 lectures**
Viruses:-Discovery, physiochemical and biological characteristics; classification (Baltimore), general structure with special reference to viroids and prions; replication (general account), DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV). Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases. **5 lectures**
MODULE-2: Bacteria: - Discovery, general characteristics, types-archaebacteria, eubacteria, wall-less forms(mycoplasma and spheroplasts), cell structure, nutritional types, reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction). Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine). **5 lectures**
MODULE-3: 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). Role of algae in the environment, agriculture, biotechnology and industry. **6 lectures**
MODULE-4: Cyanophyta:- Ecology and occurrence, range of thallus organization, cell structure, heterocyst, reproduction. economic importance; role in biotechnology. Morphology and life-cycle of *Nostoc.* **5 lectures**
Chlorophyta:- General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles of *Chlamydomonas, Volvox, Oedogonium, Coleochaete.* Evolutionary significance of *Prochloron.*
MODULE-5: Charophyta:- General characteristics; occurrence, morphology, cell structure and life-cycle of *Chara*; evolutionary significance. **2 lectures**
Xanthophyta:- General characteristics; range of thallus organization; Occurrence, morphology and life-cycle of *Vaucheria.* **3 lectures**
Phaeophyta:- Characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles of *Ectocarpus* and *Fucus.*
Rhodophyta:- General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycle of *Polysiphonia.* **4 lectures**

PRACTICAL: Mark 25 / Credit- 2
Microbiology 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 soilbacteria).
Phycology Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* (electron micrographs), Volvox, *Oedogonium, Coleochaete, Chara, Vaucheria, Ectocarpus, Fucus and Polysiphonia, Procholoron* through electron micrographs, temporary preparations and permanent slides.

Suggested Readings
1. Pelczar M.J, Chan E.C.S., Kreig N.R; Microbiology; Tata McGraw Hill publishing Company, New Delhi.
2. R,P.SINGH; Microbiology; KALYANI PUBLISHER
3. Prescot,Harley and Kleins; Microbiology; Tata McGraw Hill publishing Company, New Delhi.
4. R.C.Dubey And P.K.Maheswari ; Microbiology; S,Chand
5. Stainer RY., Ingharam J.I., Wheelis M.I., Printer P.R; General Microbiology; Mc Millan Education Ltd.
6. Vashistha B.R.; Botany for Degree Students : Algae; S. Chand and Company, New Delhi

7. Kumar, H.D.; Introductory Phycology; Affililated East-West Press Ltd. New Delhi
8. Lee, R.E.; Phycology (4th Edn.); Cambridge University Press
9. Anil k. Thakur and Sushil K Bassi; Diversity of microbes and cryptogams; S. Chand and Company, New Delhi

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CORE-2: BIOMOLECULES AND CELL BIOLOGY

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Biomolecules:- Types and significance of chemical bonds; Structure and properties of water; pH and buffers. **2 lectures**

Carbohydrates: Nomenclature and classification; Role of monosaccharides (glucose, fructose, sugar alcohols – mannitol and sorbitol); Disaccharides (sucrose, maltose, lactose), Oligosaccharides and polysaccharides (structural-cellulose, hemicelluloses, pectin, chitin, mucilage; storage – starch, insulin)

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. **2 lectures**

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. **2 lectures**

Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA. **4 lectures**

MODULE-2: Bioenergenetics: Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as a energy currency molecule. **3 lectures**

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 theroy), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity. **4 lectures**

MODULE-3: The cell: Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).

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

MODULE-4: 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.

Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast. **2 lectures**

Endoplasmic Reticulum, Golgi Apparatus, Lysosomes **2 lectures**

MODULE-5: Cell division: Eukaryotic cell cycle, different stages of mitosis and meiosis.Cell cycle, Regulation of cell cycle. **6 lectures**

PRACTICAL: Mark 25 / Credit- 2

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.
4. Measurement of cell size by the technique of micrometry.
5. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).
6. Study of cell and its organelles with the help of electron micrographs.
7. Study the phenomenon of plasmolysis and deplasmolysis.
8. Study different stages of mitosis and meiosis using aceto carmine and aceto orcine method.

