



**Chhatrapati Shahu Ji Maharaj University, Kanpur
Uttar Pradesh State University (Formerly Kanpur University, Kanpur)**

**New Under Graduate Degree (Science) Course Proposal
As per National Education Policy-2020**

Subject: 3 years Degree course

B.Sc. (Biochemistry Botany and Zoology)

Proposed By:

Dr Annika Singh

Dr Rolee Sharma

Dr Siddharth Kumar Mishra

Department of Life Science and Biotechnology
School of Science, CSJMU, Kanpur

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B.Sc. (Biochemistry, Botany, Zoology) degree course

➤ ABOUT THE PROGRAMME

The BSc degree course will be a three years (six semesters) programme. This programme will be offered as B.Sc. (Biochemistry, Botany, Zoology) programme in advanced Biology.

Those opting for this course will be eligible to become Science graduate, and/or teachers of biological sciences after completion of B.Ed. the students will be eligible for pursuing MSc in Applied Biosciences (Biochemistry, Biotechnology, Microbiology, Life Science etc.) along with Zoology/Botany

B.Sc. Programme is currently running successfully in various State Universities Successfully.

➤ ENTRY QUALIFICATIONS

The entry qualification for admission to the BSc. dual degree programme will be the successful completion of secondary level of schooling i.e. Class XII. The admission procedure for the programmes will be as per the University Ordinance.

The Main objective of B.Sc. (Biochemistry, Botany, Zoology) degree course is to provide deep Knowledge of advanced biological science along with professional skill development in clinical and molecular Diagnostics.

➤ STRUCTURE OF THE PROGRAMME

This programme is designed in such a way that it will seamlessly fit with the scheme of the newly restructured graduate programmes of different disciplines in the State of Uttar Pradesh. The proposed programme structure offers varied flexibility to the students in terms of course choice and exit routes. The following will detail this unique conception:

First Year (2 Semesters): Students will have to study Three subjects from a advanced Biology stream, (Biochemistry, Zoology, Botany), an elective courses related to other faculty, and Co-curricular Courses. In case any student decides to leave after one year, s/he will be awarded a Certificate in Clinical Biochemistry.

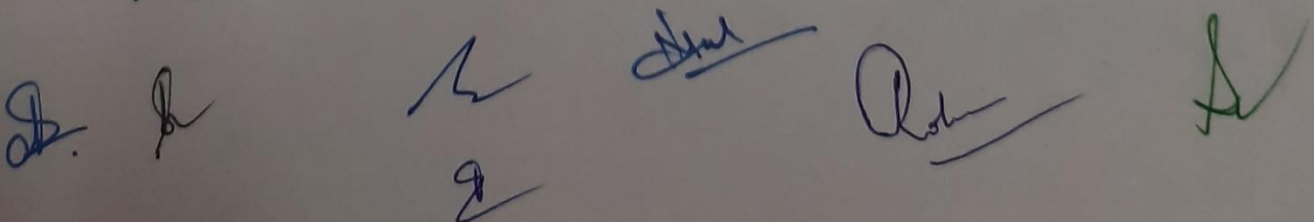
Second Year (2 Semesters): Students will have to continue studying three subjects chosen in the first year, another elective course from other faculty (Art or Commerce), and Co-curricular Courses. In case any student decides to leave after two years, s/he will be awarded a Diploma in Molecular Diagnostics.

Third Year (2 Semesters): Students will opt for Two major subject from the stream, along with one co-curricular course after successful completion of three years course s/he will be awarded a Bachelor in B.Sc. (BBZ).

➤ **No of Seats Proposed B.Sc.(ZBB) - 60**

➤ **Fees Proposed – 30,000/Year OR - 15,000/Semester**

➤ **Note: Each student pursuing dissertation in house may be charged a bench fee as per university rule**



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Model UG (BSc) Programme Design according to NEP 2020

Model UG (BSc) Programme Design according to NEP 2020									
	Subject 1	Subject 2	Subject 3	Subject 4	Vocational/Skill Development course	Co-Curricular course	Industrial Training/Survey/Research Project	Minimum/Maximum Credit for the year	Cumulative minimum credit required for award of certificate/Diploma or Degree
	Major	Major	Major	Minor Elective	Minor Elective	Minor Qualifying	Major		
	6 Credits	6 Credits	6 Credits	4 Credits	3 Credits		4 Credits		
	Own faculty	Own faculty	Own faculty	Other faculty					
	Select any two major subject available in college from the subject offered in the faculty of Science for 6 semester		Select any one major subject (other than subject 1 and 2)	Select one Subject from other Faculty for first year	Select any one subject in each Semester for four Semesters in a sequence – other Faculty	Compulsory Course (one paper in each Semester for six Semester). Qualifying in nature.	Inter/intra faculty related to major subject Qualifying in nature	Minimum Credits required to pass in respective Year	
1st year	I	Theory - 01	Theory - 01	Theory - 01	Theory - 01	Theory - 01	Theory - 01 (English)	46/60	Certificate in Clinical Diagnostics
		Practical - 01	Practical - 01	Practical - 01	-				
	II	Theory - 01	Theory - 01	Theory - 01	Theory - 01	Theory - 01	Theory - 01 (Environment)		
		Practical - 01	Practical - 01	Practical - 01	-	-			
2nd Year	III	Theory - 01	Theory - 01	Theory - 01	-	Theory - 01	Theory - 01	46/60	Diploma in Molecular Diagnostic
		Practical - 01	Practical - 01	Practical - 01	-	-			
	IV	Theory - 01	Theory - 01	Theory - 01	-	Theory - 01	Theory - 01		
		Practical - 01		Practical - 01	-	-			
3rd Year	V	Theory - 02	Theory - 02	-	-	-	Theory - 01	40	B.Sc. in Advanced Biology
		Practical - 02	Practical - 02	-	-	-			
	VI	Theory - 02	Theory - 02				Theory - 01		
		Practical - 02	Practical - 02						

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➤ **PROGRAMME OBJECTIVES (POS)**

1. The programme has been designed in such a way so that the students get the flavour of both classical and modern aspects of Animal Sciences/ Plant Sciences. It aims to enable the students to study animal diversity in Indian subcontinent, environmental science and behavioural ecology.
2. The modern areas including cell biology and genetics, molecular biology, biochemistry, physiology followed by biostatistics, Evolutionary biology, bioinformatics and genetic engineering have been included to make the study of animals more interesting and relevant to human studies which is the requirement in recent times.
3. The lab courses have been designed in such a way that students will be trained to join public or private labs.

➤ **PROGRAMME OUTCOMES**

1. The Certificate courses will enable students to apply for technical positions in government and private labs/institutes.
2. The Diploma courses will ensure employability in Hospitals/Diagnostics and Pathology labs with good hands-on training. It will also enable students to take up higher studies and Research as their career and work in renowned labs in the country and abroad.
3. The Degree courses will enable students to go for higher studies like Masters and Ph.D in Biology and Applied Biology subjects
4. The programme is economically viable for educational institutions, and academically enriching for the learners.

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First year Structure of degree course B.Sc. (ZBB)

YEAR	SEM	SUBJECT	COURSE CODE	PAPER TITLE	CREDITS/ TEACHING HOURS
1 st year Certificate in	I	Biochemistry (Subject 1 Major)	B110101T	Fundamentals of Biochemistry	04/60
			B110102P	Bio safety Measures, Preparation of Solutions and Qualitative Analysis of Biomolecules	02/60
		Zoology (Subject 2 Major)	B050101T	Cytology, Genetics and Infectious Diseases	04/ 60
			B050102P	Cell Biology & Cytogenetics	02/ 60
		Botany (Subject 3 Major)	B040101T	Microbiology & Plant Pathology	04/60
			B040102P	Techniques in Microbiology & Plant Pathology	02/60
		Subject 4(Minor Elective)	T-01		04/
			P-01		
		Vocational/ Skill Development course (Minor Elective)	English/ Environmental Science		03/
		Co-Curricular (Minor Qualifying)	-	As per University Guidelines	
	II	Biochemistry (Subject 1 Major)	B110201 T	Human Physiology and Clinical Biochemistry	04/60
			B110202 P	Clinical Biochemistry Lab	02/60
		Zoology (Subject 2 Major)	B050201T	Biochemistry and Physiology	04/ 60
			B050202P /R	Physiological, Biochemical & Hematology Lab	02/60
		Botany (Subject 3 Major)	B040201T	Archegoniates & Plant Architecture	04/60
			B040202P	Land Plants Architecture	02/60
		Subject 4 (Minor Elective)	T-01		04/
			P-01		
		Vocational/ Skill Development course (Minor Elective)	English/ Environmental Science		03/
			English/ Environmental Science		
Co-Curricular (Minor Qualifying)	Course offered by Computer science based on Basics of Computer science and artificial Intelligence	As per University Guidelines			

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Second year Structure of degree course B.Sc. (ZBB)					
YEAR	SEM	SUBJECT	COURS ECODE	PAPER TITLE	CREDITS/ TEACHING HOURS
2 nd year Diploma in Molecular Diagnosis	III	Biochemistry (Subject 1 Major)	B110301T	B110301T Tools and Techniques in Biochemistry	04/60
			B110302 P	B110302 P Biochemical Tools and Techniques Lab	02/60
		Zoology (Subject 2 Major)	B050301T	Bioinstrumentation & Molecular Biology, Biotechniques	04/ 60
			B050302P	Bioinstrumentation & Molecular Biology Lab	02/ 60
		Botany (Subject 3 Major)	B040301T	Characteristics Flowering Plants Identification & Aesthetic	04/60
			B040302P	Plant Identification technology	02/60
		Vocational/ Skill Development course (Minor Elective)		As per University Guidelines	04/
	Co-Curricular (Minor Qualifying)		As per University Guidelines		
	IV	Biochemistry (Subject 1 Major)	B110401T	Enzymology and Immunology	04/60
			B11040 2P	Enzymes and Immunological Techniques Lab	02/60
		Zoology (Subject 2 Major)	B050401 T	Gene Technology, Immunology and Computational Biology	04/ 60
			B050402 P/R	Genetic Engineering and Counselling Lab	02/60
		Botany (Subject 3 Major)	B040401 T	Economic Botany, Ethnomedicine & Phytochemistry	04/60
			B040402 P	Commercial Botany & Phytochemical Analysis	02/60
		Vocational/ Skill Development course (Minor Elective)		As per University Guidelines	04/
Co- Curricular (Minor Qualifying)		As per University Guidelines			

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Third year Structure of degree course B.Sc. (ZBB)						
Year	Sem	Subject	Course Code	Paper Title	Credits/ Teaching Hours	
3 rd year B.Sc. Degree	V	Biochemistry (Subject 1 Major)	B110501T	Bioenergetics and Metabolism	04/60	
			B110502 T	Fundamentals of Microbiology	04/60	
			B110503 P	Microbial Techniques and Metabolism Lab	02/60	
		Zoology (Subject 2 Major)	B050501T	Diversity of Non-Chordates, Parasitology and Economic Zoology	04/ 60	
			B050502T	Diversity of Chordates and Comparative Anatomy	04/60	
			B050503P	Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitology	02/ 60	
		OR Botany (Subject 2 Major)	B040501T	Plant Physiology, Metabolism & Biochemistry	04/60	
			B040502T	Molecular Biology & Bioinformatics		
			B040503P	Experiments in physiology, Biochemistry & molecular biology	02/60	
			B040504R	*Project-I		
						04/-
		Co-Curricular (Minor Elective)		As per University Guidelines		
		VI	Biochemistry (Subject 1 Major)	B110601T	Cell, molecular biology and Genetic Engineering	04/60
				B110602T	Biostatistics, Bioinformatics and Computer application in Biochemistry	
	B110603P			Genetic engineering and Bioinformatics Lab	02/60	
	Zoology (Subject 2 Major)		B050601T	Evolutionary and Developmental Biology	04/ 60	
			B050602T	Ecology, Ethology, Environmental Science and Wildlife Theory 04	04/60	
			B050603P	Lab on Environmental Science, Behavioral Ecology, Developmental Biology, Wildlife, Ethology	02/60	
	OR Botany (Subject 2 Major)		B040601T	Cytogenetics, Plant Breeding & Nanotechnology	04/60	
			B040602T	Ecology & Environment		
B040603P			Cytogenetics, Conservation & Environment management	02/60		
B040604R			*Project-II	03/60		
					04/-	
Cocurricular (Minor Elective)			As per University Guidelines			

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Semester-wise Titles of the Papers in B.Sc (Biochemistry) as per National Education Policy-2020





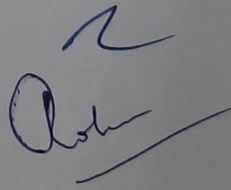

Common Minimum Syllabus for all UP State Universities and Colleges For First Three Years of Higher Education (UG)

Proposed Year wise Structure of UG Program in Biochemistry

Program/ Year	Sem.	Course code	Paper title	Credits	Teaching hours
Certificate course in clinical biochemistry	1	B110101T	Fundamentals of Biochemistry	4	60
		B110102P	Biosafety Measures, Preparation of Solutions and Qualitative Analysis of Biomolecules	2	60
	2	B110201T	Human Physiology and Clinical Biochemistry	4	60
		B110202P	Clinical Biochemistry Lab	2	60
Diploma in tools and techniques in biochemistry	3	B110301T	Tools and Techniques in Biochemistry	4	60
		B110302P	Biochemical Tools and Techniques Lab	2	60
	4	B110401T	Enzymology and Immunology	4	60
		B110402P	Enzymes and Immunological Techniques Lab	2	60
Degree in Bachelor of Science Biochemistry	5	B110501T	Bioenergetics and Metabolism	4	60
		B110502T	Fundamentals of Microbiology	4	60
		B110503P	Microbial Techniques and Metabolism Lab	2	60
	6	B110601T	Cell, Molecular Biology and Genetic Engineering	4	60
		B110602T	Biostatistics, Bioinformatics and computer application in Biochemistry	4	60
		B110603P	Genetic Engineering and Bioinformatics Lab	2	60

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Note: The detailed Syllabus approved by Department Of Higher Education U.P. Government, Lucknow (UG) is attached in separate pdf file

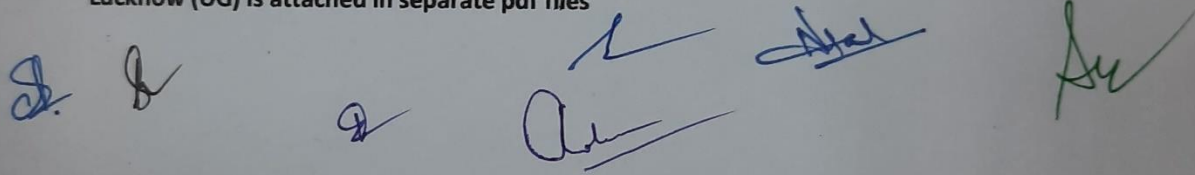







Semester-wise Titles of the Papers in B.Sc (Botany) as per National Education Policy-2020

Common Minimum Syllabus for all UP State Universities and Colleges For First Three Years of Higher Education (UG)

Semester-wise Titles of the Papers in B.Sc. (Botany)					
Year	Sem.	Course Code	Paper Title	Theory/ Practical	Credits
<i>Certificate Course In Microbial Technology & Applied Botany</i>					
FIRST YEAR	I	B040101T	Microbiology & Plant Pathology	Theory	4
		B040102P	Techniques in Microbiology & Plant Pathology	Practical	2
	II	B040201T	Archegoniates & Plant Architecture	Theory	4
		B040202P	Land Plants Architecture	Practical	2
<i>Diploma in Plant Identification, Utilization & Ethnomedicine</i>					
SECOND YEAR	III	B040301T	Flowering Plants Identification & Aesthetic Characteristics	Theory	4
		B040302P	Plant Identification technology	Practical	2
	IV	B040401T	Economic Botany, Ethnomedicine & Phytochemistry	Theory	4
		B040402P	Commercial Botany & Phytochemical Analysis	Practical	2
<i>Bachelor of Science</i>					
THIRD YEAR	V	B040501T	Plant Physiology, Metabolism & Biochemistry	Theory	4
		B040502T	Molecular Biology & Bioinformatics	Theory	4
		B040503P	Experiments in physiology, Biochemistry & molecular biology	Practical	2
		B040504R	*Project-I	Practical	3
	VI	B040601T	Cytogenetics, Plant Breeding & Nanotechnology	Theory	4
		B040602T	Ecology & Environment	Theory	4
		B040603P	Cytogenetics, Conservation & Environment management	Practical	2
		B040604R	*Project-II	Practical	3

Note: The detailed Syllabus approved by Department Of Higher Education U.P. Government, Lucknow (UG) is attached in separate pdf files



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Semester-wise Titles of the Papers in B.Sc (Zoology) as per National Education Policy-2020

Common Minimum Syllabus for all UP State Universities and Colleges For First Three Years of Higher Education (UG)

Semester-wise Titles of the Papers in B.Sc (Zoology)

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
1	I	B050101T	Cytology, Genetics and Infectious Diseases	Theory	04
		B050102P	Cell Biology and Cytogenetics Lab	Practical	02
	II	B050201T	Biochemistry and Physiology	Theory	04
		B050202P/R	Physiological, Biochemical & Hematology Lab	Practical/Field work	02
2	III	B050301T	Molecular Biology, Bioinstrumentation & Biotechniques	Theory	04
		B050302P	Bioinstrumentation & Molecular Biology Lab	Practical	02
	IV	B050401T	Gene Technology, Immunology and Computational Biology	Theory	04
		B050402P/R	Genetic Engineering and Counselling Lab	Practical/Field work	02
3	V	B050501T	Diversity of Non-Chordates, Parasitology and Economic Zoology	Theory	04
		B050502T	Diversity of Chordates and Comparative Anatomy	Theory	04
		B050503P	Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitology	Practical	02
	VI	B050601T	Evolutionary and Developmental Biology	Theory	04
		B050602T	Ecology, Ethology, Environmental Science and Wildlife	Theory	04
		B050603P	Lab on Environmental Science, Behavioral Ecology, Developmental Biology, Wildlife, Ethology	Practical	02

Note: The detailed Syllabus approved by Department Of Higher Education U.P. Government, Lucknow (UG) is attached in separate pdf file

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**DEPARTMENT OF HIGHER EDUCATION
U.P. GOVERNMENT, LUCKNOW**

**National Education Policy-2020
Common Minimum Syllabus
For all U.P. State Universities and
Colleges For the first three years of
Higher Education (UG)**



PROPOSED STRUCTURE OF SYLLABUS

BOTANY (PLANT SCIENCE)

(FACULTY OF LIFE SCIENCE)

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National Education Policy-2020
Common Minimum Syllabus for all U.P. State Universities/ Colleges
SUBJECT: BIOCHEMISTRY

Name	Designation	Affiliation
Steering Committee		
Mrs. Monika S. Garg, (I.A.S.) Chairperson Steering Committee	Additional Chief Secretary	Dept. of Higher Education U.P., Lucknow
Prof. Poonam Tandan	Professor	Dept. of Physics, Lucknow University, U.P.
Prof. Hare Krishna	Professor	Dept. of Statistics, CCS University Meerut, U.P.
Dr. Dinesh C. Sharma	Associate Professor	Dept. of Zoology, K.M. Govt. Girls P.G. College Badalpur, G.B. Nagar, U.P.
Supervisory Committee-Science Faculty		
Dr. Vijay Kumar Singh	Associate Professor	Dept. of Zoology, Agra College, Agra
Dr. Santosh Singh	Dean	Dept. of Agriculture, Mahatma Gandhi Kashi Vidhyapeeth, Varanasi
Dr. Baby Tabussam	Associate Professor	Dept. of Zoology, Govt. Raza P.G. College Rampur, U.P.
Dr. Sanjay Jain	Associate Professor	Dept. of Statistics, St. John's College, Agra

Syllabus Developed by:

Name	Designation	Affiliation
DR.NEELAM PATHAK	Professor & Head	Department of Biochemistry Dr. Rammanohar Lohia Avadh University, Ayodhya
DR. SAMIR SHARMA	Associate professor	Department of Biochemistry Lucknow University, Lucknow,
SANJEEV ARORA	Assistant Professor	Department of Zoology Govt. Model Degree College Arniya, Bulandshahr

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Department of Higher Education
U.P. Government, Lucknow



National Education Policy-2020
Common Minimum Syllabus for all U.P. State Universities

Proposed Titles for Theory and Practical Papers
Under Graduate Programme

SUBJECT: BIOCHEMISTRY

DR. NEELAM PATHAK
Professor and Head
Department of
Biochemistry
Dr. Rammanohar Lohia
Avadh university,
Ayodhya
M:9532038720
pathak.neelam007@gmail.com

DR. SAMIR SHARMA
Associate professor
Department of
Biochemistry
Lucknow University,
Lucknow,
M:9415788981
samiersharma@gmail.com

SANJEEV ARORA
Assistant professor,
Department of Zoology
Govt. Model Degree
College
Arniya, Bulandshahr
M:7895585303
arora.sanjeev08@gmail.com



**Department of Higher Education
U.P. Government, Lucknow**

National Education Policy-2020
Common Minimum Syllabus for all U.P. State Universities

Semester-wise Titles of the Papers in B.Sc (Biochemistry)

Year	Sem	Course Code	Paper title	Theory/practical	credits
1.	I	B110101T	Fundamentals of Biochemistry	Theory	4
		B110102P	Biosafety Measures, Preparation of Solutions and Qualitative Analysis of Biomolecules	Practical/Field Work	2
	II	B110201T	Human Physiology and Clinical Biochemistry	Theory	4
		B110202P	Clinical Biochemistry Lab	Practical/Field Work	2
2.	III	B110301T	Tools and Techniques in Biochemistry	Theory	4
		B110302P	Biochemical Tools and Techniques Lab.	Practical	
	IV	B110401T	Enzymology and Immunology	Theory	4
		B110402P	Enzymes and Immunological Techniques Lab	Practical	2
3	V	B110501T	Bioenergetics and Metabolism	Theory	4
		B110502T	Fundamentals of Microbiology	Theory	4
		B110503P	Microbial Techniques and Metabolism Lab	Practical	2
	VI	B110601T	Cell, Molecular Biology and Genetic Engineering	Theory	4
		B110602T	Biostatistics, Bioinformatics and computer application in Biochemistry	Theory	4
		B110603P	Genetic Engineering and Bioinformatics Lab	Practical	2

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Proposed Year wise Structure of UG Program in Biochemistry

Program/ Year	Sem.	Course code	Paper title	Credits	Teaching hours
Certificate course in clinical biochemistry	1	B110101T	Fundamentals of Biochemistry	4	60
		B110102P	Biosafety Measures, Preparation of Solutions and Qualitative Analysis of Biomolecules	2	60
	2	B110201T	Human Physiology and Clinical Biochemistry	4	60
		B110202P	Clinical Biochemistry Lab	2	60
Diploma in tools and techniques in biochemistry	3	B110301T	Tools and Techniques in Biochemistry	4	60
		B110302P	Biochemical Tools and Techniques Lab	2	60
	4	B110401T	Enzymology and Immunology	4	60
		B110402P	Enzymes and Immunological Techniques Lab	2	60
Degree in Bachelor of Science Biochemistry	5	B110501T	Bioenergetics and Metabolism	4	60
		B110502T	Fundamentals of Microbiology	4	60
		B110503P	Microbial Techniques and Metabolism Lab	2	60
	6	B110601T	Cell, Molecular Biology and Genetic Engineering	4	60
		B110602T	Biostatistics, Bioinformatics and computer application in Biochemistry	4	60
		B110603P	Genetic Engineering and Bioinformatics Lab	2	60

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Subject prerequisite

To study BIOCHEMISTRY at undergraduate, a student must have Chemistry, Biology and /or Biotechnology in Class 12.

Programme Objectives (POs)

1. The programme intends to develop a strong theoretical and practical background in various domains of biochemistry.
2. The programme includes details of biomolecules, clinical biochemistry, tools and techniques, enzymes, immunology, cell biology, molecular biology, genetic engineering, biostatistics, and bioinformatics to make the living system more interesting human studies, which is the need of the hour.
3. The practical courses will equip the students with laboratory skills in biochemistry. Students will be able to design and conduct experiments, as well as to analyze and interpret scientific data.
4. The programme will provide students with the knowledge and skill base that would enable them to undertake further studies in biochemistry and related areas or in multidisciplinary areas that involve biochemistry and help develop a range of generic skills that are relevant in enhancing entrepreneurship skills among students.
5. The students will be exposed to a wide range of careers that combine biology, plants, and medicine.

Certificate Course in Clinical Biochemistry

B.Sc. I Programme Specific Outcomes (PSOs)

PSO1	This course introduces fundamentals of structure and function of biomolecules. Students will be able to develop an understanding of: the inter relationships within and between anatomical and physiological systems of the human body.
PSO1	The students will develop the understanding of basic concepts of clinical biochemistry, they would be able to relate clinical disorders with metabolic processes.
PSO1	The students will learn the basic principles of biochemistry relevant to possibilities of employment and research. Stress will be rigorous learning of lab practices like accurate preparation of solutions, and buffers. The course is intended to develop a sound, fundamental understanding of Biomolecular testing.
PSO1	The students will have hands-on training on qualitative estimation of important which will help them in getting employment in pathology labs and contribute to health care system.
PSO1	This Certificate course will enable students to apply for technical positions in government and private labs, academic and research institutes.

Diploma in tools and techniques in biochemistry

B.Sc. II Programme based outcomes

PSO 1	Students will develop an understanding of: Principle, working, and applications of Biochemical tools & techniques to prepares them for independent execution of laboratory experiments using standard methods and techniques.
PSO 2	The objective of this course is to develop an understanding of the concepts of enzyme and enzyme kinetics.
PSO3	The students will develop an understanding of the basics of Immunology, types of Immune Responses, antigens and antibodies, histocompatibility, vaccines, and immunization. The students will develop a capability to function as paramedical staff during the current COVID crisis also.
PSO4	The course aims to develop an understanding of the concepts of enzyme dynamics. The students will also have understanding of basics of immunology, types of Blood grouping, cell counts, ELISA, Ouchterlony Double diffusion (ODD) and Separation of serum from blood & precipitation of Immunoglobulins
PSO5	The Diploma courses will ensure employability in Hospitals/Diagnostics and Pathology labs with good hands-on training. It will also enable students to take up higher studies and Research as their career and work in renowned national and international labs. Students can have their own start-ups as well.

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Degree in Bachelor of Science	
B.Sc III Programme Specific Outcomes (PSOs)	
PSO1	The student at the completion of the course will be able to have a detailed and conceptual understanding of molecular processes.
PSO2	The students will be able to understand and apply the principles and techniques of molecular biology which prepares students for further career in molecular biology. Independently execute a laboratory experiment using the standard methods and techniques.
PSO3	The principles of genetic engineering, gene cloning and related technologies will enable students to play an important role in applications of biotechnology in various fields like agriculture, forensic sciences, industry and human health and make a career out of it. Students can have their own start-ups as well.
PSO4	The basic tools of bioinformatics will enable students to analyze large amount of genomic data and its application to evolutionary biology. Apply knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics existing software effectively to extract information from large databases and to use this information in computer modeling.
PSO5	The Degree courses will enable students to go for higher studies like Masters and Ph.D in Biochemistry and Allied subjects.

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Programme/Class: Certificate	Year: First	Semester: First
Subject: Biochemistry		
Course Code: B110101 T	Course Title: Fundamental of Biochemistry	
Course outcomes: The student at the completion of the course will learn to understand: <ul style="list-style-type: none"> • Basic details of structure, function of carbohydrate molecules and its classification • Details of structure, function and classification of amino acid & structural levels of protein molecules • Structure and function of fatty acids, storage and structural lipids • Details of structure and Function of Nucleotide, DNA and RNA • Basic details of Vitamin molecules and its classification • Classification, structural features and Function of Plant & Animal Hormone 		
Credits: 4		Core Compulsory
Max. Marks: 25+75		Min. Passing Marks: As per rules
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		
Unit	Topics	No. of Lectures (60)
I	Basics of Biochemistry <ul style="list-style-type: none"> • History of biochemistry with special reference to contribution of Indian biochemists. • General idea about normality, molarity, molality, percentage solutions, mole fraction. W/v and v/v solutions. • Concept of pH determinations using indicators, buffer solutions and their biological importance. • Water as universal solvent 	5
II	Amino acids and proteins <ul style="list-style-type: none"> • Structural features and classification, Physical properties, optical properties (Stereoisomerism) • Chemical properties of amino acids • Uncommon amino acids and their function. • Classification of protein, structural organization as primary, secondary, tertiary and quaternary structure of protein and characteristics of the peptide bond 	10
III	Carbohydrate <ul style="list-style-type: none"> • Monosaccharides - structure of aldoses and ketoses, Ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers • Structure of biologically important sugar derivatives, oxidation and reduction of sugars • Formation of disaccharides, reducing and non-reducing disaccharide • Polysaccharides - homo- and heteropolysaccharides, structural and storage polysaccharides 	10

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IV	Lipids <ul style="list-style-type: none"> • Building blocks of lipids - fatty acids, glycerol, ceramide • Storage lipids - triacyl glycerol and waxes • Structural lipids in membranes - glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols • Plant steroids 	10
V	Nucleic acids <ul style="list-style-type: none"> • Nucleotides - structure and properties • Nucleic acid structure - Watson-Crick model of DNA • Structure of major species of RNA - mRNA, tRNA and rRNA • Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA • Other functions of nucleotides - source of energy, component of coenzymes, second messengers 	10
VI	Vitamins <ul style="list-style-type: none"> • Structure and active forms of water soluble and fatsoluble vitamins, • Deficiency diseases and symptoms, hypervitaminosis • Sources, dietary requirements 	5
VII	Plant Hormones <ul style="list-style-type: none"> • Classification, structural features & functions in Plants: • Auxins, gibberellins, Ceytokinins, ethylene, and abscisic acid 	5
VIII	Animal Hormones <ul style="list-style-type: none"> • Classification, structural features & Functions of hormones secreted by endocrine glands: Hypothalamus, pituitary gland- anterior pituitary and posterior pituitary, thyroid gland, adrenal gland, Pancreas, gonads 	5

Suggested readings

1. Lehninger, Albert, Cox, Michael M. Nelson, David L. (2017) *Lehninger principles of biochemistry*/ New York: W. H. Freeman.
2. Voet, D., & Voet, J. G. (2011). *Biochemistry*. New York: J. Wiley & Sons
3. *Biochemistry - Lubertstryer Freeman International Edition*.
4. *Biochemistry - Keshav Trehan Wiley Eastern Publications*
5. *Fundamentals of Biochemistry - J. L. Jain S. Chand and Company*
6. Voet & Voet: *Biochemistry Vols 1 & 2: Wiley (2004)*
7. Murray et al: *Harper's Illustrated Biochemistry: McGraw Hill (2003) Elliott and Elliott:*
8. *Biochemistry and Molecular Biology: Oxford University Press*
9. Taiz, L., Zeiger, E., *Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.*
10. Hopkins, W.G., Huner, N.P., *Introduction to Plant Physiology. John Wiley & Sons,*
11. *Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T. McGraw Hill International Publications, ISBN: 978-0-07-128366-3.*
12. *Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.*

A. D. S.

Course Books published in Hindi must be prescribed by the Universities and Colleges

Course prerequisites: To study this course, a student must have had the subject Biology/Biotechnology/Chemistry in class/12th/ certificate/diploma.

Suggested Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

Further Suggestions:**None**

At the End of the whole syllabus any remarks/ suggestions: None

None

Programme/Class: Certificate	Year: First	Semester: First
Subject: Biochemistry		
Course Code: B110102 P	Course Title: Biosafety Measures, Preparation of Solutions and Qualitative Analysis of Biomolecules	
Course outcomes: After the successful course completion, learners will develop following attributes <ul style="list-style-type: none"> • Preparation of various solutions • Preparation of Buffers • Perform Qualitative test of Biomolecules • Estimation of vitamin C • Perform spot test for amino acids in a given sample 		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks: As per rules	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4		
	Topics	Total No. of Lectures
I	<ul style="list-style-type: none"> • Safety measures in laboratories • Preparation of normal and molar solutions • Preparation of buffers • Determination of pKa of acetic acid and glycine • Qualitative tests for carbohydrates, lipids, amino acids, proteins and nucleic acids • Estimation of vitamin C • Perform spot test for amino acids in a given sample 	60
Suggested readings <ol style="list-style-type: none"> 1. Principles of Biochemistry- Albert L. Lehninger CBS Publishers & Distributors 2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4. 3. An Introduction to Practical Biochemistry, David T. Plummer (2006) Tata McGraw Hill Education, 3rd edition <p style="text-align: center;">Course Books published in Hindi must be prescribed by the Universities and Colleges</p>		
Course prerequisites: To study this course, a student must have had the subject Biology/Biotechnology/Chemistry in class/12 th / certificate/ diploma. The eligibility for this paper is 10+2 from Arts/ Commerce/ Science		
Suggested Continuous Evaluation Methods:		
Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks		
Further Suggestions: None		

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Programme/Class: Certificate	Year: First	Semester: Second
Subject: Biochemistry		
Course Code: B110201 T	Course Title: Human Physiology and Clinical Biochemistry	
Course outcomes-		
After the successful course completion, learners will develop following attributes		
<ul style="list-style-type: none"> • Develop an understanding of the inter relationships within and between anatomical and physiological systems of the human body. • Develop the understanding of basic concepts of clinical biochemistry. • To understand disorder related with bio molecules metabolism. • Anticoagulant preservatives for blood and urine. • Metabolism of bilirubin, jaundice - types, differential diagnosis and Liver function. 		
Credits: 4		Core Compulsory
Max. Marks: 25+75		Min. Passing Marks:
Total No. of Lectures (in hours per week):		
Unit	Topics	No. of Lectures (60)
I	Digestion and Respiration <ul style="list-style-type: none"> • Structural organization and functions of gastrointestinal tract and associated glands • Mechanical and chemical and enzymatic digestion of food, Absorptions of • carbohydrates, lipids, proteins, water, minerals and vitamins, • Mechanism of respiration, Pulmonary ventilation, Respiratory volumes and capacities, Transport of oxygen and carbon dioxide in blood Respiratory pigments, Dissociation curves and the factors influencing it, Control of respiration 	8
II	Circulation and Excretion <ul style="list-style-type: none"> • Components of blood and their functions Haemostasis: Blood clotting system, Blood groups: Rh factor, ABO and MN • Cardiac cycle, Cardiac output and its regulation, Electrocardiogram, Blood pressure and its regulation • Structure of kidney and its functional unit, Mechanism of urine formation 	8
III	Nervous System and Muscular System <ul style="list-style-type: none"> • Structure of neuron, and physiology of nerve impulse transmission • Histology of different types of muscle, Ultra structure of skeletal muscle • Molecular and chemical basis of muscle contraction • Control of muscle contraction by nerve impulses 	8

R. O. S.

IV	Basic concepts of Clinical Biochemistry <ul style="list-style-type: none"> • A Brief review of units and abbreviations used in expressing concentrations and standard solutions • Specimen collection and processing (Blood, urine, feces) • Anticoagulant and preservatives for blood and urine samples • Transport of specimens 	8
V	Hematology: Blood <ul style="list-style-type: none"> • Composition and functions of various components, • Anemia:- classifications, erythrocyte indices • Blood coagulation system, Clotting time, Bleeding time, Prothrombin time, RBC count, WBC count, Platelet count, Differential count • determination of Hb, PCV and ESR. Hemoglobinopathies, Thalassemia 	8
VI	Disorders of Carbohydrate metabolism <ul style="list-style-type: none"> • Regulation of blood sugar • Glycosuria-types of Glycosuria • Oral glucose tolerance test in normal and diabetic condition • Diabetes mellitus and Diabetic insipidus - hypoglycemia, hyperglycemia. Ketonuria, ketosis 	4
VII	Disorders of Lipid metabolism <ul style="list-style-type: none"> • Cholesterol: Factors affecting blood cholesterol level • Dyslipoproteinemia, atherosclerosis risk factor and fatty liver. • Involvement of enzymes in diagnostics of heart disease including aspartate transaminase, isoenzymes of creatine kinase and lactate dehydrogenase and troponin 	4
VIII	Liver function test <ul style="list-style-type: none"> • Types, differential diagnosis • Liver function test - Icteric index, Vandenberg test, plasma protein changes. Renal function test: Clearance test-Urea, Creatinine • Para- aminohippuric acid (PAH) test, Concentration and dilution test. Enzymology: Clinical significance of SGOT, SGPT, ALP, ACP, CPK and LDH 	8
Suggested readings <ol style="list-style-type: none"> 1. Textbook of Medical Physiology by Guyton. A.C., H. Sanders Philadelphia. 1988. 2. Physiological basis of Medical practice, West J.B., Best and Taylor. 3. Introduction to Physiology by Davidson H and Segal M.B. Academic Press. 4. Sherwood L - Human Pysiology: From Cells to Systems, (Wadsworth Publishing, 2000,ISBN: 0534568262) 5. Tortora G J Principles of Anatomy & Physiology, (John Wiley & Sons, 1999, ISBN: 0471366927) 6. Medical Biochemistry by MN Chatterjee, Rana Shinde, 8 edition, 2013, Jaypee publications. 7. Textbook of Medical Laboratory Technology by Praful B. Godkar and Darshan P. Godkarth 8. Medical Laboratory Technology by Ramniksood, 5 Edition, 1999, Jaypee publishers. 9. Text book of Biochemistry with clinical correlation, Thomas M. Devlin, 3rd edition, A. JohnWiley-Liss Inc. Publication. 10. Practical Clinical Biochemistry, Harold Varley, 4th edition, CBS Publication and Distributors, New Delhi. <p>Course Books published in Hindi must be prescribed by the Universities and Colleges</p>		

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Course prerequisites: To study this course, a student must have had the subject Biology/Biotechnology/Chemistry in class/12th/ certificate/diploma.

Suggested Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Qui

Programme/Class: certificate	Year: First	Semester: Second
Subject: Biochemistry		
Course Code: B110201 T	Course Title: Clinical Biochemistry Lab	
Course outcomes-		
<ul style="list-style-type: none"> • To learn qualitative and quantitative analysis of constituents of biological fluids such as urine, blood and their estimation using standard methods. • Students will able to Perform basic hematological laboratory testing 		
Credits: 4	Core Compulsory	
Max. Marks: 25+75 Min.	Passing Marks: As per rules	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4		
UNIT	Topic	Total No.of Lectures
	<ul style="list-style-type: none"> • Qualitative and quantitative analysis of urine : proteins, Bence-Jones proteins, Cl⁻ , Ca⁺² • Qualitative analysis of abnormal constituents in urine - glucose, albumin, bile pigments, bile salts and ketone bodies. • Experiments on blood (a) Estimation of haemoglobin by cyanmethemoglobin method (b) Determination of A/G ratio in serum • Isolation and estimation of serum cholesterol • Serum enzyme assays: alkaline phosphatase, SGOT, SGPT • Estimation of haemoglobin using Sahli's haemoglobinometer • Recording of blood pressure using a sphygmomanometer • Recording of blood glucose level by using glucometer • Ninhydrin test for N-amino acids. • Test for sugar and acetone in urine. 	60
Suggested Readings:		
<ol style="list-style-type: none"> 1. Medical Biochemistry by MN Chatterjee, Rana Shinde, 8 edition, 2013, Jaypee publications. 2. Textbook of Medical Laboratory Technology by Praful B. Godkar and Darshan P. Godkarth 3. Medical Laboratory Technology by Ramniksood, 5 Edition, 1999, Jaypee publishers. 4. Text book of Biochemistry with clinical correlation, Thomas M. Devlin, 3rd edition, A. JohnWiley-Liss Inc. Publication. 5. Practical Clinical Biochemistry, Harold Varley, 4th edition, CBS Publication and Distributors, New Delhi. 		
Course Books published in Hindi must be prescribed by the Universities and Colleges		
Suggested Continuous Evaluation Methods:		
Total Marks: 25		
House Examination/Test: 10 Marks		
Written Assignment/Presentation/Project/ Research Orientation/ Term Papers/Seminar: 10 Marks		
Class performance/Participation: 5 Marks		
Further Suggestions: None		

At the End of the whole syllabus any remarks/ suggestions: None

Quin

Programme/Class: DIPLOMA	Year: SECOND	Semester: THIRD
Subject: Biochemistry		
Course Code: B110301 T	Course Title: Tools and Technique in Biochemistry	
Course outcomes:		
<ul style="list-style-type: none"> The objective of the course is to introduce various techniques to the students, which are used in biological research. Students will acquire knowledge about the principles and applications of spectrophotometric and chromatography techniques used in a biochemistry lab. Students will learn about the principle and application of electrophoresis, centrifugation techniques, microscopic and molecular biological techniques. 		
Credits: 4		Core Compulsory
Max. Marks: 25+75		Min. Passing Marks:
Total No. of Lectures (in hours per week): L-T-P: 4-0-0		
Unit	Topics	No. of Lectures (60)
I	Basics of Biophysics <ul style="list-style-type: none"> Chemical bonding – Ionic bond, covalent bond, hydrogen bond and Vander-Waals force. 	4
II	Chromatography <ul style="list-style-type: none"> Introduction & Principle of Chromatography Paper, thin-layer, column, HPLC, GLC and molecular sieving,, Ion exchange chromatography Affinity Chromatography 	8
III	Centrifugation <ul style="list-style-type: none"> Principle of centrifugation Basic rules of sedimentation, sedimentation coefficient. Various types of centrifuges, low speed centrifuge, high speed centrifuge and ultracentrifuge, types of rotors. Application of centrifugation, differential centrifugation, density gradient centrifugation-zonal and isopycnic. 	8
IV	Electrophoresis: <ul style="list-style-type: none"> Basic Principle of electrophoresis, Gel electrophoresis, PAGE, SDS-PAGE, Native gels, denaturing gels Agarose gel electrophoresis, 	8
VI	Microscopy <ul style="list-style-type: none"> Principle of light microscopy, Phase contrast microscopy Fluorescence microscopy Electron microscopy Permanent and temporary slide preparation, histology and staining. 	8
VII	Radioactivity <ul style="list-style-type: none"> Types, their importance in biological studies Measure of radioactivity GM counters and Scintillation counting. 	4

VIII	Fundamental principles and basics of instrument design of: <ul style="list-style-type: none"> • UV-Visible spectrophotometry and Beer-Lambert law • Fluorescence techniques • Infra-Red and Raman spectrometry • Circular Dichroism and Optical Rotatory dispersion • Nuclear Magnetic Resonance spectrometry • Atomic absorption and emission spectrometry • X Ray diffraction • Mass spectrometry • 	8
Suggested readings <ol style="list-style-type: none"> 1. Boyer, R.F., Biochemistry Laboratory: Modern Theory and Techniques, 6th ed., Boston, Mass: Prentice Hall, 2012, 2. Plummer D. T., An Introduction to Practical Biochemistry 3rd ed., Tata McGraw Hill Education Pvt. Ltd. 2006. 3. Wilson K. and Walker J., Principles and Techniques of Biochemistry and Molecular Biology, 7th ed., Cambridge University Press, 2010 4. Rastogi & Pathak, Genetic Engineering, Oxford University Press, 2009 <p style="text-align: center;">Course Books published in Hindi must be prescribed by the Universities and Colleges.</p>		
This course can be opted as an elective by the students of following subjects: The eligibility for this paper is 10+2 with Biology/Biotechnology/Chemistry as one of the subject		
Suggested Continuous Evaluation Methods: House Examination/Test: 10 Marks Written Assignment/Presentation/Project/Research Orientation / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks		
Further Suggestions: None		

At the End of the whole syllabus any remarks/ suggestions: None

R. Q. S.

Programme/Class: DIPLOMA		Year: SECOND	Semester: THIRD
Course Code: B110201 T		Course Title: Biochemical Tools and Techniques Lab	
Course outcomes- It will also give them an opportunity to get hands on experience to develop their experimental skills expected from any biochemist working in a pathology/diagnostic/research lab.			
Credits: 4	Core Compulsory		
Max. Marks: 25+75 Min.	Passing Marks: As per rules		
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4			
UNIT	Topic	Total No. of Lectures	
	<ul style="list-style-type: none"> • Verification of Beer's Law • Estimation of proteins by Biuret/Lowry method • Separation of amino acid acids by TLC/paper chromatography • To perform agarose gel electrophoresis • To isolate mitochondria by differential centrifugation • Visualization of cells by methylene blue • SDS PAGE 	60	
Suggested Readings:			
<ol style="list-style-type: none"> 1. Narayanan, P (2000) Essentials of Biophysics, New Age Int. Pub. New Delhi. 2. Roy R.N. (1999) A Text Book of Biophysics New Central Book Agency. 3. Plummer D. T., An Introduction to Practical Biochemistry 3rd ed., Tata McGraw Hill Education Pvt. Ltd. 1998, 4. Wilson K. and Walker J., Principles and Techniques of Biochemistry and Molecular Biology, 7th ed., Cambridge University Press, 2010 			
Course Books published in Hindi must be prescribed by the Universities and Colleges			
This course can be opted as an elective by the students of following subjects: The eligibility for this paper is 10+2 with Biology/Biotechnology/Chemistry as one of the subject			
Suggested Continuous Evaluation Methods:			
Total Marks: 25			
House Examination/Test: 10 Marks			
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks			
Class performance/Participation: 5 Marks			
Further Suggestions: None			