Suggested Readings

1. Jain, J.L.; Elementary Biochemistry; S. Chand and Company, New Delhi.
2. D.Nelson and M.M.Cox; Lehninger Principles of Biochemistry; Macmillon Worth Publishers.
3. Stryer,; Biochemistry; W.H.Freeman & Co..
4. U. Satya Narayan And Chakrapani; Biochemistry; Pd Pharma Dost Books And Allied(P) Ltd.
5. C.B. Power; Cell Biology; Himalaya Pblishers Ltd.
6. Rastogi S.C,; Cell and Molecular Biology; New Age international Publisher, New Delhi. Albert B, Bary D, Lewis J, RaffM, Roberts K and Watson JD; Molecular Biology of the Cell.; Garland Science (Toylor & Francis group).
7. Damell J, Lodish H and Baltimore D.; Molecular Cell Biology; Scientific American Books, Inc.
8. Karp, G.; Cell Biology; John Wiley & Sons,USA

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SEMESTER-II

CORE-3: MYCOLOGY AND PHYTOPATHOLOGY

(CREDITS: 6, Theory 4+ Pratical 2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Introduction to true fungi: Definition, General characteristics; Affinities with plants and animals; Thallus organization; Cellwall composition; Nutrition; Classification.
Chytridiomycetes: General account
Zygomycota: General characteristics; Ecology; Thallus organisation; Life cycle with reference to *Rhizopus*.
Ascomycota: General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, eterokaryosis and parasexuality; life cycle and classification with reference to *Saccharomyces, Aspergillus*, *Penicillium, Alternaria* and *Neurospora, Peziza.*
MODULE-2: Basidiomycota: General characteristics; Ecology; Life cycle and Classification with reference to black stem rust on wheat *Puccinia* (Physiological Specialization), loose and covered smut (symptoms only), *Agaricus*; Bioluminescence, Fairy Rings and Mushroom Cultivation.
Allied Fungi: General characterises; Status of Slime molds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies.
Oomycota: General characteristic; Ecology; Life cycle and classification with reference to *Phytophthora, Albugo.*
MODULE-3: 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.
MODULE-4: Applied Mycology: Role of fungi in biotechnology, Application of fungi in food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins); Secondary metabolites (Pharmaceutical preparations); Agriculture (Biofertilizers); Mycotoxins; Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematicides); Medical mycology.
MODULE-5: 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 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. **5 lectures**

PRACTICAL: Mark 25 / Credit- 2

1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, asocarps & basidiocarps).
2. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanent slides.
3. *Aspergillus* and *Penicillium*: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.
4. *Peziza*: sectioning through ascocarp.
5. *Alternaria:* Specimens/photographs and temporary mounts.

6. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberryleaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.
7. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, fairy rings and bioluminescent mushrooms to be shown.
8. *Albugo:* Study of symptoms of plants infected with *Albugo*; asexual phase study throughsection/ temporary mounts and sexual structures through permanent slides.
9. 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)
10. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Viral diseases: TMV, Fungal diseases: Early blight of potato, and White rust of crucifers.

Suggested Readings

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

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CORE-4: ARCHEGONIATE

(CREDITS: 6, Theory 4+ Pratical 2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Introduction: Unifying features of archegoniates; Transition to land habit; Alternation of generations.
MODULE-2: Bryophytes: General characteristics; Adaptations to land habit; Classification; Range of thallus organization. Classification (up to family).*Riccia, Marchantia, Pellia, Porella, Anthoceros, Sphagnum and Funaria*; Reproduction and evolutionary trends in Riccia, Marchantia , Anthoceros and Funaria (developmental stages not included). Ecological and economic importance of bryophytes with special reference to *Sphagnum*.
MODULE-3: Pteridophytes: General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of *Psilotum*, *Selaginella*, *Equisetum* and *Pteris*.(Developmental details not to be included). Apogamy, and apospory, heterospory andseed habit, telome theory, stelar evolution.Ecological and economic importance.
MODULE-4: Gymnosperms: General characteristics, classification (up to family), morphology, anatomy and reproduction of *Cycas*, *Pinus, Ginkgo* and *Gnetum*. (Developmental details not to be included). Ecological and economic importance.
MODULE-5: Fossils: Geographical time scale, fossils and fossilization process. Morphology, anatomy and affinities of *Rhynia, Calamites, Lepidodendron, Lyginopteris* and *Cycadeoidea.*