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Programme/Class: DIPLOMA	Year: SECOND	Semester: FOURTH
Subject: Biochemistry		
Course Code: B110301 T	Course Title: Enzymes and Immunology	
Course outcomes: <ul style="list-style-type: none"> The objective of the course is to provide detailed knowledge about enzymes, the biological catalysts with remarkable properties that sustain life. Students will learn the nature and importance of enzymes in living systems Students will gain insight into the thermodynamic and molecular basis of catalysis by enzymes and the underlying basis of their specificity Students will learn about the mechanisms of enzyme action, kinetics of enzyme catalyzed reactions and clinical importance of enzyme inhibitors Students will also learn to appreciate how enzymes are regulated and the physiological importance of enzyme regulation in the cell Students will develop the understanding of basics of Immunology, types of Immune Responses, antigens and antibodies, histocompatibility, vaccines and immunization 		
Credits: 4		Core Compulsory
Max. Marks: 25+75		Min. Passing Marks:
Total No. of Lectures (in hours per week): L-T-P: 4-0-0		
Unit	Topics	No. of Lectures (60)
I	Introduction to enzymes <ul style="list-style-type: none"> General characteristics of enzymes Co-factor and prosthetic group, apoenzyme, holoenzyme. Classification and nomenclature of enzymes. Enzyme assays- Enzyme activity, specific activity, units to express enzyme activity. Features of enzyme catalysis Catalytic power and specificity of enzymes (concept of active site), Fischer's lock and key hypothesis Koshland's induced fit hypothesis. 	8
II	Enzyme kinetics <ul style="list-style-type: none"> Relationship between initial velocity and substrate concentration Michaelis-Menten equation Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot Determination of K_m and V_{max}, K_{cat}, specificity constant Effect of pH and temperature on the activity of enzymes. 	8
III	Enzyme inhibition and Regulation <ul style="list-style-type: none"> Reversible inhibition (competitive, uncompetitive, non-competitive and mixed) 	8

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	<ul style="list-style-type: none"> • Irreversible inhibition • Substrate inhibition • Allosteric regulation and feedback inhibition (ATPase) • Isoenzymes • Enzyme immobilization and its applications 	
IV	<p>Introduction of Immunology</p> <ul style="list-style-type: none"> • Types of Immunity: Passive, Active, Innate and Acquired immunity, Humoral and Cell Mediated Immunity • Antigens: haptens, epitopes and Factors influencing immunogenicity • Antibodies: Structure, types, production and functions of immunoglobulins Clonal selection theory. • Antigen Antibody reaction: Precipitation, Immunoelectrophoresis, Haem-agglutination, RIA and ELISA. • Cell and organs of immune responses and their functions • B & T cells • factors responsible for immunogenicity • Monoclonal antibodies production and applications 	8
VI	<p>Histocompatibility</p> <ul style="list-style-type: none"> • Structure of MHC class I, II & III antigens and their mode of antigen presentation • MHC restriction, • Complement system: Components, Classical and alternate pathways of complement activation • Hypersensitivity • Autoimmunity. 	8
VII	<p>Vaccines and Immunization</p> <ul style="list-style-type: none"> • Passive and Active immunization • Types of Vaccines: Inactivated, Attenuated, Recombinant and Vaccines • Peptide and DNA Vaccines • RNA Vaccines 	4
VIII	<p>Transplantation immunology</p> <ul style="list-style-type: none"> • Immunological basis of graft rejection 	4

- Clinical manifestations
- Immunosuppressive therapy and privileged sites

Suggested readings

1. Lehninger, AL "Principles of Biochemistry".
2. Lubert Stryer "Biochemistry".
3. Voet & Voet "Biochemistry".
4. Alan Fersht "Enzyme Structure and Mechanism".
5. David S. Sigman, Paul S. Sigman "The Enzymes: Mechanisms of Catalysis".
6. Trevor Palmer and Philip Bonner 2008 Enzymes Biochemistry, Biotechnology, Clinical Chemistry, 2nd edn EWP
7. Gerhart W 2003 Enzymes in Industry Production and Applications, Wiley VCH
8. Wilson, K and Walker, J. (eds 2000 Principles and Techniques of
9. Practical Biochemistry, 5th edn Cambridge University Press Palmer "Enzymes"
10. Dixon & Webb "Enzymes"
11. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York)
12. William, E. Paul (1989) Fundamental Immunology, 2nd Edition Raven Press, New York.
13. William, R. Clark (1991) The Experimental Foundations of Modern Immunology (4th Edition) John Wiley and Sons, New York.
14. Basic Immunology, A.K. Abbas and A.H. Lichtman, Saunders W.B. Company
15. Fundamentals of Immunology, W. Paul, Lippincott Williams and Wilkins
16. Immunology, W.L. Anderson, Fence Creek Publishing (Blackwell).

Course Books published in Hindi must be prescribed by the Universities and Colleges.

This course can be opted as an elective by the students of following subjects:

The eligibility for this paper is 10+2 with Biology/Biotechnology/Chemistry as one of the subject.

Suggested Continuous Evaluation Methods:

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project/Research Orientation / Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

Further Suggestions: None

PO

Programme/Class: DIPLOMA		Year: SECOND	Semester: FOURTH
Course Code: B110402P T		Course Title: Enzymes and Immunological Techniques Lab	
Course outcomes- After the successful course completion, learners will develop following attributes: <ul style="list-style-type: none"> • Know how to isolate enzyme and determine enzyme activity. • Know how to study the effect of pH and temperature on the enzyme activity. • Know how to study the effect of varying substrate and inhibitor concentration on the enzyme activity • Know how to detect Amino acids by Paper chromatography and TLC • This course aims to develop the understanding of basics of immunology, types of Blood grouping, cell counts, ELISA, Ouchterlony Double diffusion (ODD) and Separation of serum from blood & precipitation of Immunoglobulins • It will also give them an opportunity to get hands on experience to develop their experimental skills expected from any biochemist working in a pathology/ diagnostic/ research lab. 			
Credits: 4	Core Compulsory		
Max. Marks: 25+75Min.	Passing Marks: As per rules		
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4			
UNIT	Topic	Total No.of Lectures	
	<ul style="list-style-type: none"> • Isolation of enzyme and determination of enzyme activity • Study of the effect of pH on the enzyme activity. • Study of the effect of varying substrate concentration on the enzyme activity and determination of Km and Vmax. • Study of the effect of temperature on the enzyme activity. • Study of the effect of inhibitors on the enzyme activity. • Blood grouping • Differential Count of WBC • Detergent lysis of RBC • Dot ELISA • ELISA - Demonstration • Ouchterlony Double diffusion (ODD) • Separation of serum from blood & precipitation of Immunoglobulins 	60	
Suggested Readings: <ol style="list-style-type: none"> 1. Clark & Switzer. Experimental Biochemistry. Freeman (2000) 2. Trevor Palmer and Philip Bonner 2008 Enzymes Biochemistry, Biotechnology, Clinical Chemistry, 2nd edn EWP 3. Wilson, K and Walker, J ..(eds 2000 Principles and Techniques of Practical Biochemistry, 5th edn Cambridge University Press 4. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York) 5. William, E. Paul (1989) Fundamental Immunology, 2nd Edition Raven Press, New York. 6. William, R. Clark (1991) the Experimental Foundations of Modern Immunology (4th Edition) John Wiley and Sons, New York. 7. Basic Immunology, A.K. Abbas and A.H. Lichtman, Saunders W.B. Company 			
<p align="center">Course Books published in Hindi must be prescribed by the Universities and Colleges</p>			
This course can be opted as an elective by the students of following subjects: The eligibility for this paper is 10+2 with Biology/Biotechnology/Chemistry as one of the subject			
Suggested Continuous Evaluation Methods: Total Marks: 25 House Examination/Test: 10 Marks			

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Further Suggestions: None

Qu

Programme/Class: DEGREE	Year: THIRD	Semester: FIFTH
Subject: Biochemistry		
Course Code: B110501 T	Course Title Bioenergetics and Metabolism	
Course outcomes: The learners will be able to: <ul style="list-style-type: none"> • Understand the concepts of metabolism, characteristics of metabolic pathways and strategies used to study these pathways. • Gain a detailed knowledge of various catabolic and anabolic pathways • Understand the regulation of various pathways • Gain knowledge about the diseases caused by defects in metabolism with emphasis on the metabolic control 		
Credits: 4		Core Compulsory
Max. Marks: 25+75		Min. Passing Marks:
Total No. of Lectures (in hours per week):		
Unit	Topics	No. of Lectures
I	Principle of Bioenergetics: <ul style="list-style-type: none"> • Bioenergetics and thermodynamics, • Laws of Thermodynamics • Gibbs free energy, enthalpy • Entropy and their relationships • Free energy change • ATP as universal currency in biological system • Coenzymes and proteins as universal electron carriers 	60
II	Oxidative phosphorylation <ul style="list-style-type: none"> • The electron transport chain - its organization and function • Peter Mitchell's chemiosmotic hypothesis and Proton motive force • FoF₁ATP synthase, structure and mechanism of ATP synthesis • Metabolite transporters in mitochondria • Regulation of oxidative phosphorylation • ROS production and antioxidant mechanisms • Oxidative phosphorylation and ATP synthesis uncouplers 	4
III	Carbohydrate Metabolism: <ul style="list-style-type: none"> • Glycolysis • TCA cycle • Electron Transport Chain • Pentose phosphate pathway • Gluconeogenesis and Glycogen metabolism • Diseases associated with metabolic irregularities. 	8

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IV	Photosynthesis <ul style="list-style-type: none"> • Light harvesting and photosynthetic electron transport • Water splitting, formation of H⁺ gradient and photophosphorylation • Calvin cycle, and its regulation • Photo respiration • C4 and CAM pathways in plants 	8
V	Lipid Metabolism: <ul style="list-style-type: none"> • Degradation of fatty acids • β oxidation • regulation of fatty acid oxidation • ω oxidation and α oxidation • Ketone-body metabolism • Cholesterol synthesis • Fatty acid synthase complex enzyme • Synthesis of saturated, unsaturated, odd and even chain fatty acids • Regulation of fatty acid metabolism • Diseases associated with abnormal lipid metabolism 	8
VI	Protein Metabolism <ul style="list-style-type: none"> • Urea Cycle • Transport of ammonia • Deamination and transamination reactions • Inborn errors of protein metabolism • Glucogenic and ketogenic amino acids • Overview of amino acid synthesis 	8
VII	Nucleic Acid Metabolism <ul style="list-style-type: none"> • De novo synthesis of purine and pyrimidine nucleotides • regulation and salvage pathways • degradation of purine and pyrimidine nucleotides • Inhibitors of nucleotide metabolism • Disorders of purine and pyrimidine metabolism 	8
VIII	Nitrogen metabolism <ul style="list-style-type: none"> • Biological nitrogen fixation by free living and in symbiotic association Structure and function of the enzyme nitrogenase • Nitrate assimilation: Nitrate and Nitrite reductase • Primary and secondary ammonia assimilation in plants • ammonia assimilation by glutamine synthetase-glutamine oxoglutarate amino transferase (GS-GOGAT) pathway 	8

Suggested readings

1. Lehninger, Albert, Cox, Michael M. Nelson, David L. (2017) *Lehninger principles of biochemistry/*

<p>New York: W.H. Freeman.</p> <ol style="list-style-type: none"> 2. Voet, D., & Voet, J.G. (2011). Biochemistry. New York: J. Wiley & Sons 3. Biochemistry - Lubertstryer Freeman International Edition. 4. Biochemistry - Keshav Trehan Wiley Eastern Publications 5. Fundamentals of Biochemistry - J.L. Jain S. Chand and Company 6. Voet & Voet: Biochemistry Vols 1 & 2: Wiley (2004) 7. Murray et al: Harper's Illustrated Biochemistry: McGraw Hill (2003) Elliott and Elliott: 8. Biochemistry and Molecular Biology: Oxford University Press 9. Taiz, L., Zeiger, E., Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition. 10. Hopkins, W.G., Huner, N.P., Introduction to Plant Physiology. John Wiley & Sons,
<p>This course can be opted as an elective by the students of following subjects: The eligibility for this paper is 10+2 with Biology/Biotechnology/Chemistry as one of the subject</p>
<p style="text-align: center;">Suggested Continuous Evaluation Methods:</p> <p>Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks</p>
<p>Further Suggestions: None</p>

Devi

Programme/Class: DEGREE	Year: THIRD	Semester: FIFTH
Subject: Biochemistry		
Course Code: B110502 T	Course Title Fundamentals of Microbiology	
Course outcomes: After the successful course completion, learners will develop following attributes		
<ul style="list-style-type: none"> • Know the basics of microbiology • Have knowledge of the general classification of microbes • understand basics of Control of Microorganisms • Study microbes in extreme environments and microbial interactions • Know the basics of recombination in Prokaryotes • Food & Industrial Microbiology • Basics of virology 		
Credits: 4		Core Compulsory
Max. Marks: 25+75		Min. Passing Marks:
Total No. of Lectures (in hours per week):		
Unit	Topics	No. of Lectures (60)
I	History of Microbiology <ul style="list-style-type: none"> • Spontaneous generation versus biogenesis • Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Alexander Fleming • Various forms of microorganisms (bacteria, fungi, viruses, protozoa, PPOs) 	4
II	Classification of microbiology <ul style="list-style-type: none"> • Nutritional classification of microorganisms • Nature of the microbial cell surface • Gram positive and Gram negative bacteria • Growth curve 	8
III	Control of Microorganisms <ul style="list-style-type: none"> • Physical agents (Autoclave, Hot air oven, Laminar airflow and membrane filter.) • Chemical agents (Alcohol, Halogens and Gaseous agents antibiotics), Radiation Methods (UV rays) 	8
IV	Pathogenicity of Microorganisms and Antimicrobial Chemotherapy <ul style="list-style-type: none"> • Introduction to pathogenic microbes, Bacteria, Viruses, Algae, protozoa and fungi • General Characteristics of antimicrobial drugs • determining the level of microbial activity • dilution susceptibility test and disc diffusion test • Range of activity and mechanism of action of penicillin, vancomycin and tetracycline. 	8
V	Microbes in extreme environments and microbial interactions <ul style="list-style-type: none"> • The thermophiles alkalophiles, acidophiles • symbiosis and antibiosis among microbial population • N₂ fixing microbes in agriculture and forestry. 	8

R. D. D.

VI	Recombination in Prokaryotes <ul style="list-style-type: none"> Transformation Conjugation Transduction 	4
VII	Food and Industrial Microbiology <ul style="list-style-type: none"> Importance of microbiology in food and industries Basic design of fermenter Continuous and discontinuous culture Preparation of fermented food products such as yoghurt, curd and cheese. Preparation of alcoholic beverages like wine and beer Single cell proteins Treatment of wastewater and sewage bBioremediation and biodegradation 	8
VIII	Brief outline of virology <ul style="list-style-type: none"> Discovery of virus Early development of virology nomenclature classification and taxonomy of viruses - based on host, nucleic acids and structure Evolution of viruses 	8
Suggested readings <ul style="list-style-type: none"> Brock Biology of Microorganisms 11th edition and Brock Biology of Microorganisms ILLUSTRATIONS ISBN 0-13-196893-9 © Prentice Hall MICROBIOLOGY - AN INTRODUCTION, 8th edition Gerard J. Tortora, Bergen Community College by Berdell R. Funke, North Dakota State University Christine L. Case, Skyline College ©2004 Pearson J. Willey, L. Sherwood & C. Woolverton, Prescott's Microbiology, 10th Ed., McGraw Hill international, (2017). ISBN 13: 9781259657573 2. MJ Chan, ECS Krieg & NR Pelczar, Microbiology, 5th Ed. McGraw Hill International, (2004) 		
Course prerequisites: To study this course, a student must have had the subject Biology/Biotechnology in class/12 th / certificate/diploma.		
Suggested Continuous Evaluation Methods:		
Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project/ Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks		
Further Suggestions: None		

At the End of the whole syllabus any remarks/ suggestions: None

Q

Programme/Class: DIGREE		Year: THIRD	Semester: FIFTH
Course Code: B110503P T	Course Title: Microbial Techniques and Metabolism Lab		
Course outcomes <ul style="list-style-type: none"> • On successful completion of this paper, students should be able to: • Perform enzyme assay • Identify different microbes • Perform routine microbiological practices including sterilization, media preparation, maintenance of microbial culture, staining etc. • To carry out research using microbes. • To test microbial culture for antibiotic resistance. 			
Credits: 4	Core Compulsory		
Max. Marks: 25+75Min.	Passing Marks: As per rules		
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4			
UNIT	Topic	Total No. of Lectures	
	<ul style="list-style-type: none"> • Enzyme assay (one example) • Biochemical tests–starch hydrolysis, gelatin liquefaction. • Assay of salivary amylase. • Cholesterol estimation. • Cleaning and sterilization of glassware. • Study of instruments: Compound microscope, Autoclave, Hot air oven, pH meter, Laminar airflow and centrifuge • Media preparation: Nutrients agar, Nutrient broth and LB. • Staining Techniques: Simple, Negative staining, Gram staining, Endospore staining, fungal staining. • Isolation of bacteria and fungi from soil/ air/ water - dilution and pour plate methods • Study of Rhizobium from root nodules of legumes • Growth curve of bacteria 	60	
Suggested Readings: <ul style="list-style-type: none"> • Wilson, K and Walker, J ..(eds 2000 Principles and Techniques of Practical Biochemistry, 5th edn Cambridge University Press • M.T. Madigan, J.M. Martinko & D.A. Stahl, Brock Biology of Microorganisms, 13th Ed., Pearson Education International. (2010) • J.G. Cappuccino, and N. Sherman, Microbiology: A Laboratory manual, 10th Ed. Benjamin/Cummings (2013) 			
Course Books published in Hindi must be prescribed by the Universities and Colleges			
This course can be opted as an elective by the students of following subjects: The eligibility for this paper is 10+2 with Biology/Biotechnology/Chemistry as one of the subject			
Suggested Continuous Evaluation Methods: Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project/ Research Orientation/ Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks			
Further Suggestions: None			

A. Qureshi

Programme/Class: DEGREE	Year: THIRD	Semester: SIXTH
Subject: Biochemistry		
Course Code: B110601 T	Course Title: Cell, Molecular Biology and Genetic Engineering	
Course outcomes: After the successful course completion, learners will develop following attributes:		
<ul style="list-style-type: none"> • Distinguish between the cellular organization of prokaryotic and eukaryotic cells • Would have deeper understanding of cell at structural and functional level. • Will able to understand details of central dogma of life • Get proper knowledge about the DNA manipulative enzymes: Restriction enzymes and DNA ligases, and Gene cloning vectors. • Gain knowledge about In vitro construction of recombinant DNA molecules vector DNA • learn about screening and selection of recombinant host cells, Gene Libraries, cloning techniques, Expression of cloned DNA • Have knowledge of Application of r-DNA technique in human health and quality crop production 		
Credits: 4		Core Compulsory
Max. Marks: 25+75		Min. Passing Marks:
Total No. of Lectures (in hours per week):		
Unit	Topics	Total no. of Lectures (60)
I	Cell Biology: <ul style="list-style-type: none"> • Intracellular organization: • Cell Membrane, Fluid Mosaic Model, and membrane transport. • Structure and functions of organelles, • Prokaryotic and eukaryotic cell wall, • Cell cycle, cell death and cell renewal: • Eukaryotic cell cycle, restriction point, and checkpoints. • Cell division: Mitosis and Meiosis. • Apoptosis and necrosis 	4
II	<ul style="list-style-type: none"> • Fundamental principles of cell signalling. Concept of signalling as a two-box system • G-Protein and Receptor Tyrosine Kinase mediated signalling • Elements of eukaryotic cytoskeleton. Organisation and dynamics of actin microfilaments and microtubules • Endomembrane system, secretory pathways and vesicular trafficking 	8

Qui

III	Basics of Molecular Biology: <ul style="list-style-type: none"> • Central dogma of Life • Organization of Genetic Material, • DNA Replication • Prokaryotic- Enzymes and proteins involved in replication • Spontaneous and induced mutations, • Physical and chemical mutagens, • Mutation at the molecular level, • DNA damage & Repair • Mutations in plants, animals, and microbes for economic benefit of man. 	10
IV	Transcription: <ul style="list-style-type: none"> • Transcription in prokaryotes, • Mechanism, Promoters • RNA polymerase • Transcription factors 	8
V	Translation: <ul style="list-style-type: none"> • Genetic code, • Properties and Wobble hypothesis. • Translation: Mechanism of translation in Prokaryotes • Regulation of Gene expression: • Regulation of Gene expression in Prokaryotes: • Operon concept (Lac) 	8
VI	Recombinant DNA Technology: <ul style="list-style-type: none"> • DNA manipulative enzymes • Restriction enzymes and DNA ligases, • Gene cloning vectors: Plasmids, Bacteriophage and Chimeric plasmids, • Creation of r-DNA, • Transformation of r-DNA by different methods, • Screening and selection of recombinant host cells, • Gene Libraries: Genomic DNA and cDNA cloning techniques 	8
VII	Applications of r-DNA technique in human health <ul style="list-style-type: none"> • Production of Insulin, • Production of recombinant vaccines: Hepatitis B, • Production of human growth hormone 	6

Ques

VIII	Transgenic plants <ul style="list-style-type: none"> • Methods of plant transformation • Agrobacterium mediated plant transformation • Application of plant genetic engineering: • Insect resistance, • Disease resistance, • Herbicide resistance • Abiotic stress tolerance • Delayed fruit ripening 	8
Suggested readings <ol style="list-style-type: none"> 1. Lehninger, Albert L., Cox, Michael M. Nelson, David L. (2017) <i>Lehninger principles of biochemistry</i> /New York : W.H. Freeman 2. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. M. (2013). <i>Molecular biology of the gene.</i> 3. Voet, D., & Voet, J. G. (2011). <i>Biochemistry</i>. New York: J. Wiley & Sons. 4. Ulrich Hubscher, Giovanni Maga, and Silvio Spadari (2007), <i>Eukaryotic dna polymerases</i> <i>Annu. Rev. Biochem.</i> 2002. 71:133-63 DOI:10.1146/annurev.biochem.71.090501.150041. 5. Smita Rastogi and Neelam Pathak (2009), <i>Genetic Engineering</i>, Oxford University Press. 6. <i>Gene Cloning and DNA Analysis</i> (2010) 6th ed., Brown, T.A., Wiley-Blackwell publishing (Oxford, <i>Principles of Gene Manipulation and Genomics</i> (2006) 7th ed., Primrose, S.B., and Twyman, R. M., Blackwell publishing (Oxford, UK) 7. <i>Molecular Biotechnology: Principles and Applications of Recombinant DNA</i> (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), 8. <i>Molecular Cloning: A laboratory manual</i> (2014), 4th ed., Michael R Green and J. Sambrook Cold spring Harbor laboratory press (3vol.), ISBN: 978-1-936113-42-2 		
Course prerequisites: To study this course, a student must have had the subject Biology/Biotechnology/Chemistry in class/12 th /certificate/diploma.		
Suggested Continuous Evaluation Methods:		
Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks		
Further Suggestions: None		

At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: DEGREE	Year: THIRD	Semester: SIXTH
Subject: Biochemistry		
Course Code: B110602 T	Course Title: Biostatistics, Bioinformatics and computer application in Biochemistry	
Course outcomes: After the successful course completion, learners will develop following attributes: <ul style="list-style-type: none"> • Understand the principles of biological data collection, statistical analysis and presentation. • Learn and appreciate various factors that influence type of sample collected and sample size. • Collect, analyze and interpret biological data using appropriate statistical tools • Improve their computational, mathematical and computer skills, which would increase their eligibility to pursue research based higher education. • Formulate and justify appropriate choices in technology, strategy, and analysis for a range of projects involving DNA, RNA, or protein sequence data. • Explain common methods and applications for analysis of gene or protein expression. • Use data visualization software to effectively communicate results. 		
Credits: 4		Core Compulsory
Max. Marks: 25+75		Min. Passing Marks:
Total No. of Lectures (in hours per week):		
Unit	Topics	No. of Lectures (60)
I	Handling of data <ul style="list-style-type: none"> • Tabulation and diagrammatic representation of data • Bar diagram and pie diagram. • Measures of central tendency: mean, median and mode. • Measures of dispersion: range, quartile deviation, mean deviation and standard deviation. • Coefficient of variation. 	4
II	Tests of significance: <ul style="list-style-type: none"> • Null hypothesis and alternative hypothesis, • Z-test, • Student's distribution, • Paired t – test, • F-test for equality of population variances. • Contingency table, • Chi-square test for goodness of fit and independence of attributes, Correlation analysis 	8
III	<ul style="list-style-type: none"> • Molecular Techniques • DNA sequencing, Polymerase Chain Reaction (PCR) • Primer designing, DNA fingerprinting, site directed mutagenesis, RFLP, RAPD • Southern, Northern and Western Blotting 	4

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IV	Basics of Computer and Bioinformatics <ul style="list-style-type: none"> • Operating systems • Hardware, Software, • DOS, Data Access Using Data Control • Internet, LAN, WAN, Web servers. • MS word office, excel ,powerpoint • Definition and need of Bioinformatics, • Brief history of biological databases • International nucleotide databases (e.g., Gen Bank, European Molecular Biology Laboratory (EMBL) • Bio information and DNA Data Bank of Japan (DDBJ) Center) • International Nucleotide Sequence Database Collaboration (INSDC). 	8
V	Protein Databases <ul style="list-style-type: none"> • Classification of protein databases (e.g., primary, secondary, and composite databases) • Brief overview of ExPASy (Expert Protein Analysis System) bioinformatics resource portal • Protein 3D structural databases (e.g., RCSB-PDB (Research Collaboratory for Structural Bioinformatics Protein Data Bank), and MMDB (Molecular Modeling Database) of NCBI) 	8
	Database Similarity Searches: <ul style="list-style-type: none"> • BLAST, • FASTA, • PSI-BLAST, algorithms, • Multiple sequence alignments - CLUSTAL, PRAS. Primer Designing, • Homology Modeling, • Phylogenetic analysis • Drug Designing, • Determination of Secondary & Tertiary of proteins. 	8
VII	Biological File Formats and Literatures Databases <ul style="list-style-type: none"> • Brief overview of biological sequence and 3D structure file formats (e.g., GenBank/GenPept, EMBL, FASTA, PIR, and PDB), • NCBI's literature databases (e.g., PubMed, PubMed Central, PubChem Project and OMIM database) 	8
VIII	Database Similarity Searching and Phylogenetics <ul style="list-style-type: none"> • Requirements of database searching, • BLAST (Basic Local Alignment Search Tool) algorithm, • Statistical significance and variants of BLAST • FASTA algorithm and its statistical significance • Comparison of BLAST and FASTA • Brief Overview of phylogenetic analysis 	8
Suggested readings <ol style="list-style-type: none"> 1. Analysis of biological data, M. Whitlock and D. Schluter (2009), Roberts and company publishers 2. Principles of biostatistics, M. Pagano and K. Gauvreau (2000), Duxbury Thomas learnings 		

3. Protein Bioinformatics: From Sequence to Function, Academic Press, 2011, ISBN 0123884241, 9780123884244.
4. Essential Bioinformatics, Cambridge University Press, 2006, ISBN 113945062X, 9781139450621
5. Kerns EH, Di L. Drug-Like Properties: Concepts, Structure Design and Methods: from ADME to Toxicity Optimization, Academic Press, Oxford, 2008

Course prerequisites: To study this course, a student must have had the subject Biology/ Biotechnology/ Chemistry in class/12th/ certificate/ diploma.

Suggested Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project/ Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None



Programme/Class: DIGREE		Year: THIRD	Semester: Sixth
Course Code: B110603P T	Course Title: Genetic Engineering and Bioinformatics Lab		
Course outcomes On completion of this course, students will be able to: <ul style="list-style-type: none"> • Isolate genomic DNA from bacteria, plant and animal tissues • Isolate plasmid DNA (E. coli) • Perform restriction digestion of DNA • Perform Agarose Gel Electrophoresis • Develop understanding of Bioinformatics as tools for Sequence Alignment, FASTA & BLASTsearch, Multiple Sequence Alignment, Protein Structure Visualization, as well as for Gene Finding 			
Credits: 4	Core Compulsory		
Max. Marks: 25+75Min.	Passing Marks: As per rules		
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4			
UNIT	Topic	Total No. of Lectures	
	<ul style="list-style-type: none"> • Isolate genomic DNA from bacteria, plant and animal tissues • Isolate plasmid DNA (E. coli) • Perform restriction digestion of DNA • Perform Agarose Gel Electrophoresis • Learning to analyze data using SPSS or R software • Introduction to types of sequence databases (Nucleotides & Protein) • Pair wise Sequence Alignment (NW and SW approach) • FASTA & BLAST search • Multiple Sequence Alignment (ClustalX&Treeview) 	60	
Suggested Readings: <ol style="list-style-type: none"> 1. Molecular Cloning: A laboratory manual (2014),4nd ed., Michael R Green and J. SambrookCold spring Harbor laboratory press (3vol.), 2. Bioinformatics - Principles and Applications (2008), 1st ed. Ghosh, Z. and Mallick, B., Oxford University Press (India) 			
Course Books published in Hindi must be prescribed by the Universities and Colleges			
This course can be opted as an elective by the students of following subjects: The eligibility for this paper is 10+2 with Biology/Biotechnology/Chemistry as one of the subject			
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Further Suggestions: None			

**DEPARTMENT OF HIGHER EDUCATION
U.P. GOVERNMENT, LUCKNOW**

**National Education Policy-2020
Common Minimum Syllabus
For all U.P. State Universities and
Colleges For the first three years of
Higher Education (UG)**



PROPOSED STRUCTURE OF SYLLABUS

BOTANY (PLANT SCIENCE)

(FACULTY OF LIFE SCIENCE)

13/05/22
[Signatures]

SUBJECT: BOTANY

Name	Designation	Affiliation
Syllabus Steering Committee		
Mrs. Monika S. Garg, (I.A.S.) Chairperson Steering Committee	Additional Chief Secretary	Dept. of Higher Education U.P., Lucknow
Prof. Poonam Tandan	Professor, Dept. of Physics	Lucknow University, U.P.
Prof. Hare Krishna	Professor, Dept. of Statistics	CCS University Meerut, U.P.
Dr. Dinesh C. Sharma	Associate Professor, Dept. of Zoology	K.M. Govt. Girls P.G. College Badalpur, G.B. Nagar, U.P.
Supervisory Committee-Science Faculty		
Dr. Vijay Kumar Singh	Associate Professor, Dept. of Zoology	Agra College, Agra
Dr. Santosh Singh	Dean, Dept. of Agriculture	Mahatma Gandhi Kashi Vidhyapeeth, Varanasi
Dr. Baby Tabussam	Associate Professor, Dept. of Zoology	Govt. Raza P.G. College Rampur, U.P.
Dr. Sanjay Jain	Associate Professor, Dept. of Statistics	St. John's College, Agra

Syllabus Developed by:

S.No.	Name	Designation	Department	College/University
1.	Dr Seema Bhadauria	Head & Associate Professor	Botany & Biotechnology	R B S College, Agra
2.	Dr Shweta Shekhar	Assistant Professor	Botany	DDU Gorakhpur University, Gorakhpur
3.	Dr Himshikha Yadav	Assistant Professor	Botany	VRALGM Degree College, Bareilly

Semester-wise Titles of the Papers in B.Sc. (Botany)					
Year	Sem.	Course Code	Paper Title	Theory/ Practical	Credits
<i>Certificate Course In Microbial Technology & Applied Botany</i>					
FIRST YEAR	I	B040101T	Microbiology & Plant Pathology	Theory	4
		B040102P	Techniques in Microbiology & Plant Pathology	Practical	2
	II	B040201T	Archegoniates & Plant Architecture	Theory	4
		B040202P	Land Plants Architecture	Practical	2
<i>Diploma in Plant Identification, Utilization & Ethnomedicine</i>					
SECOND YEAR	III	B040301T	Flowering Plants Identification & Aesthetic Characteristics	Theory	4
		B040302P	Plant Identification technology	Practical	2
	IV	B040401T	Economic Botany, Ethnomedicine & Phytochemistry	Theory	4
		B040402P	Commercial Botany & Phytochemical Analysis	Practical	2
<i>Bachelor of Science</i>					
THIRD YEAR	V	B040501T	Plant Physiology, Metabolism & Biochemistry	Theory	4
		B040502T	Molecular Biology & Bioinformatics	Theory	4
		B040503P	Experiments in physiology, Biochemistry & molecular biology	Practical	2
		B040504R	*Project-I	Practical	3
	VI	B040601T	Cytogenetics, Plant Breeding & Nanotechnology	Theory	4
		B040602T	Ecology & Environment	Theory	4
		B040603P	Cytogenetics, Conservation & Environment management	Practical	2
		B040604R	*Project-II	Practical	3

Subject prerequisites:

1. To study Botany, a student must have had the subject Biology/Biotechnology learnt at 10+2 level.
2. Keen interest in plants and plant-related research, Potential in mathematics, biology and chemistry
3. Skills and aptitude for scientific study and research
4. Creativity and good comprehension while working on scientific procedures and research
5. Computer aptitude.

COURSE INTRODUCTION

The new curriculum of B.Sc. in Science (Botany) offers essential knowledge and technical skills to study plants in a holistic manner. Students would be trained in all areas of plant biology using a unique combination of core, elective and vocational papers with significant inter-disciplinary components.

Students would be exposed to cutting-edge technologies that are currently used in the study of plant life forms, their evolution and interactions with other organisms within the ecosystem. Students would also become aware of the social and environmental significance of plants and their relevance to the national economy.

B.Sc. Botany Programme covers academic activities within the classroom sessions along with practical concepts at laboratory sessions. Infield, outstation activities and projects are also required to be organized for real-life experience and learning.

Candidates who have curiosity in plants kingdom, ecosystem, love exploring exotic places and wish to work as researchers or professions like Botanist, Conservationist, Ecologist, etc. can choose B.Sc. Botany course.

Programme outcomes (POs):	
Transformed curriculum shall develop educated outcome-oriented candidature, fostered with discovery-learning, equipped with practice & skills to deal practical problems and versed with recent pedagogical trends in education including e-learning, flipped class and hybrid learning to develop into responsible citizen for nation-building and transforming the country towards the future with their knowledge gained in the field of plant science.	
PO 1	CBCS syllabus with a combination of general and specialized education shall introduce the concepts of breadth and depth in learning
PO2	Shall produce competent plant biologists who can employ and implement their gained knowledge in basic and applied aspects that will profoundly influence the prevailing paradigm of agriculture, industry, healthcare and environment to provide sustainable development.
PO 3	Will increase the ability of critical thinking, development of scientific attitude, handling of problems and generating solutions, improve practical skills, enhance communication skill, social interaction, increase awareness in judicious use of plant resources by recognizing the ethical value system.
PO 4	The training provided to the students will make them competent enough for doing jobs in Govt. and private sectors of academia, research and industry along with graduate preparation for national as well as international competitive examinations, especially UGC-CSIR NET, UPSC Civil Services Examination, IFS, NSC, FCI, BSI, FRI etc.
PO 5	Certificate and diploma courses are framed to generate self- entrepreneurship and self-employability, if multi exit option is opted.
PO 6	Lifelong learning be achieved by drawing attention to the vast world of knowledge of plants and their domestication.

Programme specific outcomes (PSOs):
B.Sc. I Year / Certificate course in Microbial Technology & Classical Botany

This Programme imparts knowledge on various fields of plant biology through teaching, interactions and practical classes. It shall maintain a balance between the traditional botany and modern science for shifting it towards the frontier areas of plant sciences with applied approach. This syllabus has been drafted to enable the learners to prepare them for self-entrepreneurship and employment in various fields including academics as well as competitive exams. Students would gain wide knowledge in following aspects:

1. Diversity of plants and microbes, their habitat, morphology, architecture and reproduction.
2. Plant disease causing microbes, symptoms & control.
3. Economic value of plants and their use in Human Welfare.

Programme specific outcomes (PSOs):
B.Sc. II Year/ (Diploma in Plant Identification, Utilization & Ethnomedicine)

This course provides a broad understanding of identifying, growing and using plants. This course is primarily aimed to introduce people to the richness of plant diversity found in surrounding areas. Lecture sessions are designed to cover fundamental topics concerning classification of plants and their utilization required for understanding the flora and vegetation. Practical sessions are organized following theory for easy understanding of the various parts of the plants, structural organization of floral parts and diversity therein. Participants are taken to different locations covering a variety of habitats and forest types to acquaint them with the native flora. in the long run, will contribute towards building momentum for

people's participation in environmental conservation without compromising on academic rigor and our rich wealth of knowledge inherited over generations.

1. The course will cover conventional topics in Field Botany like Evolutionary History & Diversity of plants, Complete Morphology, Nomenclature of plants, Systems of Classification, Keys to important Families of Flowering Plants, Field Data Collection & Herbarium Techniques.
2. The course is designed to become a commercial crop grower, florist, protected cultivator, green belt plant advisor to industries, pharmacologist & taxonomist.

Programme specific outcomes (PSOs):
B.Sc. III Year / Bachelor of Science

The learning outcomes of a three years graduation course are aligned with programme learning outcomes but these are specific to-specific courses offered in a program. The core courses shall be the backbone of this framework whereas discipline electives, generic electives and skill enhancement courses would add academic excellence in the subject together with a multi-dimensional and multidisciplinary approach.

1. Understanding of plant classification systematics, evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics and molecular biology of various life-forms.
2. This course is suitable to produce expertise in conservation biology like ex-situ conservation, response to habitat change, genotype characterization and reproductive biology.
3. Understanding of various analytical techniques of plant sciences, use of plants as industrial resources or as a human livelihood support system and is well versed with the use of transgenic technologies for basic and applied research in plants.
4. Understanding of various life forms of plants, morphology, anatomy, reproduction, genetics, microbiology, molecular biology, recombinant DNA technology, transgenic technology and use of bioinformatics tools and databases and the application of statistics to biological data.
5. Entrepreneurship Skill Development, Understand the issues of environmental contexts and sustainable development, Inculcation of human values,
6. Strengthen mathematical and computational skills. Enable students to use ICT & AI effectively.
7. Develop good skills in the laboratory such as observation and evaluation by the use of modern tools and technology.

PSO 1

Understanding the nature and basic concepts of all the plant groups, their metabolism, components at the molecular level, biochemistry, taxonomy and ecology. The course will make them aware of natural resources and the environment and the importance of conserving it. Hands-on training in various fields will develop practical skills, handling equipment and laboratory use along with collection and interpretation of biological materials and data. Knowledge gained through theoretical and lab-based experiments will generate technical personnel in various priority areas such as genetics, cell and molecular biology, plant systematics and biotechnology.

PSO 2	Botanists are able to contribute to all these fields and therefore, are mainly employed with educational institutions, government or public sectors or companies in industries, such as agriculture or forestry, oil, chemical, biotechnology, geological survey, environmental protection, drugs, genetic research, plant resources laboratories, plant health inspection services, lumber and paper, food, fermentation, nursery, fruit and so on. Jobs available as a botanist: •Microbiologist, plant pathologist, Taxonomist • Plant Physiologist • Plant Biochemist • Researcher • Mycologist • Ecologist • Weed Scientist • Palaeobotanist • Conservationist • Fruit Grower • Morphologist • Cytologist • Ethnobotanist • Plant geneticists etc.
PSO 3	Inculcate strong fundamentals on modern and classical aspects of Botany, understand knowledge of Botany is an essential pre-requisite for the pursuit of many applied sciences. It will facilitate students for taking up and shaping a successful career in Botany and allied sciences.
PSO 4	Introduction of research project will inculcate research aptitude and passion for higher education and scientific research.

Proposed Year wise Structure of B.Sc. in Botany (CORE / ELECTIVE COURSES & PROJECTS)											
Subject: Botany											Total Credits /hrs/
Course/Entry –Exit levels	Year	Sem.	Paper 1	Credit/ hrs	Paper 2	Credit/ hrs	Paper 3	Credits/hrs	Research Project	Credit/	
<i>Certificate Course In Microbial Technology & Applied Botany</i>	I	I	Microbiology & Plant Pathology	4/60	Techniques in Microbiology & Plant Pathology	2/60	--		Nil	Nil	6/120
		II	Archegoniates & Plant Architecture	4/60	Land Plants Architecture	2/60	--		Nil	Nil	6/120
<i>Diploma in Plant Identification, Utilization & Ethnomedicine</i>	II	III	Flowering Plants Identification & Aesthetic Characteristics	4/60	Plant Identification technology	2/60	--		Nil	Nil	6/120
		IV	Economic Botany, Ethnomedicine & Phytochemistry	4/60	Commercial Botany & Phytochemical Analysis	2/60	-		Nil	Nil	6/120
<i>Bachelor of Science</i>		V	Plant Physiology, Metabolism & Biochemistry	4/60	Molecular Biology & Bioinformatics	4/60	Experiments in physiology, Biochemistry &	2/60	*Project-I	3/45	13/205

	III						molecular biology				
	VI	Cytogenetics, Plant Breeding & nanotechnology	4/60	Ecology & Environment	4/60	Cytogenetics, Conservation & Environment management	2/60	*Project- II	3/45	13/205	
Comments	Total Credits/Hrs. / lectures: (Credits can be earned from On-line Portals of UGC to create Academic Bank and 15% of the topics of each paper can be taught by on-line/ Virtual/ ICT based as per choice of the Institution) * Suggestive List of Projects mentioned in Detailed Paper Syllabus										50/890
Botany Course is One of the Major Subjects for Biology Students and Minor or Elective for students of other faculties Second Major Subject Can be Zoology/ Biotechnology /Microbiology Third Major Subject can be from Science or Any other faculty of UGC /AICTE – (Arts/ Agriculture/ Education/ law/ Commerce) Fourth Subject is Minor or Elective to be selected from any one of other Faculties as per student’s own interest One Vocational Course has to be opted from the list given in Syllabus as per NSDC guidelines One Co-curricular Course is compulsory											
Internal Assessment & External Assessment											
Internal Assessment				Marks		External Assessment				Marks	
Class Interaction				5		Viva Voce on Practicals				10	
Quiz				5		Report of Botanical Excursion/ Lab Visits/Industrial training/ Survey/Collection/ Models				10	
Seminar				7		Table work / Experiments				45	
Assignments (Charts/ Flora/ Rural Service/ Technology Dissemination/ Botanical Excursion/ Lab Visits/Industrial training)				8		Practical Record File				10	
TOTAL				25						75	
* Botanical Excursion/ Lab Visits/Industrial training Is compulsory											

CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY & CLASSICAL BOTANY / B.Sc.-I

Programme: <i>Certificate Course in Microbial Technology & Classical Botany</i>		Year: I	Semester: I/Paper-I
Subject: Botany			
Course Code: B040101T	Course Title: Microbiology & Plant Pathology		
Course outcomes: After the completion of the course the students will be able to: <ol style="list-style-type: none">1. Develop understanding about the classification and diversity of different microbes including viruses, Algae, Fungi & Lichens & 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 algae, fungi and lichens8. Gain Knowledge about the economic values of this lower group of plant community.			
Credits: 4		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
Unit	Topic		No. of Lectures (60 hrs)

I	<p>A. Introduction to Indian ancient, Vedic and heritage Botany and contribution of Indian Botanists, in context with the holistic development of modern science and technology, has to be taught, practiced and assessed via class interaction/ assignments / self-study mentioned under Continuous Internal Evaluation (CIE).</p> <p>B. Microbial Techniques & instrumentation Microscopy – 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.</p>	8
II	<p>Microbial world Cell structure of Eukaryotic and prokaryotic cells, Gram positive and Gram-negative bacteria, Structure of a bacteria; 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. Viruses, general characteristics, viral culture, Structure of viruses, Bacteriophages, Structure of T4 & λ-phage; Lytic and Lysogenic cycles, viroid, Prions & mycoplasma & phytoplasma, Actinomycetes & plasmids and their economic uses.</p>	8
III	<p>Phycology Range of thallus organization in Algae, Pigments, Reserve food –Reproduction - Classification and life cycle of – <i>Nostoc, Chlorella, Volvox, Hydrodictyon, Oedogonium, Chara; Sargassum, Ectocarpus, Polysiphonia</i>. Economic importance of algae - Role of algae in soil fertility- biofertilizer – Nitrogen fixation- Symbiosis; Commercial products of algae –biofuel, Agar.</p>	7
IV	<p>Mycology General characteristics, nutrition, life cycle, Economic importance of Fungi, Classification upto class. Distinguishing characters of Myxomycota: General characters of Mastigomycotina, Zygomycota: <i>Rhizopus</i>, Ascomycota: <i>Saccharomyces, Penicillium, Peziza</i>. Basidiomycotina: <i>Ustilago, Puccinia, Agaricus</i>; Deuteromycotina: <i>Fusarium, Alternaria</i>. Heterothallism, Physiological specialization, Heterokaryosis & Parasexuality.</p>	7
V	<p>Mushroom Cultivation, Lichenology & Mycorrhiza Mushroom cultivation. General account of lichens, reproduction and significance; <i>Mycorrhiza: ectomycorrhiza and endomycorrhiza</i> and their significance.</p>	7
VI	<p>Plant Pathology Disease concept, Symptoms, Etiology & causal complex, Primary and secondary inoculum, Infection, Pathogenicity and pathogenesis, Koch's Postulates. Mechanism of infection (Brief idea about Pre-penetration, Penetration and Post-penetration), Disease cycle (monocyclic, polycyclic and polyetic). Defense mechanism with special reference to Phytoalexin, Resistance- Systemic acquired and Induced systemic fungicides- Bordeaux mixture, Lime Sulphur, Tobacco decoction, Neem cake & oil</p>	7
VII	<p>Diseases and Control Symptoms, Causal organism, Disease cycle and Control measures of – Early & Late Blight of Potato, False Smut of Rice/ Brown spot of rice, Black Stem Rust of Wheat, <i>Alternaria</i> spot' and 'White rust of Crucifers, Red Rot of Sugarcane, Wilting of Arhar, Mosaic diseases on tobacco and cucumber, yellow vein mosaic of bhindi; Citrus Canker, Little leaf of brinjal; Damping off of seedlings, Disease management: Quarantine, Chemical, Biological, Integrated pest disease management</p>	8

v. http://wgbis.ces.iisc.ernet.in/biodiversity/sahyadri/wgbis_info/botany_history.pdf

vi Ancient Botany (Sciences of Antiquity) Paperback – 1 October 2015 by Gavin Hardy (Author), Laurence Totelin (Author)

vii. <https://www.plantsdiseases.com/p/symptoms.html>

viii. <https://www.plantsdiseases.com/p/pathogenic-diseases-in-plants.html>

UNIT-I B.