PRACTICAL: Mark 25 / Credit- 2

1. ***Riccia*** – Morphology of thallus.
2. ***Marchantia***- 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. ***Anthoceros***- Morphology of thallus, dissection of sporophyte (to show stomata, spores, pseudoelaters, columella) (temporary slide), vertical section of thallus (permanent slide).
4. ***Pellia, Porella***- Permanent slides.
5. ***Sphagnum***- Morphology of plant, whole mount of leaf (permanent slide only).
6. ***Funaria***- 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.
7. ***Psilotum***- Study of specimen, transverse section of synangium (permanent slide).
8. ***Selaginella***- Morphology, whole mount of leaf with ligule, transverse section of stem, whole mount of strobilus, whole mount of microsporophyll and megasporophyll (temporary slides), longitudinal section of strobilus (permanent slide).

9. ***Equisetum***- Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent 12 slide).
10. ***Pteris***- Morphology, transverse section of rachis, vertical section of sporophyll, Whole mount of sporangium, whole mount of spores (temporary slides), transverse section of rhizome, whole mount of prothallus with sex organs and young sporophyte (permanent slide).
11. ***Cycas***- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll, transverse section of coralloid root, transverse section of rachis, vertical section of leaflet, vertical section of microsporophyll, whole mount of spores (temporary slides), longitudinal section of ovule, transverse section of root (permanent slide).
12. ***Pinus***- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male And female cones), transverse section of Needle, transverse section of stem, longitudinal section of transverse section of male cone, whole mount of microsporophyll, whole mount of Microspores (temporary slides), longitudinal section of female cone, tangential longitudinal section & radial longitudinal sections stem (permanent slide).
13. ***Gnetum***- Morphology (stem, male & female cones), transverse section of stem, verticalsection of ovule (permanent slide)
14. **Botanical excursion.**

Suggested Readings

1. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.
2. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
3. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.
4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
5. Vander-Poorteri 2009 Introduction to Bryophytes. COP.

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SEMESTER-III

CORE-5: ANATOMY OF ANGIOSPERMS

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

Theory: 60 Lectures (40 min duration)

MODULE-1: Introduction and scope of Plant Anatomy: Applications in systematics, forensics and pharmacognosy**.**

Tissues: Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances.

MODULE-2: 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.

Leaf: Structure of dicot and monocot leaf, Kranz anatomy.

Root: Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescentcentre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root.

MODULE-3: Vascular Cambium: Structure, function and seasonal activity of cambium; Secondary growth in root and stem.

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.

MODULE-4: Adaptive and Protective Systems **5 Lectures**

Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Adcrustation and incrustation; Anatomical adaptations of xerophytes and hydrophytes.

MODULE-5: Secretory System: Hydathodes, cavities, lithocysts and laticifers.

PRACTICAL: Mark 25 / Credit- 2

1. Study of anatomical details through permanent slides/temporary stain mounts/ macerations / museum specimens with the help of suitable examples.
2. Apical meristem of root, shoot and vascular cambium.
3. Distribution and types of parenchyma, collenchyma and sclerenchyma.
4. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.
5. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood.
6. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
7. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
8. Root: monocot, dicot, secondary growth.
9. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
10. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).
11. Adaptive Anatomy: xerophytes, hydrophytes.
12. Secretory tissues: cavities, lithocysts and laticifers.

Suggested Readings

1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.
4. Esau, K. (1977). Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.

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CORE-6 : ECONOMIC BOTANY

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Origin of Cultivated Plants:
Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversty.
MODULE-2: Cereals : Wheat and Rice (origin, morphology, processing & uses), brief account of millets.
Legumes: General account, importance to man and ecosystem.
Sugars & Starches: Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses.
MODULE-3: Spices: Listing of important spices, their family and part used, economic importance with special reference to fennel, saffron, clove and black pepper
Beverages: Tea, Coffee (morphology, processing & uses)
Drug-yielding plants: Therapeutic and habit-forming drugs with special reference to *Cinchona, Digitalis, Papaver* and *Cannabis*.
Tobacco: Tobacco (Morphology, processing, uses and health hazards)
MODULE-4: Oils & Fats: General description, classification, extraction, their uses and health implications groundnut, coconut, linseed and *Brassica* and Coconut (Botanical name, family & uses)
Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.
MODULE-5: Natural Rubber: Para-rubber: tapping, processing and uses.
Timber plants: General account with special reference to teak and pine.
Fibres: Classification based on the origin of fibres, Cotton and Jute (morphology, extraction and uses).