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. Aggarwal, S. K. 2009. Foundation Course in Biology, A one books Pvt. Ltd., New Delhi.
5. Aneja, K. R. 1993. Experiments in Microbiology, Pathology and Tissue Culture, Vishwa Prakashan, NewDelhi.
6. Annie Ragland, 2012. Algae and Bryophytes, Saras Publication, Kanyakumari, India.
7. Basu, A. N. 1993. Essentials of Plant Viruses, Vectors and Plant diseases, New Age International, New Delhi.
8. Chopra. G. L. 1984. A text book of Algae, Rastogi publications, Meerut,India.
9. Desikachari, T. V. 1959. Cyanophyta, ICAR, New Delhi.
10. Dubey, R. C. and Maheshwari. D.K. 2012. Practical Microbiology, S. Chand & Company, Pvt. Ltd., NewDelhi.
11. Fritsch, R. E. 1977. Structure and Reproduction of Algae, Cambridge University Press, London.
12. Kodo, C.I. and Agarwal, H.O.1972. Principles and techniques in Plant Virology, Van Nostrand, Reinhold Company, New York.
13. Agrios, G.N. (1997). Plant Pathology, 4th edition. Cambridge, U.K.: Academic Press.
14. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, 4th edition. Singapore, Singapore: John Wiley & Sons.
15. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies. Noida, U.P.: Macmillan Publishers India Ltd.
16. Reven, F.H., Evert, R. F., Eichhorn, S.E. (1992). Biology of Plants. New York, NY: W.H. Freeman and Company.
17. Sharma, P.D. (2011). Plant Pathology. Meerut, U.P.: Rastogi Publication.
18. Webster, J., Weber, R. (2007). Introduction to Fungi, 3rd edition. Cambridge, U.K.: Cambridge University Press..
19. Pandey B.P. 2001. College Botany Volume 1, S Chand & Company Pvt.Ltd, New Delhi.
20. Pandey. B.P. 2014 Modern Practical Botany, (Vol-I) S. Chand and Company Pvt. Ltd., New Delhi.
21. Pelzar, 1963. Microbiology, Tata Mc Graw Hill, New Delhi
22. Rangaswamy, G. 2009, Disease of Crop Plants in India, Prientice Hall of India, New Delhi.
23. Sambamurty. A.V.S.S. 2006, A Text book of Algae, I. K. International Publishing House, Pvt. Ltd., New Delhi.
24. Sharma, P. D. 2012, Microbiology and Plant Pathology, Rastogi Publication Pvt Ltd., Meerut, India.
25. Singh, R. P. 2007. Microbial Taxonomy and Culture Techniques, Kalyani Publication, New Delhi.
26. Smith. G. M. 1996. Cryptogamic Botany Volume I, Tata Mc Graw Hill, New Delhi.
27. Sundar Rajan. S. 2010.College Botany Volume I, Himalaya Publications, Mumbai.
28. Vashishta, B.R. Sinha, A.K. and Singh, V. P. 1991. Algae, S. Chand and Company, Pvt. Ltd., New Delhi

This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Microbiology, B.Sc. Agriculture, B.A. (Curators), B.A. Archaeology, B.A. Geology, BAMS.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall

Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	7
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8
	25

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Biotech/ Forestry/ Microbiology/Gardening /biomedical Science.

Facilities: Smart and Interactive Class

Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts

Suggested equivalent online courses:

<https://indianculture.gov.in/rarebooks/economic-botany-india>

<https://community.plantae.org/tags/mooc>

<futurelearn.com/courses/teaching-biology-inspiring-students-with-plants-in-science>

<https://www.coursera.org/courses?query=plants>

<http://egyankosh.ac.in/handle/123456789/53530>

<https://www.classcentral.com/tag/microbiology>

<https://www.edx.org/learn/microbiology>

<https://www.mooc-list.com/tags/microbiology>

<https://www.udemy.com/topic/microbiology/>

<https://ucmp.berkeley.edu/bacteria/bacteria.html>

<https://www.livescience.com/53272-what-is-a-virus.html>

<https://gclambathach.in/lms/Economic%20importance%20of%20Algae.pdf>

<https://www.slideshare.net/sardar1109/algae-notes-1>

<https://www.onlinebiologynotes.com/algae-general-characteristics-classification/>

<https://www.sciencedirect.com/topics/immunology-and-microbiology/fungus>

<https://ucmp.berkeley.edu/fungi/fungi.html>

<https://agrimoon.com/wp-content/uploads/Mashroom-culture.pdf>

<http://ecoursesonline.iasri.res.in/mod/page/view.php?id=11293>

<http://www.hillagric.ac.in/edu/coa/ppath/lect/plpath111/Lect.%201%20%20Introduction-PI%20Path%20111.pdf>

http://www.jnkvv.org/PDF/11042020102651plant_pathology.pdf

<https://www.apsnet.org/edcenter/disimpactmngmnt/topc/EpidemiologyTemporal/Pages/ManagementStrategies.aspx>

<https://learn.saylor.org/course/view.php?id=23§ionid=6821>

<https://www.sciencedirect.com/topics/earth-and-planetary-sciences/microscopy>

http://physics.fe.uni-lj.si/students/predavanja/Microscopy_Kulkarni.pdf

<https://lipidnanostructuresgroup.weebly.com/>

<https://zoology4civilservices.wordpress.com/2016/06/18/65/>

<https://microbenotes.com/laminar-flow-hood/>

CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY & CLASSICAL BOTANY / B.Sc.-I

Programme: <i>Certificate Course In Microbial Technology & Classical Botany</i>	Year: I	Semester: I/Paper-II
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Subject: **Botany**

Course Code: **B040102P**

Course Title: **Techniques in Microbiology & Plant Pathology**

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

1. Understand the instruments, techniques, lab etiquettes and good lab practices for working in a microbiology laboratory.
2. Develop skills for identifying microbes and using them for Industrial, Agriculture and Environment purposes.
3. Practical skills in the field and laboratory experiments in Microbiology & Pathology.
4. learn to identify Algae, Lichens and plant pathogens along with their Symbiotic and Parasitic associations.
5. Can initiate his own Plant & Seed Diagnostic Clinic
6. Can start own enterprise on microbial products

Credits: **2**

Core Compulsory

Max. Marks: **25+75**

Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): **0-0-2**

Unit	Topic * (Minimum Any three from each unit depending on facilities)	No. of Lectures (60 hrs)
I.	INSTRUMENTS & TECHNIQUES 1. Laboratory safety and good laboratory practices 2. Principles and application of Laboratory instruments-microscope, incubator, autoclave, centrifuge, LAF, filtration unit, shaker, pH meter. 3. Buffer preparation & titration 3. Cleaning and Sterilization of glasswares 4. Preparation of media- Nutrient Agar and Broth 5. Inoculation and culturing of bacteria in Nutrient agar and nutrient broth 6. Preparation of agar slant, stab, agar plate 7. Phenol Coefficient method to test the efficacy of disinfectants	7
II	BACTERIAL IDENTIFICATION 1. Isolation of bacteria. 2. Identification of bacteria. 3. Staining techniques: Gram's, Negative, Endospore, Capsule and Cell Wall. 4. Cultural characteristics of bacteria on NA. 5. Pure culture techniques (Types of streaking). 6. Biochemical characterization: IMViC, Carbohydrate fermentation test, Mannitol motility test, Gelatin liquefaction test, Urease test, Nitrate reduction test, Catalase test, Oxidase test, Starch hydrolysis, Casein hydrolysis.	8
III	MYCOLOGICAL STUDY: 1. Isolation of different fungi: Saprophytic, Coprophilous, Keratinophilic. 2. Identification of fungi by lactophenol cotton blue method. <i>Rhizopus, Saccharomyces, Penicillium, Peziza, Ustilago, Puccinia; Fusarium, Curvularia, Alternaria.</i> 3. <i>Agaricus</i> : Specimens of button stage and full grown mushroom; Sectioning of gills of <i>Agaricus</i> . 4. Lichens: crustose, foliose and fruticose specimens.	8
IV	PHYCOLOGY: 1. Type study of algae and Cyanobacteria – <i>Spirulina, Nostoc.</i> Chlorophyceae - <i>Chlorella, Volvox, Oedogonium, Cladophora, and Chara</i> ; Xanthophyceae – <i>Vaucheria</i> ; Bacillariophyceae – <i>Pinnularia</i> Phaeophyceae – <i>Sargassum</i> Rhodophyceae - <i>Polysiphonia</i>	7
V	EXPERIMENTAL PLANT PATHOLOGY 1. Preparation of fungal media (PDA) & Sterilization process. 2. Isolation of pathogen from diseased leaf. Identification: Pathological specimens of Brown spot of rice, Bacterial blight of rice, Loose smut of wheat, Stem rot of mustard, Late blight of potato; Slides of uredial, telial, pycnial & aecial stages of <i>Puccinia</i> , Few viral and bacterial plant diseases.	8
VI	PRACTICALS IN APPLIED MICROBIOLOGY-1 1. Isolation of nitrogen fixing bacteria from root nodules of legumes. 2. Enumeration of rhizosphere to non rhizosphere population of bacteria. 3. Isolation of antagonistic <i>Pseudomonas</i> from soil. 4. Microscopic observations of root colonization by VAM fungi. 5. Isolation of <i>Azospirillum</i> sp. from the roots of grasses. 6. Isolation of phyllosphere microflora. 7. Isolation of P solubilizing microorganisms.	8
VII	PRACTICALS IN APPLIED MICROBIOLOGY-2 1. Wine production. 2. Isolation of lactic acid bacteria from curd. 3. Isolation of lipolytic organisms from butter or cheese. 4. Immobilized bacterial cells for production of hydrolytic enzymes. 5. Enzyme production and assay – cellulase, protease and amylase. 6. Immobilization of yeast. 7. Isolation of cellulolytic and anaerobic sulphate reducing bacteria. 8. Isolation and characterization of acidophilic, alkalophilic and halophilic bacteria.	8
VIII	1. Cultivation of <i>Spirulina</i> , & <i>Chlorella</i> in lab for biofuel 2. Visit to NBAIM, Mau, Varanasi (Kashi)/ IMTECH (Institute of Microbial Technology), Chandigarh for viewing Culture Repository 3. Visit to biofertilizers and biopesticides unit to understand about the Unit operation procedures 4. Mushroom cultivation for Protein	6

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Biotech/ Microbiology/biomedical Science).

Facilities: Smart and Interactive Class

Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts

Lab Requisites: Microscopes, Stains, Dissection box, Haemocytometer, Specimens, Permanent slides, Autoclave, incubator, Oven, laminar flow cabinet, balances, Fermenter, Anaerobic jar and Spectrophotometer.

Suggested equivalent online courses:

<https://community.plantae.org/tags/mooc>

futurelearn.com/courses/teaching-biology-inspiring-students-with-plants-in-science

<https://microbiologysociety.org/publication/education-outreach-resources/basic-practical-microbiology-a-manual.html>

<https://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf>

<http://allaboutalgae.com/benefits/>

<https://repository.cimmyt.org/xmlui/bitstream/handle/10883/3219/64331.pdf>

<https://www.mooc-list.com/tags/microbiology>

<http://www.agrifis.ir/sites/default/files/A%20text%20book%20of%20practical%20botany%201%20%7BAshok%20Bendre%20%7D%20%5B8171339239%5D%20%281984%29.pdf>

<https://www.coursera.org/courses?query=plants>

<http://egyankosh.ac.in/handle/123456789/53530>

<https://www.classcentral.com/tag/microbiology>

<https://www.edx.org/learn/microbiology>

<https://www.mooc-list.com/tags/microbiology>

<https://www.udemy.com/topic/microbiology/>

Programme /Class: B.Sc.-I/ Certificate Course In Microbial Technology & Classical Botany	Year: I	Semester: II Paper-I
Subject: Botany		
Course Code: B040201T	Course Title: Archegoniates and Plant Architecture	
Course outcomes: After the completion of the course the students will be able to: <ol style="list-style-type: none"> 1. Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms 2. Understanding of plant evolution and their transition to land habitat. 3. Understand morphology, anatomy, reproduction and developmental changes therein through typological study and create a knowledge base in understanding the basis of plant diversity, economic values & taxonomy of plants 4. Understand the details of external and internal structures of flowering plants. 		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		

Unit	Topic	Lectures (60hrs)
I	Introduction to Archegoniates & Bryophytes Unique features of archegoniates, Bryophytes: General characteristics, adaptations to land habit, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of <i>Riccia</i> , <i>Marchantia</i> , <i>Anthoceros</i> and <i>Sphagnum</i> . (Developmental details not to be included). economic importance of bryophytes .	7
II	Pteridophytes General characteristics, Early land plants (<i>Rhynia</i>). Classification (up to family) with examples, Heterospory and seed habit, stelar evolution, economic importance of Pteridophytes.	8
III	Gymnosperms Classification and distribution of gymnosperms; Salient features of Cycadales, Ginkgoales, Coniferales and Gnetales, their examples, structure and reproduction; economic importance	8
IV	Palaeobotany General account of Cycadofilicales, Bennettitales and Cordaitales; Geological time scale; Brief account of process of fossilization & types of fossils and study techniques ; Contribution of Birbal Sahni	8
V	Angiosperm Morphology (Stem, Roots, Leaves & Flowers, Inflorescence) Morphology and modifications of roots; Stem, leaf and bud. Types of inflorescences; flowers, flower parts, fruits and types of placentation; Definition and types of seeds.	7
VI	Plant Anatomy: Meristematic and permanent tissues, Organs (root, stem and leaf). Apical meristems & theories on apical organization - Apical cell theory, Histogen theory, Tunica - Corpus theory. Secondary growth - Root and stem- cambium (structure and function) annular rings, Anomalous secondary growth - <i>Bignonia</i> , <i>Boerhaavia</i> , <i>Dracaena</i> , <i>Nyctanthes</i>	7
VII	Reproductive Botany Plant Embryology, Structure of microsporangium, microsporogenesis, , 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 and monocot embryo, Endosperm, Double fertilization, Apomixis and polyembryony.	8
VIII	Palynology: Pollen structure, pollen morphology, pollen allergy , Applied Palynology: Basic concepts, Palaeopalynology, Aeropalynology, Forensic palynology, Role in taxonomic evidences.	7

Suggested Readings:

Course Books published in Hindi may be prescribed by the Universities.

1. गंगुली (Gangulee) (1992) कॉलेज बॉटनी (College Botany) भाग I और II, (नई केंद्रीय किताब एजेंसी) , दिल्ली, भारत।
2. बघातगार (Bhatnagar) और मोय्त्रा (Moitra) (1996) जिमिनोस्पर्म (Gymnosperms), नई अज इंटरनैशनल (P) लिमिटेड पब्लिशर्स, नई दिल्ली, भारत।
3. पारीहार (Parihar) (1991) एन इंट्रोडक्शन टू एम्ब्रियोफाइट (An introduction to Embryophyta), भाग I. ब्रियोफाइट (Bryophyta), केंद्रीय किताब डिपॉट, अलहाबाद।
4. राशिद (Rashid) (1999) एन इंट्रोडक्शन टू प्टेरिडोफाइट (An Introduction to Pteridophyta), विकास पब्लिशिंग हाउस प्राइवेट लिमिटेड, नई दिल्ली।
5. शर्मा (Sharma) (1990) टेक्स्टबुक ऑफ प्टेरिडोफाइट (Textbook of Pteridophyta), मैकमिलान इंडिया लिमिटेड, दिल्ली।
6. वाशिश्ठा (Vashishtha), सिन्हा (Sinha) और कुमार (Kumar) (2010) बॉटनी फॉर डिग्री स्टूडेंट्स – प्टेरिडोफाइट (Botany for Degree Students – Pteridophyta), एस. चंद एंड कंपनी, नई दिल्ली।
7. वाशिश्ठा (Vashishtha), सिन्हा (Sinha) और कुमार (Kumar) (2010) बॉटनी फॉर डिग्री स्टूडेंट्स – जिमिनोस्पर्म (Botany for Degree Students – Gymnosperms), एस. चंद एंड कंपनी, नई दिल्ली।
8. पारीहार (Parihar) (1976) बायोलॉजी एंड मोर्फोलॉजी ऑफ प्टेरिडोफाइट (Biology and Morphology of Pteridophytes), केंद्रीय किताब डिपॉट, अलहाबाद।
9. बघातगार (Bhatnagar) (1996) जिमिनोस्पर्म (Gymnosperms), नई अज इंटरनैशनल पब्लिशर्स, नई दिल्ली।
10. पण्डे (Pandey) (2010) कॉलेज बॉटनी भाग II, एस. चंद एंड कंपनी, नई दिल्ली।
11. माहेश्वरी (Maheswari) (1971) एन इंट्रोडक्शन टू एम्ब्रियोलॉजी ऑफ एंगियोस्पर्म (An Introduction to Embryology of Angiosperms), मैग्ग्रॉव हिल बुक को., लंदन।
12. भट्टाचार्य (Bhattacharya) एट अल (2007) ए टेक्स्टबुक ऑफ पालिनॉलॉजी (A textbook of Palynology), केंद्रीय किताब डिपॉट, नई दिल्ली।
13. भोजवानी (Bhojwani), एस.एस. और एस.पी. बघातगार (S. P. Bhatnagar) (2000) द एम्ब्रियोलॉजी ऑफ एंगियोस्पर्म (4th Ed.), विकास पब्लिशिंग हाउस, नई दिल्ली।
14. पी.के.के. नैर (P.K.K. Nair) - ए टेक्स्टबुक ऑफ पालिनॉलॉजी (A textbook of Palynology), स्प्रींगर-वर्लेग, बर्लिन।
15. जोहरी (Johri), बी.एम. (1984) एम्ब्रियोलॉजी ऑफ एंगियोस्पर्म (Embryology of Angiosperms), स्प्रींगर-वर्लेग, बर्लिन।
16. दुत्ता (Dutta) (2016) बॉटनी फॉर डिग्री स्टूडेंट्स (Botany for Degree Students), ऑक्सफर्ड यूनिवर्सिटी प्रेस, ऑक्सफर्ड।
17. ई.जे.ईमस (E.J.Eames) . मोर्फोलॉजी ऑफ वसकुलर प्लांट्स (Morphology of Vascular Plants), स्टैंडर्ड यूनिवर्सिटी प्रेस, न्यू यॉर्क।
18. डिकिन्सन (Dickinson), वी.सी. (2000) इंटिग्रेटिव प्लांट एनाटॉमी (Integrative Plant Anatomy), हार्कर्ट अकादमिक प्रेस, यूएसए।
19. फाह्न (Fahn), ए. (1974) प्लांट एनाटॉमी (Plant Anatomy), पेरगमॉन प्रेस, यूएसए।
20. एवर्ट (Evert), री.एफ. (2006) एसाउ'स प्लांट एनाटॉमी: मेरिस्टेम्स, सेल, एंड टिससूज ऑफ द प्लांट बॉडी: दैर स्ट्रक्चर, फंक्शन एंड डेवलपमेंट (Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development), जॉन विली एंड सॉन्स, इंक, न्यू यॉर्क।

This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.A. (Curators), B.A. Archaeology, B.A. Geology, BAMS

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	7
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8
	25

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 4 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry).