PRACTICAL: Mark 25 / Credit- 2

1. **Cereals**: Rice (habit sketch, study of paddy and grain, starch grains, micro- chemical tests).
2. **Legumes**: Soya bean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).
3. **Sugars & Starches**: Sugarcane (habit sketch; cane juice- micro-chemical tests), Potato(habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests).
4. **Spices:** Black pepper, Fennel and Clove (habit and sections).
5. **Beverages**: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).

6. **Oils & Fats**: Coconut- T.S. nut, Mustard–plant specimen, seeds; tests for fats in Crushed seeds.
7. **Essential oil-yielding plants**: Habit sketch of*Rosa*, V*etiveria, Santalum* and *Eucalyptus* (specimens/photographs).
8. **Rubber**: specimen, photograph/model of tapping, samples of rubber products.
9. **Drug-yielding plants**: Specimens of *Digitalis, Papaver*and*Cannabis.*
10. **Tobacco**: specimen and products of Tobacco.
11. **Woods:** Tectona, Pinus: Specimen, Section of young stem.
12. **Fibre-yielding plants**: Cotton (specimen, whole mount of seed to show lint and fuzz;whole mount of fibre and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fibre).

Suggested Readings

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
3. Chrispeels, M.J. and Sadava, D.E. (2003). Plants, Genes and Agriculture. Jones & Bartlett Publishers.

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CORE-7: GENETICS

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Mendelian genetics and its extension: Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Numericals; Polygenic inheritance.
MODULE-2: Extrachromosomal Inheritance: Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in *Paramecium.*
MODULE-3: Linkage, crossing over and chromosome mapping: Linkage and crossing over-Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage.
MODULE-4: Variation in chromosome number and structure:
Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy
Gene mutations: Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: CIB method. Role of Transposons in mutation.DNA repair mechanisms.
MODULE-5: Fine structure of gene:
Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, Rii Locus.
Population and Evolutionary Genetics: Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection,
mutation, genetic drift. Genetic variation and Speciation.

PRACTICAL: Mark 25 / Credit- 2

1. Meiosis through temporary squash preparation.
2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square analysis.
3. Chromosome mapping using test cross data.
4. Pedigree analysis for dominant and recessive autosomal and sex linked traits with floral chart.
5. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
6. Blood Typing: ABO groups & Rh factor.
7. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.
8. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.

Suggested Readings

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. Benjamin Cummings, U.S.A. 10th edition.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

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SEMESTER-IV

CORE-8: MOLECULAR BIOLOGY

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Nucleic acids: Carriers of genetic information: Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment.

MODULE-2: The Structures of DNA and RNA / Genetic Material:
DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves; Organization of DNAProkaryotes, Viruses, Eukaryotes. RNA Structure- Organelle DNA - mitochondria and chloroplast DNA.The Nucleosome -Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

The replication of DNA: Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semi-conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA, replication of the 5'end of linear chromosome; Enzymes involved in DNA replication.

MODULE-3: Central dogma and genetic code:
Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of mRNAtemplate), Genetic code (deciphering & salient features)

Mechanism of Transcription: Transcription in prokaryotes; Transcription in eukaryotes

Processing and modification of RNA: Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I & group II intron splicing, alternative splicing eukaryotic mRNA processing(5' cap, 3' polyA tail); Ribozymes, exon shuffling; RNA editing and mRNA transport.

MODULE-4: Translation (Prokaryotes and eukaryotes): Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; Post-translational modifications of proteins.

MODULE-5: Regulation of transcription in prokaryotes and eukaryotes: Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E.coli.* Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing.

PRACTICAL: Mark 25 / Credit- 2

1. Preparation of LB medium and raising *E.Coli.*
2. Isolation of genomic DNA from *E.Coli.*
3. DNA isolation and RNA estimation by orcinol method.
4. DNA estimation by diphenylamine reagent/UV Spectrophotometry.
5. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
6. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
7. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery etal, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments)
8. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.

Suggested Readings

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin . U.S.A. 9th edition.
4. Russell, P. J. (2010). iGenetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

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CORE-9 : PLANT ECOLOGY AND PHYTOGEOGRAPHY

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Introduction: Concept of ecology, Autoecology, Synecology, system ecology, Levels of organization. Inter-relationships between the living world and the environment, the components of environmental, concept of hydrosphere and lithospgere and dynamism, homeostasis.

MODULE-2: Soil: Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development.

Water: Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.

Light, temperature, wind and fire: Variations; adaptations of plants to their variation.

MODULE-3: Biotic interactions:

Population ecology: Characteristics and Dynamics .Ecological Speciation

Plant communities: Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts.

MODULE-4: Ecosystems: Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.

Functional aspects of ecosystem: Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.

MODULE-5: Phytogeography: Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation.

PRACTICAL: Mark 25 / Credit- 2

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
4. Determination of organic matter of different soil samples by Walkley & Black rapid titration method.
5. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.
6. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
7. (a). Study of morphological adaptations of hydrophytes and xerophytes (four each). (b). Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*) Epiphytes, Predation (Insectivorous plants).
8. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
9. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
10. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
11. Field visit to familiarise students with ecology of different sites.

Suggested Readings

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.

3. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
5. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

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CORE-10 : PLANT SYSTEMATICS

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Plant identification, Classification, Nomenclature; Biosystematics.
Identification: Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access.
MODULE-2: Taxonomic hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).
Botanical nomenclature: Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.
MODULE-3: Systematics- an interdisciplinary science: Evidence from palynology, cytology, phytochemistry and molecular data.
Systems of classification: Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm
Phylogeny Group (APG III) classification.
MODULE-4: Biometrics, numerical taxonomy and cladistics: Characters; Variations; OTUs, character weighting and coding; cluster analysis; Phenograms, cladograms (definitions and differences).
MODULE-5: Phylogeny of Angiosperms: Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades).origin& evolution of angiosperms; coevolution of angiosperms and animals; methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).

PRACTICAL: Mark 25 / Credit- 2

1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):
   Ranunculaceae - *Ranunculus, Delphinium*
   Brassicaceae - *Brassica, Alyssum / Iberis*
   Myrtaceae - *Eucalyptus, Callistemon*
   Umbelliferae - *Coriandrum /Anethum / Foeniculum*
   Asteraceae - *Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax*
   Solanaceae - *Solanum nigrum/Withania*
   Lamiaceae - *Salvia/Ocimum*
   Euphorbiaceae - *Euphorbia hirta/E.milii, Jatropha*
   Liliaceae - *Asphodelus/Lilium/Allium*
   Poaceae - *Triticum/Hordeum/Avena*
2. Field visit (local) – Subject to grant of funds from the university.
3. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book)

Suggested Readings

1. Singh, G. (2012). *Plant Systematics:* Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi.3rdedition.
2. Jeffrey, C. (1982). An Introduction to *Plant Taxonomy*. Cambridge University Press, Cambridge.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
4. Maheshwari, J.K. (1963). *Flora* of Delhi. CSIR, New Delhi.
5. Radford, A.E. (1986). Fundamentals of *Plant Systematics*. Harper and Row, New

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SEMESTER-V

CORE-11: REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODILE-1: Introduction: Introduction: History (contributions of G.B. Amici, W. Hofmeister, E.Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J.Heslop-Harrison), scope.

MODILE-2: Anther and pollen biology: Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance;

Pollen biology: Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.

MODILE-3: Ovule, Endosperm & Embryo: Ovule: Structure; Types; Special structures-endothelium, obturator, aril, caruncle and hypostase; Female gametophyte-megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details ofPolygonum type); Organization and ultrastructure of mature embryo sac.

Endosperm: Types, development, structure and functions.

Embryo: Six types of embryogeny; General pattern of development of dicotand monocot embryo; Suspensor: structure and functions; Embryoendospermrelationship; Nutrition of embryo; Unusual features; Embryodevelopment in *Paeonia*.

MODILE-4: Pollination, fertilization and self incompatibility

Pollination and fertilization: Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.

Self incompatibility: Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome selfincompatibility: mixed pollination, bud pollination, stub pollination; Intraovarian and *in vitro* pollination; Modification of stigma surface, parasexual hybridization; Cybrids, *in vitro* fertilization.

MODILE-5: Seed, Polyembryony, apomixes and Germline transformation

Seed: Structure, importance and dispersal mechanisms

Polyembryony and apomixes: Introduction; Classification; Causes and applications.

Germline transformation: Pollen grain and ovules through pollen tube pathway method/ *Agrobacterium*/ electrofusion/floral dip/biolistic.