Facilities: Smart and Interactive Class ,wifi facility

Other Requisites: : Videos,Books, CDs, Flora, Herbarium, Access to On-line resources, Display Charts

Suggested equivalent online courses:

<https://www.anbg.gov.au/bryophyte/what-is-bryophyte.html>

<https://pteridoportal.org/portal/index.php>

<https://www.conifers.org/zz/gymnosperms.php>

<http://www.mobot.org/MOBOT/research/APweb/>

<https://milneorchid.weebly.com/plant-id-for-beginners.html>

<https://www.botany.org/PlantImages/PlantAnatomy.php>

<http://webapp1.dlib.indiana.edu/inauthors/view?docId=VAC0868&doc.view=print>

<https://palynology.org/>

<http://www2.estrellamountain.edu/faculty/farabee/biobk/Biobookflowers.html>

<https://www.sciencelearn.org.nz/resources/100-plant-reproduction>

<https://palaeobotany.org/>

Programme/Class: <i>Certificate Course In Microbial Technology & Classical Botany</i>		Year: I	Semester: II Paper-II (Practical)
Subject: Botany			
Course Code: B040202P		Course Title: Land Plants Architecture	
Course outcomes:			
<ol style="list-style-type: none"> The students will be made aware of the group of plants that have given rise to land habit and the flowering plants. Through field study they will be able to see these plants grow in nature and become familiar with the biodiversity. Students would learn to create their small digital reports where they can capture the zoomed in and zoomed out pictures as well as videos in case they are able to find some rare structure or phenomenon related to these plants. Develop an understanding by observation and table study of representative members of phylogenetically important groups to learn the process of evolution in a broad sense. Understand morphology, anatomy, reproduction and developmental changes therein through typological study and create a knowledge base in understanding plant diversity, economic values & taxonomy of lower group of plants Understand the composition, modifications, internal structure & architecture of flowering plants for becoming a Botanist. 			
Credits: 2		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-2			
Unit	Topic	No. of Lectures	
I	Bryophytes: Marchantia- morphology of thallus, W.M. rhizoids and scales, V.S. thallus through Gemma cup, W.M. gemmae (all temporary slides), V.S. antheridiophore, archegoniophore, L.S. sporophyte (all permanent slides). <i>Sphagnum</i> - morphology, W.M. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, L.S. capsule and protonema.	8	
II	Pteridophytes: <i>Lycopodium</i> : Habit, stem T. S. stobilus V. S., <i>Selaginella</i> : Habit, rhizophore T. S, stem T. S, axis with strobilus, V.S. of strobilus, Megasporephyll and microsporephyll. <i>Equisetum</i> - Habit, rhizome and stem T.S. and V. S. of strobilus. <i>Azolla</i> – Habitat & its structure	7	
III	Gymnosperms 1. <i>Cycas</i> – seedling, coralloid root and coralloid root T. S., T. S. of leaflet and Rachis, micro and megasporephyll, male cone V. S., microsporephyll T. S. entire and V. S. of ovule. <i>Pinus</i> - Branch of indefinite growth, spur shoot, T. S of old stem and needle R.L.S and T. L. S. of stem, male and female cone, V.S. of male and female cone. 2. <i>Ephedra & Thuja</i> : Habit, stem T. S (young and mature), leaf T. S, male and female strobilus, V. S. of male and female cone, ovule V. S. and seed.	8	
IV	Palaeobotany & Palynology 1. Morphology of <i>Rhynia</i> and fossils gymnosperms & other groups. 2. Visit Birbal Sahni Institute of Palaeosciences or virtual conference with their scientists to learn fossilization. 3. Mark and know about Indian geographical sites rich in plant fossils.	6	
V	Angiosperm Morphology 1. To study diversity in leaf shape, size and other foliar features. 2. To study monopodial and sympodial branching. 3. Morphology of Fruits 4. Inflorescence types- study from fresh/ preserved specimens 5. Flowers- study of different types from fresh/ preserved specimens 6. Fruits- study from different types from fresh/preserved specimens 7. Study of ovules (permanent slides/ specimens/photographs)- types (anatropous, orthotropous, amphitropous and campylotropous) 8. Modifications in Roots, stems, leaves and inflorescences	8	

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry).

Facilities: Smart and Interactive Class

Other Requisites: Microscopes, Stains, Dissection box, Haemocytometer, Specimens, Permanent slides, Autoclave, incubator, Oven, laminar flow cabinet, balance

Suggested equivalent online courses:

<https://www.easybiologyclass.com/topic-botany>

<http://www3.botany.ubc.ca/bryophyte/index.html>

http://ecflora.cavehill.uwi.edu/bio_courses/bl14apl/practical_3.1.htm

<http://mydunotes.blogspot.com/p/botany.html>

<http://www.fao.org/3/a-v9236e.pdf>

<https://iinrg.icar.gov.in/library/nrg/nrg.pdf>

https://agritech.tnau.ac.in/banking/nabard_pdf/Azolla%20Cultivation/Model_project_on_Azolla_cultivation.pdf

<http://arnoldia.arboretum.harvard.edu/pdf/articles/1977-37-1-propagation-manual-of-selected-gymnosperms.pdf>

https://www.fs.fed.us/rm/pubs_other/wo_AgricHandbook730/wo_AgricHandbook727_153_175.pdf

***Detail Syllabus of
B.Sc.-II Year
or
Diploma in
Plant Identification, Utilization & Ethnomedicine***

Diploma in Plant Identification, Utilization & Ethnomedicine

Diploma in Plant Identification, Utilization & Ethnomedicine		
Programme /Class: <i>Diploma in Plant Identification, Utilization & Ethnomedicine</i>	Year: II	Semester: III Paper-I
Subject: Botany		
Course Code: B040301T	Course Title: Flowering Plants Identification & Aesthetic Characteristics	
<p>Course outcomes: After the completion of the course the students will be able to:</p> <ol style="list-style-type: none"> 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. To become familiar with major taxa and their identifying characteristics, and to develop in depth knowledge of the current taxonomy of a major plant family. 5. To discover and use diverse taxonomic resources, reference materials, herbarium collections, publications. 6. For the entrepreneur career in plants, one can establish a nursery, Start a landscaping business, Set up a farm Or Run a plantation consultancy firm 		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lectures (60hrs)
I	<p>Taxonomic Resources & Nomenclature Components of taxonomy (identification, nomenclature, classification) ; Taxonomic resources: Herbarium- functions & important herbaria, Botanical gardens, Flora, Keys- single access and multi-access. Principles and rules of Botanical Nomenclature according to ICN (ranks and names; principle of priority, binomial system; type method, author citation, valid-publication).</p>	7
II	<p>Types of classification & Evidences Artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series) angiosperm phylogeny group (APG IV) classification. Introduction to taxonomic evidences from palynology, cytology, phytochemistry & Molecular biology data (Protein and Nucleic acid homology).</p>	8
III	<p>Identification of Angiospermic families -I: (Families can be chosen University wise as per local available flora) A study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham & Hooker's system) Ranunculaceae, Malvaceae, Rutaceae, Fabaceae, Myrtaceae , Cucurbitaceae, Rubiaceae, Asteraceae, Apocynaceae, Acanthaceae, Asclepiadaceae, Solanaceae.</p>	8
IV	<p>Identification of Angiospermic families -II: (Families can be chosen University wise as per local available flora) A study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham & Hooker's system)- Amaranthaceae, Euphorbiaceae, Papaveraceae, Apiaceae, Lamiaceae, Orchidaceae, Liliaceae, Musaceae, Poaceae.</p>	7

V	Modern trends in Plant taxonomy: Brief idea on Phenetics, Biometrics, Cladistics (Monophyletic, polyphyletic and paraphyletic groups; Plesiomorphy and apomorphy).	8
VI	TOOLS & SOFTWARES IN PLANT IDENTIFICATION- GIS (Mapping of (i) Patterns(ii) Features (iii) Quantities 0P02.010H11YLIP - Free Phylogenetic Software, Digital Taxonomy (e-flora), Description Language for Taxonomy – DELTA Internet directory for botany.	7
VII	Computer usage & Android Applications MS Office: PPT, Microsoft Excel, data entry, graphs, aggregate functions, formulas and functions, number systems, conversion devices, secondary storage media. GPS tagging, Plant Identification Apps.	7
VIII	Aesthetic Characteristics of Plants: Aesthetic characteristics of plants, English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Trees, shrubs and shrubberies, climbers and creepers, rockery, Flower beds, Shrubbery, Borders, Water garden). Some Famous gardens of India. Conservatory, green houses, Indoor garden, Roof garden, Topiary, Bonsai.	8

Suggested Readings:

Course Books published in Hindi may be prescribed by the Universities.

1. [www.naace.co.uk/school-improvement/ict-mark/](#)
2. [https://www.socitm.gov.uk](#), (2002) Learning in the 21st century Executive briefing A Socitm Insight publication, July 2002 Socitm.
3. Propagation And Nursery Management (hindi) (hb) ISBN : 9788177546200 Edition : 01 Year : 2016 Author : Pandey S.K. , Soni N. Publisher : Agrobios (India)
4. Dr. Amar Singh. पौधपरिचय - Plant Taxonomy (An Old and Rare Book) from the category Ayurveda in our Books collection. Uttar Pradesh Hindi Sansthan, Lucknow

1. Plant Systematics. Arun K. Pandey & Shruti Kansana. 2020. Jaya Publishing House.
2. Bole, P. V. and Vaghani, Y. (1986) Field guide to the common trees of India. Oxford University Press; Bombay.
3. Brandis, D. (1906) Indian Trees (London, 5th edition. 1971). International Book Distributors; Dehra Dun.
4. Dallwitz, M. J., Paine, T. A. and Zurcher, E. J. (2003). Principles of interactive keys. <http://delta-intkey.com>
5. <https://www.naace.co.uk/school-improvement/ict-mark/>
6. <https://www.socitm.gov.uk>, (2002) Learning in the 21st century Executive briefing A Socitm Insight publication, July 2002 Socitm.
7. K. B. Anjaria, (2015) "Electronic Herbarium and Digital Database Preparation of Common Trees of Anand District, Gujarat" MRP submitted to UGC, WRO, Pune 2015 (unpublished)
8. Lizeron Eremias and R. Subash. (2013) "E-Content Development: A Milestone In The Dynamic Progress Of E-Learning" International Journal of Teacher Educational Research (IJTER) Vol.2 No.1 January, 2013 ISSN: 2319- 4642
9. Pandey, B.P. 2007. Botany for Degree Students: Diversity of Seed Plants and their Systematics, Structure, Development and Reproduction in Flowering Plants. S. Chand & Company Ltd, New Delhi.
10. Stace, C. A. 1989. Plant Taxonomy and Biostatistics (2nd Ed.). Edward Arnold, London.
11. Singh, G. 1999. Plant Systematics: Theory and Practice. Oxford and IBH, New Delhi.
12. Dutta A.C. 2016. Botany for Degree Students. Oxford University Press.
13. Davis, P. H. and V. H. Heywood. 1963. Principles of Angiosperm Taxonomy. Oliver and Boyd, London.
14. Heywood, V. H. and D. M. Moore (Eds). 1984. Current Concepts in Plant Taxonomy. Academic Press, London.
15. Austin, R. 2002. Elements of planting design. New York: John Wiley & Sons.
16. Bertauski, T. 2005. Designing the landscape: An introductory guide for the landscape designer. Upper Saddle River, NJ: Pearson Prentice Hall.
17. Thomas, H., and S. Wooster. 2008. The complete planting design course: Plans and styles for every garden. London: Octopus Publishing Group.
18. Scarfone, S. 2007. Professional planting design: An architectural and horticultural approach for creating mixed bed plantings. New York: John Wiley & Sons.
19. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

This course can be opted as an elective by the students of the following subjects: Open to all but special for B.Sc. Biotech B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.A. (Curators), B.A. Archaeology, B.A. Geology, BAMS

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	7
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8
	25

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry).

Facilities: Smart and Interactive Class

Other Requisites: : Video collection, Books, CDs, Flora, Herbarium, Access to On-line resources, Display Charts

Suggested equivalent online courses:

<https://www.easybiologyclass.com/topic-botany/>

<http://egyankosh.ac.in/handle/123456789/53530> <https://www.delta-intkey.com/www/desc.htm>

<https://milneorchid.weebly.com/plant-id-for-beginners.html>

<https://plants.usda.gov/classification.html>

https://www.seneca.edu/pages/uploaded_files/Plant%20Classification.pdf

https://www.ladykeanecollege.edu.in/files/userfiles/file/Dr_%20S_%20Nongbri%20III%20Sem%20ppt.pdf

https://www.brainkart.com/article/Bentham-and-Hooker-s-classification-of-plants---Dicotyledonae,-Gymnospermae-and-Monocotyledonae_1000/

<https://libguides.rutgers.edu/c.php?g=336690&p=2267037>

<https://www.delta-intkey.com/>

Programme/Class: : <i>Diploma in Plant Identification, Utilization & Ethnomedicine</i>		Year: II	Semester: III Paper-II (Practical)
Subject: Botany			
Course Code: B040302P		Course Title: Plant Identification technology	
<p>Course outcomes: After the completion of the course the students will be able:</p> <ol style="list-style-type: none"> To learn how plant specimens are collected, documented, and curated for a permanent record. To observe, record, and employ plant morphological variation and the accompanying descriptive terminology. To gain experience with the various tools and means available to identify plants. To develop observational skills and field experience. To identify a taxonomically diverse array of native plants. To recognize common and major plant families. To Understand aesthetic characters of flowering plants by making-landscapes,gardens,bonsai,miniatures Comprehend the concepts of plant taxonomy and classification of Angiosperms. 			
Credits: 2		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-2			
Unit	Topic* *(Perform Any three experiments from each unit as per facility)	No. of Lecture (60Hrs)	
I	<p>Herbarium: Plant collecting, Preservation and Documentation: Stepwise Practicing Herbarium techniques: a. FIELD EQUIPMENTS, Global Positioning System (GPS) instrument & Collection of any wild 25 plant specimens b. Learn to handle Herbarium making tools c. Pressing and Drying of collected plant specimens d. Special treatments for all varied groups of plants e. Mount on standard herbarium sheets f. Label them using Standard method g. Organize them and give Index Register Number</p>	7	
II	<p>Taxonomic Identification using plant structure a. Classify 25 plants on the basis of Taxonomic description (Plant Morphology, Anatomy, Reproductive parts, Habit, adaptation anomalies) according to Bentham and Hooker natural system of classification in the following families: Malvaceae, Fabaceae (Papilionaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiatae (Lamiaceae), Rubiaceae.</p>	8	
III	<p>Identification during excursions a. Conducting Spot identification (Binomial, Family) of common wild plants from families included in the theoretical syllabus (list to be provided) and making FIELD NOTE BOOK and filling Sample of a page of field-book, used in Botanical Survey of India. b. Describe/compare flowers in semi-technical language giving V.S. of flowers, T.S. of ovaries, floral diagrams and Floral Formulae. Identify and assign them to their respective families giving reasons.</p>	8	
IV	<p>COLLECTION, PRESERVATION AND STORAGE OF ALGAE, FUNGI BRYOPHYTES, PTERIDOPHYTES (Two each)</p>	7	
V	<p>Botanical Nomenclature & reporting Method: a. Give nomenclature to collected plants as per ICN rules and prepare labels as per BSI b. Author Citation, Effective Publication and Principle of Priority: To show a specimen paper on Basic structure of a taxonomic Research published on a new species in taxonomic journal</p>	7	
VI	<p>COMPUTERS 1. Learning to use EXCEL Microsoft PowerPoint and Word., WORKING WITH FOLDER AND WINDOWS UTILITY., CREATE AND MANAGE FILES AND FOLDER TREE,</p>	7	

	<p>Delhi.</p> <p>19. Bridson, D. & L. Forman. eds. 1998. The Herbarium Handbook. 3rd ed. Royal Botanic Gardens, Kew (Reprinted 1999).</p> <p>20. De Vogel, E.F. 1987. Manual of Herbarium Taxonomy: Theory and Practice. UNESCO, Jakarta.</p> <p>21. Fosberg, F.R. & M.-H. Sachet. 1965. Manual for tropical herbaria. Int. Bur. Pl. Tax. & Nom., Regnum Vegetabile Vol. 39. Utrecht.</p> <p>22. Jain, S.K. & R.R. Rao. 1977. A handbook of field and herbarium methods. Today & Tomorrow's Printer and Publishers, New Delhi.</p> <p>23. Victor, J.E., M. Koekemoer, L. Fish, S.J. Smithies, M. Mossmer. 2004. Herbarium essentials: the Southern African Herbarium user manual. Southern African Botanical Diversity Network Report No. 25. SABONET, Pretoria.</p>										
	<p>This course can be opted as an elective by the students of the following subjects: Open to all but special for B.S Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.A. (Curators), B.A. Archaeology, B.A. Geology, BAMS</p>										
	<p>Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:</p> <table border="1"> <thead> <tr> <th>Internal Assessment</th> <th>Marks</th> </tr> </thead> <tbody> <tr> <td>Class Interaction</td> <td>5</td> </tr> <tr> <td>Botanical Excursion- compulsory</td> <td>12</td> </tr> <tr> <td>Assignment</td> <td>8</td> </tr> <tr> <td></td> <td>25</td> </tr> </tbody> </table>	Internal Assessment	Marks	Class Interaction	5	Botanical Excursion- compulsory	12	Assignment	8		25
Internal Assessment	Marks										
Class Interaction	5										
Botanical Excursion- compulsory	12										
Assignment	8										
	25										
	<p>Course prerequisites: Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry). Facilities: Smart and Interactive Class Other Requisites: : Video collection, Books, CDs, Flora, Herbarium, Access to On-line resources, Display Charts Lab Requisites: Microscopes (Compound, Stereo) Dissection box, stain, Herbarium, Herbarium press, Dryers, Grinder, Reference Flora</p>										
	<p>Suggested equivalent online courses:</p> <ol style="list-style-type: none"> http://egyankosh.ac.in/bitstream/123456789/13096/1/Unit-5.pdf https://www.for.gov.bc.ca/hfd/pubs/docs/wp/wp18.pdf https://www.researchgate.net/publication/267510854 The Flowering Plants Handbook <p>Any Other :</p> <p>Botanical Excursions: One teacher along with a batch not more than 7 students be taken for botanical excursion to places of Botanical interest, one in each term. If there are female students in a batch of 7 students, one additional lady teacher is permissible for excursion.</p> <p>Each excursion will not be more than SEVEN days during college working days. T.A. and D.A. for teachers and non-teaching staff participating in excursions should be paid as per rules. Tour report duly certified by tour in charge teacher and Head of the Department should be submitted at the time of practical examination. For every study tour take the prior permission of the head of the department and Principal.</p> <p>The marks will be counted under Internal assessment and external assessment both. In external assessment student will have to present his excursion report along with industrial training/central labs visits and BSI or Museum visits. In internal assessment he shall have to label the campus plants with botanical details/develop herbal/floristic garden/conserved plants in botanical garden/contribute specimens via collection .</p>										

	<p>A project supported along with photographs taken during field study to be submitted giving comprehensive idea about different types of inflorescence, flowers and fruits/ At least three field excursions at hills/Oceans/Deserts including one Compulsory excursion to Botanical Garden, FRI/BSI and Central National Herbarium (CNH). Central Research Institutes/Hot Spots</p>	
Programme /Class: Diploma in Plant Identification, Utilization & Ethnomedicine	Year: II	Semester: IV Paper-I
Subject: Botany		
Course Code: B040401T	Course Title: Economic Botany, Ethnomedicine and Phytochemistry	
<p>Course outcomes: After the completion of the course the students will be able to:</p> <ol style="list-style-type: none"> 1. Understand about the uses of plants –will know one plant-one employment 2. Understand phytochemical analysis related to medicinally important plants and economic products produced by the plants 3. know about the importance of Medicinal plants and its useful parts, economically important plants in our daily life and also about the traditional medicines and herbs, and its relevance in modern times. 		
Credits: 4		Core Compulsory
Max. Marks: 25+75		Min. Passing Marks:
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lectures (60hrs)
I	<p>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.</p>	7
II	<p>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, Fumitories & Masticatories, Rubber, Dyes, Timber, biofuel crops.</p>	7
III	<p>Commercial production of Flowers, Vegetables, and fruits (To be Chosen area wise) Commercial greenhouse cultivation of rose, Gerbera, Gladiolus, Anthurium/lilium/lily, tomato, bell pepper, cucumber, strawberry & Exotic leafy vegetables using Hydroponics.</p>	7
IV	<p>IPR & Traditional Knowledge IPR and WTO (TRIPS, WIPO), Patent Act 1970 and its amendments, TIFAC, NRDC, Rights, Procedure of obtaining patents, Working of patents, Infringement, Copyrights, Trademarks, Geographical Indications, Traditional Knowledge Digital Library, Protection of Traditional Knowledge & Protection of Plant Varieties and Biotech inventions.</p>	8
V	<p>Ethnobotany Methodologies of ethnobotanical research: Field work, Literature, Herbaria and Musea and other aspects of ethnobotany. Importance of ethnobotany in Indian systems of medicine (Siddha, Ayurveda and Unani), Role of AYUSH, NMPB, CI-MAP and CARI. Tribal knowledge towards disease diagnosis, treatment, medicinal plants, plant conservation and cultivation.</p>	8
VI	<p>Medicinal aspects Study of common plants used by tribes (<i>Aegle marmelos</i>, <i>Ficus religiosa</i>, <i>Cynodon dactylon</i>, <i>Eclipta alba</i>, <i>Oxalis</i>, <i>Ocimum sanctum</i> and <i>Trichopus zeylanicus</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.</p>	8

	Plants in primary health care: common medicinal plants: <i>Tinospora, Acorus, Ocimum, Turmeric</i> and <i>Aloe</i> . Indian Pharmacopeia, Quality Evaluation of crude drugs & adulteration	
VII	Pharmacognosy Preparation of drugs for commercial market - Organoleptic evaluation of drugs - Microscopic evaluation of drugs - Physical evaluation of drugs - Active and inert constituents of drugs - Classification of drug plants - individual drugs - drug adulteration. Sources of crude drugs – roots, rhizome, bulb, corm, leaves, stems, flowers, fruits and seeds ; organoleptic study of <i>Adhatoda vasica, Andrographis paniculata, Azadirachta indica, Coriandrum sativum, Datura metel, Eclipta alba, Emblica officinalis, Ocimum sanctum, Phyllanthus amarus, Ricinus communis, Vinca rosea</i> and <i>Zingiber officinale</i> .	8
VIII	Herbal Preparations & Phytochemistry : Collection of wild herbs - Capsules - compresses - Elixirs - Glycerites - Hydrotherapy or Herbal bath - Herbal oils - Liquid extracts or Tincture - Poultices - Salves - Slippery elm slurry and gruel - Suppositories - Teas. Plant natural products , general detection, extraction and characterization procedures. Glycosides and Flavonoids and therapeutic applications. Anthocyanins and Coumarins and therapeutic applications, Lignans, Terpenes, Volatile oils and Saponins, Carotenoids and Alkaloids Carotenoids and pharmacological activities.	7

Suggested Readings:

Course Books published in Hindi may be prescribed by the Universities.