PRACTICAL: Mark 25 / Credit- 2

1. **Anther:** Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
2. **Pollen grains:** Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs, fresh material), ultrastructure of pollen wall(micrograph); Pollen viability: Tetrazolium test.germination: Calculation of percentage germination in different media using hanging drop method.
3. **Ovule:** Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs).
4. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.
5. Intra-ovarian pollination; Test tube pollination through photographs.
6. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.
7. Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.

References:

1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
2. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
3. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
4. Johri, B.M. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

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CORE-12: PLANT PHYSIOLOGY

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODILE-1: Plant water relationship & Translocation in the phloem:
Plant water relationship-Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.
Translocation in the phloem- Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.
MODILE-2: Mineral nutrition: Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.
MODILE-3: Nutrient Uptake: Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems,proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.
MODILE-4: Plant growth regulators: Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene. Brassinosteroids and Jasmonic acid.
MODILE-5: Physiology of flowering & Phytochrome:
Physiology of flowering- Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.
Phytochrome- Discovery, chemical nature, role of phytochrome in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.

PRACTICAL: Mark 25 / Credit- 2
1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method.
3. Study of the effect of wind velocity and light on the rate of transpiration in excised twig/leaf.
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces).
6. To study the phenomenon of seed germination (effect of light).
7. To study the induction of amylase activity in germinating barley grains.

Demonstration experiments
1. To demonstrate suction due to transpiration.
2. Fruit ripening/Rooting from cuttings (Demonstration).
3. Bolting experiment/*Avena* coleptile bioassay (demonstration).

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SEMESTER-VI

CORE-13: PLANT METABOLISM

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODILE-1: Concept of metabolism & Carbohydrate metabolism:
Concept of metabolism: Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric ,covalent modulation and Isozymes).
Carbohydrate metabolism: Synthesis and catabolism of sucrose and starch.
MODILE-2: Carbon assimilation: Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO_2 reduction, photorespiration, C4pathways; Crassulacean acid metabolism; Factors affecting CO_2 reduction.
MODILE-3: Carbon Oxidation & ATP-Synthesis:
Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle,amphibolic role, anaplerotic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanideresistant respiration, factors affecting respiration.
ATP-Synthesis: Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyers conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers.
MODILE-4: Lipid metabolism: Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α oxidation.
MODILE-5: Mechanisms of signal transduction and nitrogen metabolism
Nitrogen metabolism: Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.
Mechanisms of signal transduction: Calcium, phospholipids, cGMP, NO.

PRACTICAL: Mark 25 / Credit- 2
1. Chemical separation of photosynthetic pigments.
2. Experimental demonstration of Hill's reaction.
3. To study the effect of light intensity on the rate of photosynthesis.
4. Effect of carbon dioxide on the rate of photosynthesis.
5. To compare the rate of respiration in different parts of a plant.
6. To demonstrate activity of Nitrate Reductase in germinationg leaves of different plant sources.
7. To study the activity of lipases in germinating oilseeds and demonstrate mobilization of lipids during germination.
8. Demonstration of fluorescence by isolated chlorophyll pigments.
9. Demonstration of absorption spectrum of photosynthetic pigments.

References:
1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.

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CORE-14: PLANT BIOTECHNOLOGY

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODILE-1: Plant Tissue Culture: Historical perspective; Aseptic tissueculture techniques, Composition of media; Nutrient and hormone requirements (role of vitamins and hormones).
MODILE-2: Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm
Conservation).
MODILE-3: Recombinant DNA technology-I: Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC and briefly PAC, MAC, HAC).Gene Cloning (Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR-mediated gene cloning).
MODILE-4: Recombinant DNA technology-II: Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain geneof interest by genetic selection; complementation, colony hybridization; Probes-oligonucleotide, heterologous, PCR; Methods of gene transfer- Agrobacterium-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics–selectable marker and reporter genes (Luciferase, GUS, GFP).
MODILE-5: Applications of Biotechnology: Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Gentically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns..

PRACTICAL: Mark 25 / Credit- 2

1. (a) Preparation of MS medium.; (b) Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura*, *Brassica* etc.
2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
3. Isolation of protoplasts.
4. Construction of restriction map of circular and linear DNA from the data provided.
5. Study of methods of gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
6. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.
7. Isolation of plasmid DNA.
8. Restriction digestion and gel electrophoresis of plasmid DNA.

Suggested Readings

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.
6. Chawla, H.S. (2010). Introduction to Plant Biotechnology.Oxford & IBH Publishing Co.Pvt. Ltd., New Delhi.
7. Singh, B. D. (2010) Biotechnology: Expanding Horizon. Kalyani Publishers. New Delhi.

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DISCIPLINE SPECIFIC ELECTIVE (DSE)

BOTANY

SEMESTER- V

DSE-1: ANALYTICAL TECHNIQUES IN PLANT SCIENCES

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Imaging and related techniques: Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

MODULE-2: Cell fractionation: Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl2gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

MODULE-3: Radioisotopes, Spectrophotometry & Chromatography:

Radioisotopes - Use in biological research, auto-radiography, pulse chase experiment.

Spectrophotometry- Principle and its application in biological research.

Chromatography: Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

MODULE-4: Characterization of proteins and nucleic acids: Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE

MODULE-5: Biostatistics: Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.

PRACTICAL: Mark 25 / Credit- 2

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Demonstration of ELISA.
3. To separate nitrogenous bases by paper chromatography.
4. To separate sugars by thin layer chromatography.
5. Isolation of chloroplasts by differential centrifugation.
6. To separate chloroplast pigments by column chromatography.
7. To estimate protein concentration through Lowry's methods.
8. To separate proteins using PAGE.
9. To separation DNA (marker) using AGE.
10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
11. Preparation of permanent slides (double staining).
12. Estimation of plant pigments.

REFERENCES:

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

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DSE-2: PLANT BREEDING

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Plant Breeding: Introduction and objectives. Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding.
MODULE-2: Methods of crop improvement : Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: For self pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants Procedure, advantages and limitations.
MODULE-3: Quantitative inheritance : Concept, mechanism, examples of inheritance of Kernel colour in wheat, Skin colour in human beings. Monogenic vs polygenic Inheritance.
MODULE-4: Inbreeding depression and heterosis : History, pure line selection, heterosis and hybrid vigour, basis of hybrid vigour, genetic basis of inbreeding depression and heterosis; Applications of heterosis in crop improvement.
MODULE-5: Crop improvement and breeding : Role of mutations; mutation agents in crop improvement, Polyploidy; Distant hybridization and role of biotechnology in crop improvement.

PRACTICAL: Mark 25 / Credit- 2
1. Self pollination and Cross pollination technique in rice/other plants.
2. Hybridization technique in rice/other plants.
3. Morphology, growth and physiology of hybrid seedlings.

References:

1. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
2. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2ndedition.
3. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

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SEMESTER-VI
DSE-3: INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Scope of microbes in industry and environment:
Bioreactors/Fermenters and fermentation processes: Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations. Components of a typical bioreactor, Types of bioreactorslaboratory, pilotscale and production fermenters; Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and airlift fermenter. A visit to any educational institute/ industry to see an industrial fermenter, and other downstream processing operations.
MODULE-2: Microbial production of industrial products: Microorganisms involved, media, fermentation conditions, downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying; Hands on microbial fermentations for the production and estimation (qualitative and quantitative) of Enzyme: amylase or lipase activity, Organic acid (citric acid or glutamic acid), alcohol (Ethanol) and antibiotic (Penicillin).
MODULE-3: Microbial enzymes of industrial interest and enzyme immobilization: Microorganisms for industrial applications_and hands on screening microorganisms for casein hydrolysis; starch hydrolysis; cellulose hydrolysis.
Microbes and quality of environment: Distribution of microbes in air; Isolation of microorganisms from soil, air and water.
MODULE-4: Microbial flora of water: Water pollution, role of microbes in sewage and domestic waste water treatment systems. Determination of BOD, COD, TDS and TOC of water samples; Microorganisms as indicators of water quality, check coliform and fecal coliform in water samples.

MODULE-5: Microbes in agriculture and remediation of contaminated soils: Biological fixation; Mycorrhizae; Bioremediation of contaminated soils. Isolation of root nodulating bacteria, arbuscular mycorrhizal colonization in plant roots.

PRACTICAL: Mark 25 / Credit- 2

1.Principles and functioning of instruments in microbiology laboratory
2.Hands on sterilization techniques and preparation of culture media.

REFERENCES:

1. Pelzar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi.
2. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition.

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DSE-4: PROJECT (CREDIT=6 / MARKS=100) (End Semester Evaluation)

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