1. [Hindi text] ([Hindi text] , [Hindi text] , [Hindi text]) [Hindi text] - [Hindi text], [Hindi text] [Hindi text] : [Hindi text] [Hindi text], [Hindi text]
2. [Hindi text] [Hindi text], [Hindi text] [Hindi text] [Hindi text]. [Hindi text] [Hindi text] [Hindi text] [Hindi text]
3. [Hindi text] [Hindi text] [Hindi text] [Hindi text] [Hindi text] - Dhankar - Sharma – Trivedi
4. Aushdhiye Poudhe (Hindi) by R.P. Sharma | 1 January 2013 YKING BOOKS

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
2. Sambamurthy, AVSS & Subrahmanyam, NS (2000). Economic Botany of Crop Plants. Asiatech Publishers. New Delhi.
3. Singh, D.K and K.V. Peter. 2014. Protected cultivation of horticultural crops. New India Publishing Agency, India.
4. Reddy P. Parvatha. 2016. Sustainable crop protection under protected cultivation. Springer, Singapore.
5. Amit Deogirikar. 2019. A Text Book on Protected Cultivation and Secondary Agriculture. Rajlaxmi Prakashan, Aurangabad, India.
6. Singh, B., B. Singh, N. Sabir and M Hasan. 2014. Advances in protected cultivation. New India Publishing Agency, India.
7. Sharma, OP. 1996. Hill's Economic Botany (Late Dr. AF Hill, adopted by OP Sharma). Tata McGraw Hill Co. Ltd., New Delhi.
8. Joe J. Hanan. 1997. Greenhouses: Advanced Technology for protected horticulture. CRC Press.
9. Krishnamurthy, K.V. (2004). An Advanced Text rbook of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi
10. N.K. Acharya: Textbook on intellectual property rights, Asia Law House (2001).
11. Manjula Guru & M.B. Rao, Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications (2003).
12. P. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill (2001).
13. Arthur Raphael Miller, Micheal H.Davis; Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers (2000).
14. Jayashree Watal, Intellectual property rights in the WTO and developing countries, Oxford University Press, Oxford.
15. Jain, S. K. and V. Mudgal. 1999. A Handbook of Ethnobotany. Bishen Singh Mahendra Pal Singh, Dehradun.
16. Jeffrey, C. 1982. An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge. London.
17. Joshi, S. G. 2000. Medicinal Plants. Oxford and IBH, New Delhi.
18. Kokate, C. and Gokeale- Pharmacognacy- Nirali Prakashan, New Delhi.
19. Lad, V. 1984. Ayurveda – The Science of Self-healing. Motilal Banarasidass, New Delhi.
20. Lewis, W. H. and M. P. F. Elwin Lewis. 1976. Medical Botany. Plants Affecting Man's Health. A Wiley Inter science Publication. John Wiley and Sons, New York.
21. Farooqui, A. A. and Sreeraman, B. S. 2001. Cultivation of medicinal and aromatic crops. Universities Press.
22. Harborne, J. B. 1998. Phytochemical methods – a guide to modern techniques of plant analysis 3 rd edition, Chapman and Hall.
23. Yesodha, D., Geetha, S and Radhakrishnan, V. 1997. Allied Biochemistry. Morgan publications, Chennai. I. Gurdeep Chatwal, 1980. Organic chemistry of natural productis. Vol. I. Himalaya Publishing house.
24. Kalsi, P. S. and Jagtap, S., 2012. Pharmaceutical medicinal and natural product chemistry. N.K. Mehra for Narosa Publishing House Pvt. Ltd. New Delhi.
25. Wallis, T. E. 1946. Text book of Pharmacognosy, J & A Churchill Ltd.

26. Roseline, A. 2011. Pharmacognosy. MJP Publishers, Chennai.
27. Jain S. K. 1989. Methods and approaches in Ethnobotany, Society of Ethnobotanists, Lucknow.
28. Sharol Tilgner, N. D. 1999. Herbal medicine - From the heart of the earth. Edn. 1, Printed in the USA by Malloy Lithographing Inc.
29. Pal, D.C. & Jain, S.K., 1998. Tribal Medicine. Naya Prakash Publishers, Calcutta.
30. Datta & Mukerji, 1952. Pharmacognosy of Indian roots of Rhizoms drugs. Bulletin No.1 Ministry of Health, Govt. of India.
31. Young Ken, H.W., 1948. Text Book of Pharmacognosy. Blakiston C., Philadelphia.
32. Shukla, R.S., 2000. Forestry for tribal development. A.H. Wheeler & Co. Ltd., India.
33. Raychudhuri, S.P., 1991. (Ed.) Recent advances in Medicinal aromatic and spice crops. Vol.1, Today & Tomorrow's printers and publishers, New Delhi.
34. Bajpai, P.K. 2006. Biological Instrumentation and methodology. S. Chand & Co. Ltd.
35. K. Wilson and J. Walker Eds. 2005. Biochemistry and Molecular Biology. Cambridge University Press.
36. k. Wilson and KH Goulding. 1986. Principles and techniques of Practical Biochemistry. (3 edn Edward Arnold, London.

This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.A. (Curators), B.A. Archaeology, B.A. Geology, BAMS

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	7
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8
	25

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry).

Facilities: Smart and Interactive Class

Other Requisites: : Video collection, Books, CDs, Flora, Herbarium, Access to On-line resources, Display Charts

Suggested equivalent online resources:

https://www.pnas.org/content/104/suppl_1/8641

<https://www.journals.uchicago.edu/doi/pdfplus/10.1086/659998>

<https://bsi.gov.in/page/en/ethnobotany>

<http://www.legalserviceindia.com/article/198-Intellectual-Property-and-Traditional-knowledge.html>

https://www.brainkart.com/article/Economic-importance-Plants---Food,-Rice,-Oil,-Fibre,-Timber-yielding-plant_1095/

<https://www.loc.gov/rr/scitech/tracer-bullets/economic-botanytb.html>

<http://nsdl.niscair.res.in/bitstream/123456789/127/1/Fibre%20crops%2C%20bamboo%2C%20timber%20-%20Final.pdf>

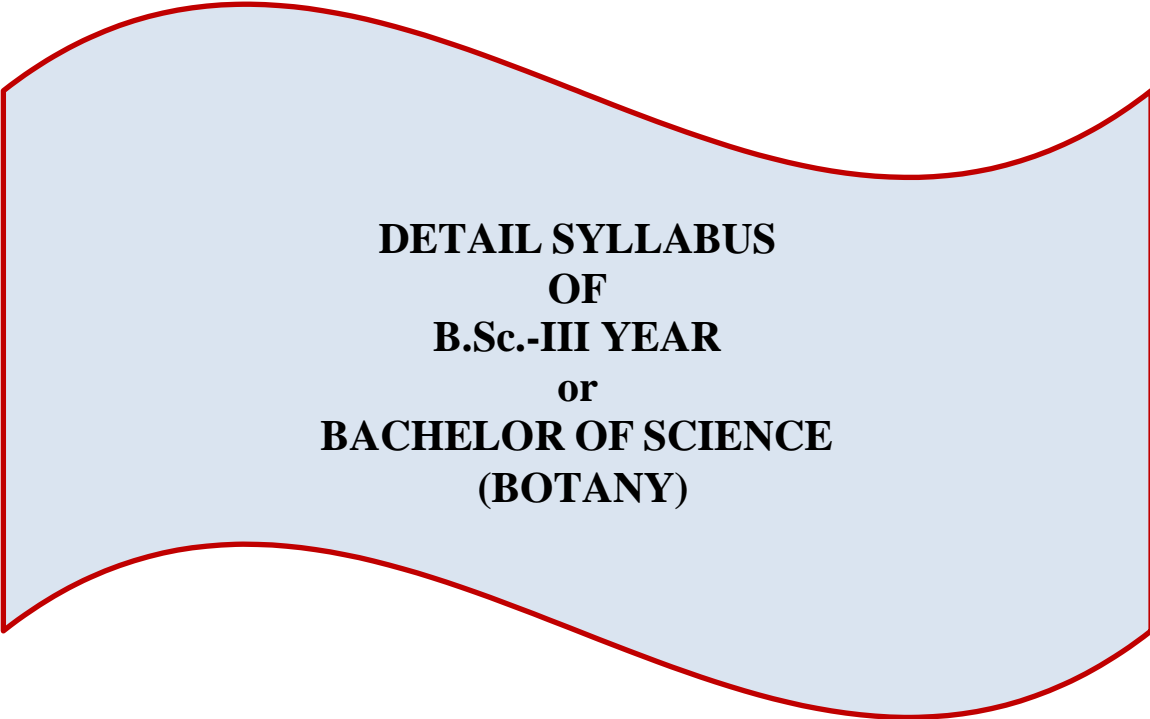
<https://www2.palomar.edu/users/warmstrong/econpls.htm>

<https://www.longdom.org/proceedings/phytochemistry-and-phytoconstituents-of-herbal-drugs-and-formulations-1668.htm>

Programme: <i>Diploma in Plant Identification, Utilization & Ethnomedicine</i>		Year: II	Semester: IV Paper-II
Subject: Botany			
Course Code: B040402P		Course Title: Commercial Botany & Phytochemical Analysis	
Course outcomes: After the completion of the course the students will be able to: <ol style="list-style-type: none"> 1. Know about the commercial products produced from plants. 2. Gain the knowledge about cultivation practices of some economic crops. 3. Understand about the ethnobotanical details of plants. 4. Learn about the chemistry of plants & herbal preparations 5. Can become a protected cultivator, aromatic oil producer, Pharmacologist or quality analyst in drug company. 			
Credits: 2		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-2			
Unit	Topic (Perform minimum any three experiments from each unit)		No. of Lectures (60hrs)
I	Economic Botany & Microtechnique: Cereals: Wheat (habit sketch, L.S./T.S. of grain, starch grains, micro-chemical tests); rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests) Legume: Pea or ground nut (habit, fruit, seed structure, micro-chemical tests) Source of sugars and starches: Sugarcane (habit sketch; cane juice- micro-chemical tests); potato (habit sketch, tuber morphology, T.S. of tuber to show localization of starch grains, W.M. of starch) grains, micro-chemical tests. Tea- tea leaves, tests for tannin Mustard- plant specimen, seeds, tests for fat in crushed seeds Timbers: section of young stem. Jute- specimen, transverse section of stem, tests for lignin on T.S. of stem and study of fiber following maceration technique. Study of specimens of economic importance mentioned in Unit I-& II		8
II	Commercial Cultivation Field visit to Green houses for understanding Floriculture & vegetables production Development of hydroponics nutrient solutions & running models for cultivation of vegetables Development of hydroponics nutrient solutions & running models for cultivation of fodder		8
III	Cultivating Medicinal and aromatic plants & Essential oil extraction a. Lemon grass/ Neem/ Zinger /Rose/Mint		7
IV	Documentation from Traditional Knowledge Digital Library, Mark the Geographic Indications on Map, Understand –Nakshtra Vatika, Navgrah vatika and develop in your college To extract the names of the plants and Botanical uses depicted in our epics. Visit NISCAIR, New Delhi		7
V	Ethnobotany Study of common plants used by tribes. <i>Aegle marmelos</i> , <i>Ficus religiosa</i> , <i>Cynodon dactylon</i> . Visit a tribal area and collect information on their traditional method of treatment using crude drugs. Familiarize with at least 5 folk medicines and study the cultivation, extraction and its medicinal application. Observe the plants of ethnobotanical importance in your area. Visit to an Ayurveda college or Ayurvedic Research Institute / Hospital		7

VI	Instrumentation and herbal Preparations Develop Capsules of herbs/ Develop Herbal oils/ Develop Poultice/cream Analyse some active ingredients using chromatography /Spectrophotometry	8												
VII	Pharmacognosy Organoleptic studies of plants mentioned in the theory : 1. Morphological studies of vegetative and floral parts. 2. Microscopic preparations of root, stem and leaf. 3. Stomatal number and stomatal index. 4. Vein islet number. 5. Palisade ratio. 6. Fibres and vessels (maceration). 7. Starch test 8. Proteins and lipid test	8												
VIII	Phytochemistry: Determination of the percentage of foreign leaf in a drug composed of a mixture of leaves. Dimensions of Calcium oxalate crystals in powdered crude drug. Preliminary phytochemical tests for alkaloids, terpenoids, glycosides, volatile oils, tannins & resins. Any 5 herbal preparations.	7												
<p>Suggested Readings: Course Books published in Hindi may be prescribed by the Universities.</p> <ol style="list-style-type: none"> 1. Plant Ecology And Economic Botany by Dhankar - Sharma - Trivedi, RBD Publication 2. Shiva Kant, Pankaj Kumar Brahmiya : Thakur Publication 3. PHARMACOGNOSY ...Hindi Edition (Paperback, Hindi, Dr. Akancha Rashi, KHUSHAL JASWANI), RM Publication 4. Pharmacognosy ...Hindi Edition (Paperback, Hindi, Dr. Akancha Rashi, KHUSHAL JASWANI), RM Publication <ol style="list-style-type: none"> 1. Wallis, T. E. 1946. Textbook of Pharmacognosy, J & A Churchill Ltd. 2. Roseline, A. 2011. Pharmacognosy. MJP Publishers, Chennai. 3. Jain S. K. 1989. Methods and approaches in Ethnobotany, Society of Ethnobotanists, Lucknow. 4. Pal, D.C. & Jain, S.K., 1998. Tribal Medicine. Naya Prakash Publishers, Calcutta. 5. Datta & Mukerji, 1952. Pharmacognosy of Indian roots of Rhizome drugs. Bulletin No.1 Ministry of Health, Govt. of India. 6. Young Ken, H.W., 1948. Text Book of Pharmacognosy. Blakiston C., Philadelphia. 7. Shukla, R.S., 2000. Forestry for tribal development. A.H. Wheeler & Co. Ltd., India. 8. Raychudhuri, S.P., 1991. (Ed.) Recent advances in Medicinal aromatic and spice crops. Vol.1, Today & Tomorrow's printers and publishers, New Delhi. 9. Khasim S.M Botanical Microtechniques: Principles and Practice- 10. Sambamurthy, AVSS & Subrahmanyam, NS (2000). Economic Botany of Crop Plants. Asiatech Publishers. New Delhi. 11. Singh, D.K and K.V. Peter. 2014. Protected cultivation of horticultural crops. New India Publishing Agency 														
<p>This course can be opted as an elective by the students of the following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.A. (Curators), B.A. Arch., BAMS</p>														
<p>Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">Internal Assessment</th> <th style="text-align: center;">Marks</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">Class Interaction</td> <td style="text-align: center;">5</td> </tr> <tr> <td style="text-align: center;">Quiz</td> <td style="text-align: center;">5</td> </tr> <tr> <td style="text-align: center;">Seminar</td> <td style="text-align: center;">7</td> </tr> <tr> <td style="text-align: center;">Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)</td> <td style="text-align: center;">8</td> </tr> <tr> <td></td> <td style="text-align: center;">25</td> </tr> </tbody> </table>			Internal Assessment	Marks	Class Interaction	5	Quiz	5	Seminar	7	Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8		25
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	25													

	<p>Course prerequisites: Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry). Facilities: Smart and Interactive Class Other Requisites: Video collection, Books, CDs, Flora, Herbarium, Access to On-line resources, Display Charts Lab requisites: Repository of economic products, Microscopes/ Botanical /Herbal Garden, TLC, Spectrophotometer.</p>
	<p>Suggested equivalent online courses: https://www.entrepreneurindia.co/Document/Download/pdfanddoc-144615-.pdf http://nopr.niscair.res.in/handle/123456789/45825 https://www.wipo.int/export/sites/www/tk/en/resources/pdf/medical_tk.pdf https://www.bentoli.com/commercial-farming-agriculture/</p>



**DETAIL SYLLABUS
OF
B.Sc.-III YEAR
or
BACHELOR OF SCIENCE
(BOTANY)**

BACHELOR OF SCIENCE (BOTANY)		
Programme/Class: <i>Bachelor of Science</i>	Year: III	Semester: V Paper-I
Subject: BOTANY		
Course Code: B040501T	Course Title: Plant Physiology, Metabolism & Biochemistry	
Course outcomes:		
After the completion of the course the students will be able to:		
1. Understand the role of Physiological and metabolic processes for plant growth and development.		
2. Learn the symptoms of Mineral Deficiency in crops and their management.		
3. Assimilate Knowledge about Biochemical constitution of plant diversity.		
4. Know the role of plants in development of natural products, nutraceuticals, dietary supplements, antioxidants		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week) 4-0-0		
Unit	Topic	No. of Lectures(60hrs)
I	Plant water relation, Mineral Nutrition, Transpiration and translocation in phloem Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation. Criteria of essentiality of elements; Role of essential elements; Symptoms of mineral deficiency in major crops, Transport of ions across cell membrane, active and passive transport, Composition of phloem sap, girdling experiment; Pressure flow model.	7
II	Carbon Oxidation Krebs cycle, Glycolysis, fate of pyruvate- aerobic and anaerobic respiration and fermentation, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of Krebs cycle, mitochondrial electron transport, oxidative phosphorylation, ATP-Synthetase, Chemiosmotic mechanism, P/O ratio, cyanide-resistant respiration, factors affecting respiration.	7
III	Nitrogen Metabolism Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes), Physiology and biochemistry of nitrogen fixation, Ammonia assimilation (GS-GOGAT), reductive amination and transamination, amino acid synthesis.	8
IV	Lipid Metabolism & Photosynthesis Lipid Metabolism: Synthesis and breakdown of triglycerides, -oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilization of lipids during seed germination, -oxidation. ; Photosynthesis: Pigments, Action spectra and Enhancement effect, Electron transport system and Photophosphorylation, C3 & C4 photosynthesis, CAM- Reaction and Significance	7
V	Plant Development, Movements, Dormancy & Responses Developmental roles of Phytohormones (auxins, gibberellins, cytokinins, ABA, ethylene.) autonomic & paratonic movements, Control and Coordination in plants, Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red-light responses on photomorphogenesis, Seed physiology & Dormancy, Vernalization & Senescence	8

This course can be opted as an elective by the students of following subjects: Open to all but special for following: B.Sc. Math, B.Sc. Statistics, B.Sc. Nutrition, B.Sc. Biophysics, B.Sc. Biotech,

Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests

Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	7
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8
	25

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry/ Biotech/ /Gardening)

Facilities: Smart and Interactive Class

Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts

Suggested equivalent online courses:

<https://www.classcentral.com/course/swayam-plant-physiology-and-metabolism-17732>

<https://www.wiziq.com/course/3249-plant-physiology-in-10-live-online-classes>

<https://www.easybiologyclass.com/plant-physiology-free-lecture-notes-online-tutorials-lecture-notes-ppts-mcqs/>

https://onlinecourses.swayam2.ac.in/cec19_bt09/preview

Programme/Class: Bachelor of Science	Year: III	Semester: V Paper-II
Subject: BOTANY		
Course Code: B040502T	Course Title: Molecular Biology & Bioinformatics	
Course outcomes:		
After the completion of the course the students will be able to:		
1. Understand nucleic acids, organization of DNA in prokaryotes and Eukaryotes, DNA replication mechanism, genetic code and transcription process.		
2. Know about Processing and modification of RNA and translation process, function and regulation of expression.		
3. Gain working knowledge of the practical and theoretical concepts of bioinformatics		
Credits: 4	CC / Elective	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week) 4-0-0		
Unit	Topic	No. of Lectures(60hrs)
I	Genetic material Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase, bacteriophage experiment, DNA structure, types of DNA, types of genetic material. DNA replication (Prokaryotes and eukaryotes): semi-conservative. DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi-conservative, semi discontinuous RNA priming, θ (theta) mode of replication, replication of linear, dsDNA, replicating the 5' end of linear chromosome including replication enzymes.	7

1. Primrose, SB. 1995. Principles of Genome Analysis. Blackwell Science Ltd. Oxford, UK..
2. E.J. Gardner and D.P. Snustad. PRINCIPAL OF GENETICS (1984), John Wiley & Sons, New York.
3. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., 2008 Molecular Biology of the Gene 6th edition. Cold Spring Harbour Lab. Press, Pearson Pub.
4. Freifelder - Molecular Biology.
5. P.K. Gupta. BIOTECHNOLOGY AND GENOMICS. Rastogi Publications, 7th Reprint (1st Edition): 2016-2017.
6. Ghosh, Z., Mallick, B. (2008). Bioinformatics – Principles and Applications, 1st edition. New Delhi, Delhi: Oxford University Press.
7. Baxevanis, A.D. and Ouellette, B.F., John (2005). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd edition. New Jersey, U.S.: Wiley & Sons, Inc.
8. Roy, D. (2009). Bioinformatics, 1st edition. New Delhi, Delhi: Narosa Publishing House.
9. Andreas, D., Baxevanis, B.F., Francis, Ouellette. (2004). Bioinformatics: A practical guide to the analysis of genes and proteins, 3rd edition. New Jersey, U.S.: John Wiley and Sons.
10. Pevsner J. (2009). Bioinformatics and Functional Genomics, 2nd edition. New Jersey, U.S.: Wiley Blackwell.
11. Xiong J. (2006). Essential Bioinformatics, 1st edition. Cambridge, U.K.: Cambridge University Press
12. A Textbook Of Basic And Molecular Genetics (pb) ISBN : 9788188826193 Edition : 01 Year : 2018 Author : Dr. Parihar

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This course can be opted as an elective by the students of following subjects:

Open to all but special for following: B.Sc. Math, B.Sc. Statistics, B.Sc. Nutrition, B.Sc. Biophysics, B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture.

Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	7
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8
	25

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry/ Biotech)

Facilities: Smart and Interactive Class

Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts

Suggested equivalent online courses:

<https://www.edx.org/learn/molecular-biology>

<https://www.vlab.co.in/broad-area-biotechnology-and-biomedical-engineering>

<https://www.classcentral.com/course/swayam-genetic-engineering-theory-and-application-14090>

<https://www.coursera.org/courses?query=genetics>

<https://www.coursera.org/courses?query=molecular%20biology>

<https://www.edx.org/learn/genetic-engineering>

<https://www.mooc-list.com/tags/genetic-engineering>

<https://www.classcentral.com/course/edx-molecular-biology-part-1-dna-replication-and-repair-2907>

<https://nptel.ac.in/courses/102/103/102103013/>

Programme/Class: Bachelor of Science		Year: III	Semester: V Paper-III
Subject: Botany			
Course Code: B040503P		Course Title: Experiments in physiology, Biochemistry & molecular biology	
Course outcomes:			
After the completion of the course the students will be able to:			
<ol style="list-style-type: none"> 1. Know and authentic the physiological processes undergoing in plants along with their metabolism 2. Identify Mineral deficiencies based on visual symptoms 3. Understand and develop skill for conducting molecular experiments for genetic engineering 			
Credits: 2		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week) 0-0-2			
Unit	Topic*		No. of Lectures(60 hrs)
<i>*(Perform any three from each unit based on facility)</i>			
I	Plant water relation, Mineral Nutrition and translocation in phloem 1. Determination of osmotic potential of plant cell sap by plasmolytic method using leaves of Rhoeo / Tradescantia. 2. Osmosis – by potato osmoscope experiment 3. Effect of temperature on absorption of water by storage tissue and determination of Q ₁₀ . 4. Experiment to demonstrate the transpiration phenomenon with the bell jar method 5. Experiment for demonstration of Transpiration by Four-Leaf Experiment: 6. Structure of stomata (dicot & monocot) 7. Determination of rate of transpiration using cobalt chloride method. 8. Experiment to measure the rate of transpiration by using Farmer’s Potometer 9. Experiment to measure the rate of transpiration by using Ganong’s potometer 10. Effect of Temperature on membrane permeability by colorimetric method. 11. Study of mineral deficiency symptoms using plant material/photographs.		8
II	Nitrogen Metabolism, Photo Synthesis & Respiration 1. A basic idea of chromatography: Principle, paper chromatography and column chromatography; demonstration of column chromatography. 2. Separation of plastidial pigments by solvent and paper chromatography. 3. Estimation of total chlorophyll content from different chronologically aged leaves (young, mature and senescence) by Arnon method. 4. Effect of HCO ₃ concentration on oxygen evolution during photosynthesis in an aquatic plant and to find out the optimum and toxic concentration (either by volume measurement or bubble counting). 5. Measurement of oxygen uptake by respiring tissue (per g/hr.) 6. Determination of the RQ of germinating seeds. 7. Effect of light intensity on oxygen evolution in photosynthesis using Wilmott’ bubble		8
III	Plant Development, Movements, Dormancy & Responses 1. Geotropism and phototropism — Klinostät 2. Hydrotropism a. Measurement of growth — Arc and Liver Auxonometer 3. To study the phenomenon of seed germination (effect of light). 4. To study the induction of amylase activity in germinating grains.		8

	<ol style="list-style-type: none"> 5. Test of seed viability by TTC method. 6. To study the effect of different concentrations of IAA on <i>Avena</i> coleoptile elongation (IAA bioassay) 	
IV	<p>Techniques for biochemical analysis</p> <ol style="list-style-type: none"> 1. Weighing and Preparation of solutions -percentage, molar & normal solutions, dilution from stock solution etc. 2. Separation of amino acids by paper chromatography. 3. Detection of organic acids: citric, tartaric, oxalic and malic from laboratory samples., 4. Qualitative Analysis of carbohydrates, 5. Estimation of reducing sugar by anthrone method, 6. Qualitative Analysis of Lipids 7. Qualitative analysis of Amino acids and Proteins 8. Quantitative Analysis of Nucleic Acids, 9. Analysis of dietary supplements, nutraceuticals & antioxidants 10. Testing of adulterants in food items. 	8
V	<p>Genetic material</p> <ol style="list-style-type: none"> 1. Instruments and equipments used in molecular biology. 2. Preparation of LB medium and cultivating E.coli on it. 3. Isolation of Genomic DNA 4. Isolation of DNA from plants 5. Examination of the purity of DNA by agarose gel electrophoresis. 6. Quantification of DNA by UV-spectrophotometer 7. Estimation of DNA by diphenylamine method. 	7
VI	<p>Preparation of models/ charts:</p> <ol style="list-style-type: none"> 1. Study of experiments establishing nucleic acid as genetic material (Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments)through photographs 2. Numericals based on DNA re-association kinetics (melting profiles and Cot curves) 3. Study of DNA replication through photographs: Modes of replication - Rolling circle, Theta and semi-discontinuous ; Semiconservative model of replication (Messelson and Stahl's experiment); Telomerase assisted end-replication of linear DNA 4. Study of structures of : tRNA (2D and 3D); prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs 5. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozymes and Alternative splicing 6. Understanding the regulation of lactose (lac) operon (positive & negative regulation) and tryptophan (trp) operon (Repression and De-repression & Attenuation) through photographs. 7. Understanding the mechanism of RNAi by photographs 	7
VII	<p>Genetic Engineering</p> <ol style="list-style-type: none"> 1. Isolation of protoplasts. 2. Construction of restriction map of circular and linear DNA from the data provided. 3. Isolation of plasmid DNA. 4. Restriction digestion and gel electrophoresis of plasmid DNA (demonstration/ photograph). 5. Calculate the percentage similarity between different cultivars of a species using RAPD profile. Construct a dendrogram and interpret results. 	7

	6. Agarose gel analysis of plasmid DNA 7. Restriction digestion of plasmid DNA -Demonstration of PCR	
VIII	Applications of Genetic engineering 1. ELISA Test, 2. Viability tests of cells 3. Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment. 4. Study of steps of genetic engineering for production of Bt cotton, Golden rice, FlavrSavr tomato through photographs.	7

Suggested Readings:

Course Books published in Hindi may be prescribed by the Universities.

1. [Hindi text]
1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. A Laboratory Manual Of Plant, Physiology, Biochemistry And Ecology ISBN : 9788177544589 Edition : 01 Year : 2012 Author : Akhtar Inam Publisher : Agrobios (India)
3. Advanced Methods In Physiology And Biochemistry (pb) ISBN : 9789381191132 Edition : 01 Year : 2016 Author : Padmanaban G , Chandrasekaran CN , Thangavelu AU , Dr. Sivakumar R , Kalimuthu N , Dr. Boominathan P , Dr. Anbarasan P, Agrobios.
4. Methods in Plant Biochemistry and Molecular Biology. 1997. Dashek, WV (ed.). CRC Press.
5. Wilson and Walker .Practical Biochemistry: Principles and Techniques. Cambridge University Press.U.K.
6. Thimmaiah, SR. 2004. Standard Methods of Biochemical Analysis. Kalyani Publishers.
7. Henry, RJ. 1997. Practical Application of Plant Molecular Biology. Chapman & Hall, London

This course can be opted as an elective by the students of following subjects:

Open to all but special for following: B.Sc. Math, B.Sc. Statistics, B.Sc. Nutrition, B.Sc. Biophysics, B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	7
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8
	25

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry/ Biotech/ /Gardening)

Facilities: Smart and Interactive Class

Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts

Lab requisites: Electrophoresis units, Gelrocker, UV-transilluminator, Vortex Mixer, Shaker, CVT,

HiMedia Biotechnology &Molecular biology Kits/Chemicals, Micropipettes, Elisa reader/Microtitre Reader

Suggested equivalent online courses:

<https://www.edx.org/learn/molecular-biology>

<https://krishikosh.egranth.ac.in/handle/1/5810039999>

<https://www.classcentral.com/course/swayam-genetic-engineering-theory-and-application-14090>

<https://www.coursera.org/courses?query=genetics>

<https://www.coursera.org/courses?query=molecular%20biology>

<https://www.edx.org/learn/genetic-engineering>

<https://www.mooc-list.com/tags/genetic-engineering>

<https://www.classcentral.com/course/edx-molecular-biology-part-1-dna-replication-and-repair-2907>

Programme/Class: Bachelor of Science	Year: III	Semester: V Paper-IV
Subject: BOTANY		
Course Code: - B040504R	Course Title: Project in Botany for Pre-graduation	
Course outcomes:		
<ul style="list-style-type: none"> ● Project work will supplement field experimental learning and deviations from classroom and laboratory transactions. ● project work will enhance the capability to apply gained knowledge and understanding for selecting, solving and decision-making processes. ● It will promote creativity and the spirit of enquiry in learners. ● They will learn to consult Scientists, libraries, laboratories and herbariums and learn importance of discussions, Botanical & field trips, print and electronic media, internet etc. along with data documentation, compilation, analysis & representation in form of dissertation writing. ● It will enhance their abilities, enthusiasm, and interest. 		
Credits: 03	Core: Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-3.		
Suggestive List Of PROJECTS		
<ol style="list-style-type: none"> 1. Rural Areas: Flora of a city/ village, Biodiversity of Village, Soil & seed testing service provision to farmers, 2. Industrial waste management 3. water pollution status of rural water & promotion of WASH in villages 4. Plant Disease identification in farms, nurseries and orchards. 5. Digital portal for plants: Campus, city or particular area 6. Rare and endangered plants & their conservation & domestication 7. Air pollution tolerance index (APTI) : Screening of sensitive/tolerant plant species at various locations in particular area 8. Science Communication by Creating science documentaries of innovators , Internet Science (Social media, Websites, Blogs, Youtube, Podcast etc.) 9. Science Outreach Talks and Public Sensitization for plant biodiversity conservation sensitization of public. 10. Phytochemistry of medicinal plants & their antimicrobial, nutraceutical and antioxidant properties 11. Study of pollen grains in different flowers 12. Study of stomata in different plants 13. Study of various types of secretory and special tissues in plants. 		
Refer: libraries, journals, Memoirs, encyclopaedias, herbaria, Museums, etc.		
This course can be opted as an elective by the students of following subjects:		Open to all
Suggested Continuous Evaluation Methods:		
Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:		
Internal Assessment		Marks
Class Interaction		5
Seminar		10
Thesis/dissertation		10
		25
Course prerequisites:		

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Biotech/ Forestry/ Microbiology/Gardening /biomedical Science.

Facilities: Smart and Interactive Class

Other Requisites: All listed under all papers of the course.

Suggested equivalent online courses:

<https://ndl.iitkgp.ac.in/>

https://asiafoundation.org/what-we-do/books-for-asia?gclid=CjwKCAiA7939BRBMEiwA-hX5J-QhBITSyPnvj3r8yeio-L9f5uTy1a6oEoALCLa9Ebu0pyz858yQZxoC5wkQAvD_BwE

<http://www.dli.ernet.in/>

<http://www.ulib.org/>

<http://www.tkdl.res.in/>

<http://www.vigyanprasar.gov.in/digilib>

<http://www.vigyanprasar.gov.in/digilib>

Directory of Open Access Repositories (DOAR)<http://www.opendoar.org>

Registry of Open Access Repositories (ROAR)<http://roar.eprints.org/>

http://www.iscnagpur.ac.in/knowledge_learning_files/5.7_General_Open_Access_e-Resources.pdf

Programme/Class: <i>Bachelor of Science</i>		Year: III	Semester: VI Paper-I
Subject: Botany			
Course Code: B040601T		Course Title: Cytogenetics, Plant Breeding & Nanotechnology	
Course outcomes: After the completion of the course the students will be able:			
<ol style="list-style-type: none"> 1. Acquire knowledge on cell ultrastructure. 2. Understand the structure and chemical composition of chromatin and concept of cell division. 3. Interpret the Mendel's principles, acquire knowledge on cytoplasmic inheritance and sex-linked inheritance. 4. Understand the concept of 'one gene one enzyme hypothesis' along with the molecular mechanism of mutation. 			
Credits: 4		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
Unit	Topic	No. of Lectures (60hrs)	
I	Cell biology Structure and function of cell wall, plasma membrane, ribosomes, Endoplasmic reticulum, golgi apparatus, mitochondria, chloroplast, lysosomes, peroxisomes and cell inclusions - Organization of nucleus: nuclear envelope, nucleoplasm and nucleolus. Chromosomal nomenclature- chromatids, centromere, telomere, satellite, secondary constriction. Organization of chromosomes- Nucleic acid and histones- types and classification. Lampbrush chromosomes and polytene chromosomes- Karyotype and idiogram. Cell cycle: G ₀ , G ₁ , S and G ₂ phases – mitosis: open and closed mitosis – amitosis - meiosis. Variation in Chromosome number (Numerical aberrations)- aneuploidy and Euploidy-haploidy, polyploidy- significance (Structural aberrations) - deletion, duplication, inversion and translocation.	8	
II	Genetics Chromosome theory of inheritance, crossing over and linkage; Incomplete dominance and codominance; Interaction of Genes; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Polygenic inheritance; Extra-nuclear Inheritance, Linkage, crossing over, Concept of sex determination and Sex chromosomes; Patterns of Sex determination in plants	7	
III	Plant breeding Plant introduction. Agencies of plant introduction in India, Procedure of introduction - Acclimatization – Achievements, Selection - mass selection, pure line selection and clonal selection. Genetic basis of selection methods, Hybridization: Procedure of hybridization, inter generic, inter specific, inter varietal hybridization with examples. Composite and synthetic varieties, Male sterility, Heterosis and its exploitation in plant breeding, Mutation, Molecular Breeding (use of DNA markers in plant breeding), achievements in India, Breeding for pest, pathogenic diseases and stress resistance.	8	
IV	Biostatistics: Definition, statistical methods, basic principles, variables- measurements, functions, limitations and uses of statistics. Biometry: Data, Sample, Population, random sampling, Frequency distribution- definition only, Central tendency– Arithmetic Mean, Mode and Median; Measurement of dispersion–Coefficient of variation, Standard Deviation, Standard error of Mean; Test of significance: chi- square test for goodness of fit. Computer application in biostatistics - MS Excel and SPSS	7	
V	Plant tissue culture	8	

7. Nelson, D.L. and Cox, M.M. (2008). *Lehninger Principles of Biochemistry*, 5th Ed., W.H. Freeman and Company.
8. Karp, G. (2010). *Cell Biology*, John Wiley & Sons, U.S.A. 6th edition.
9. Hardin, J., Becker, G., Skliensmith, L.J. (2012). *Becker's World of the Cell*. 8th edition. Pearson Education Inc. U.S.A.)
10. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). *Principles of Genetics*, John Wiley & sons, India. 8th e
11. Snustad, D.P. and Simmons, M.J. (2010). *Principles of Genetics*, John Wiley & Sons Inc., India. 5th edition.
12. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). *Concepts of Genetics*. Benjamin Cummings, U.S.A..
13. 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.
14. M K Raxdan *An Introduction to Plant Tissue Culture –*; Oxford & IBH Publishing Co.Pvt. Ltd., New Delhi
15. Aggarwal SK (2009) *Foundation Course in Biology*, 2nd Edition, Ane Books Pvt. Ltd
16. Allard RW (1960) *Principles of Plant Breeding*. John Willey and Sons. Inc. New York
17. BD Singh (2003) *Plant Breeding*. Kalyani Publishers
18. Cohn, N.S. (1964) *Elements of Cytology*. Brace and World Inc, New Delhi
19. Darnel, J. Lodish, Hand Baltimore, D. (1991) *Cell and molecular biology*. Lea and Fibiger, Washington.
20. De Robertis, E.D.P and Robertis, E.M.P (1991) *Cell and molecular biology* Scientific American books.
21. Dobzhansky, B (1961) *Genetic and origin of species*, Columbia university Press New York
22. Durbin (2007) *Biological Sequence Analysis*. Cambridge University Press India Pvt. Ltd
23. Gerald Karp (1985) *Cell biology*, Mc Graw Hill company..
24. Lewin, B, (1994) *Genes*, Oxford University Press, New York.
25. Lewis, W.H (1980) *Polyploidy*. Plenum Press, New York.
26. Nicholl T (2007) *An Introduction to Genetic Engineering*, Cambridge University Press India Pvt. Ltd
27. Roy S.C. and Kalayan kumar De (1997) *Cell biology*. New central Boos Calcutta
28. Sandhya Mitra, (1998) *Elements of molecular biology*. Macmillan, India Ltd.
29. Sharma JR (1994) *Principles and Practices of Plant Breeding*. Tata McGraw-Hill Pub. Co. New Delhi
30. Sharma, A.K and Sharma A (1980) *Chromosome technique Theory and practice*, Aditya Books, New York
31. Swanson, C.P (1957) *Cytology and Genetics*. Englewood cliffs, New York.
32. Taylor (2008) *Biological Sciences*. Cambridge University Press India Pvt. Ltd
33. Twymann, R.M. (1998) *Advanced molecular biology* Viva books New Delhi.
34. Veer Bala Rastogi (2008), *Fundamentals of Molecular Biology* Ane Books Pvt. Ltd
35. A. J. Nair . *Basics of Biotechnology-* Laxmi Publications, New Delhi.
36. S S Purohit and S K Mathur; *Biotechnology-Fundamentals and Application- Agrobotanica*, India.
37. A. J. Nair *Introduction to Genetic Engineering & Biotechnology*. Jones & Bartlett Publishers, Boston, USA.
38. H S Chawla *Introduction to Plant Biotechnology-*; Oxford & IBH publishing Co.Pvt.Ltd., New Delhi.
39. H D Kumar *Modern concept of Biotechnology*, Vikas Publishing House, Pvt. Ltd., New Delhi.
40. P C Trivedi , *Plant biotechnology*, Recent Advances Panima Publishing Corporation, New Delhi.
41. Du, C., and S. A. Jackson. 2019. Machine learning and complex biological data. *Genome Biology* 20: 76. <https://doi.org/10.1186/s13059-019-1689-0>
42. Alexis and Mathew Leon., *Fundamentals of Information Technology* Leon Vikas
43. Plant R. E., Stone N. D. (1991). *Knowledge-based systems in agriculture*. McGraw-Hill, Inc. 1221 Avenue of the Americas, New York, NY 10020.
44. Han S., Steward B.L., Tang L. (2016). Intelligent agricultural machinery and field robots. In Zhang Q. *Precision agriculture technology for crop farming* (pp.133-176). CRC Press, Taylor&Francis Group, New York.
45. Lucci S., Kopec D. (2013). *Artificial intelligence in the 21st century*. 22841 Quicksilver Drive Dulles, VA 20166.
46. V.Rajaraman *Introduction to Information Technology*,., Prentice Hill.
47. Ramesh Bangia *Learning Computer Fundamentals*,., Khanna Book Publishers
48. Bass, Joel, E and et. al., Allyn & Bacon, 2009 .*Methods for Teaching Science as Inquiry, The truth of science*, Newton R.G.,
49. R. Rangaswami (2009) *A Text book of Agriculture Statistics* .New Age International (P) Limited, Hyderabad.
50. Nageshwar Rao G. (2007) *Statistics for Agriculture Sciences* BS Publications. New Delhi
51. Nigam A.K. and Gupta, V.K. (1979) *Hand book on Analysis of Agricultural Experiments*.. IASRI Publication, New Delhi.

52. Panse V.G. Sukhatme P.V. (1985) Statistical methods for Agricultural workers . Indian Council of Agricultural Research, New Delhi
53. Snedecor GW. & Cochran WG. (1989) Statistical Methods . Iowa State University Press.
54. Design and Analysis of Experiments by Das M.N. and Giri N.C.(1986). Wiley Eastern Ltd., New Delhi.
55. Gomez, A.A. and Gomez, A.A.(1984) Statistical Procedures for Agricultural Research .John Wiley and Sons. New York.
56. Gupta, S.C. (2016) Fundamentals of Statistics .Himalaya Publishing House Mumbai - 400004, Maharashtra, India.
57. V.K. Kapoor (2007) Fundamentals of Applied statistics by Sultan Chand and Sons, New Delhi- 110 002
58. Yubing Xie. 2012. Nanotechnology. CRC Press.The Nanobiotechnology Handbook. CRC Press.
59. Sulabha K. Kulkarni. 2014 Nanotechnology : Principles and Practices. CP publishing, New Delhi.
60. B S Murty, P Shankar, Baldev Raj, B B Rath, James Murday. 2012. Textbook of Nanoscience and Nanotechnology. Springer
61. K. K. Chattopadhyay and A. N. Banarjee. 2009. Introduction to Nanoscience and Nanotechnology. PHI Publication.
62. Sharma A.K. 2005. Text Book Of Biostatistics I, Discovery Publishing House.
63. Annadurai, B. 2007. Text Book of Biostatistics. New Age International.
64. Gurumani, N. 2010. An Introduction to Biostatistics (2nd Edn). MJP Publishers.
65. David S. Goodshell. 2004. Bionanotechnology-Lessons from nature. John Wiley Publications.
66. R. Stephen Crespi, Tibtech, Patenting in Biotechnology - Part I, Vol. 9, 117-122, 1991.
67. Pattnaik, P.K., Kumar, R., Pal, S., Panda, S.N. (Eds.)IoT and Analytics for Agriculture,2020
68. <https://www.springer.com/gp/book/9789811391767>
69. <https://www.springer.com/gp/book/9789811550720>
70. Petersen Roger G. (1994) Agricultural Field Experiments Design and Analysis by Marcel Dekker, NewYork.

This course can be opted as an elective by the students of following subjects:

Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.Sc. Food Science, B.A. (Curators), B.A. Geology.

Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	7
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8
	25

Course pre-requisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry/ Biotech/ Math/Statistics/Chemistry/ Computer Science)

Facilities: Smart and Interactive Class

Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts

Suggested equivalent online courses:

<https://www.cytology-iac.org/educational-resources/virtual-slide-library>

<https://www.asct.com/ASCTWeb/Content/Cytopreparation Online Course.aspx>

<https://www.mooc-list.com/tags/genetics>

<https://www.coursera.org/learn/genetics-evolution>

<https://www.my-mooc.com/en/mooc/introduction-to-genetics-and-evolution/>

Further Suggestions:

Access to Statistics, Chemistry, Math and Biotechnology resources will be required

Programme/Class: <i>Bachelor of Science</i>		Year: III	Semester: VI Paper-II
Subject: Botany			
Course Code: B040602T		Course Title: Ecology & Environment	
Course outcomes:			
<ol style="list-style-type: none"> 1. acquaint the students with complex interrelationship between organisms and environment; 2. make them understand methods for studying vegetation, community patterns and processes, ecosystem functions, and principles of phytogeography. 3. This knowledge is critical in evolving strategies for sustainable natural resource management and biodiversity conservation. 			
Credits: 4		Core Compulsory/Elective	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
Unit	Topic	No. of Lectures (60 hrs)	
I	Natural resources & Sustainable utilization: Land Utilization, Soil degradation and management strategies; Restoration of degraded lands. Water , Wetlands; Threats and management strategies, Ramsar sites ,Forests: Major and minor forest products; Depletion, Biological Invasion, Energy: Renewable and non-renewable sources of energy , Contemporary practices in resource management : EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting.	7	
II	Ecology & Ecosystem Definition of Ecology, Ecological Factors, Positive and negative interactions. Ecosystem – Concept of an ecosystem-structure and function of an ecosystem. Abiotic and biotic com-Energy flow in an ecosystem Ecological Succession-Definition & types. Processes and types (autogenic, allogenic, autotrophic, heterotrophic, primary & secondary), Hydrosere and Xerosere. Food chains and food webs, Ecological pyramids, production and productivity; And components. Types of ecosystems: Forest Ecosystem, Grassland, Crop land, aquatic Ecosystems Ecological Adaptations – Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites.	8	
III	Soil Formation, Properties & Conservation Soil: Origin, Formation, composition, Soil types, Soil Profile, Soil Microorganisms, soil processes, Soil Erosion, Biogeochemical cycles, Soil Conservation: Biological– Contour farming, Mulching, Strip cropping, Terracing and Crop rotation. Mechanical–Basin Listing, Construction of dams, Watershed Management, Soil reclamation	7	
IV	Biodiversity and its conservation: Definition -genetic, species, and ecosystem diversity. Value of biodiversity: social, ethical, aesthetic and option values; hotspots of Biodiversity threats to biodiversity, Biotic communities and populations, their characteristics and dynamics. Endemic and endangered species of plants in India. Ecological niche, ecotypes, ecological indicators. <i>Conservation of Biodiversity:</i> Ex-situ and in-situ conservation, Red data book, botanical gardens, National park, Sanctuaries, hot & hottest spots and Bioreserves. Role of Seed Bank and Gene Bank Valuing plant resources, ecotourism, Role of NBPGR, FAO, BSI.	7	

6. Odum, F.P. Fundamentals of Ecology, Latest Ed., Saunders
7. Sharma, P.D. Elements of Ecology, Latest Ed., Rastogi Publications
8. Ambasht, R.S. & Ambasht, N.K. A Text Book of Plant Ecology, Latest Ed., CBS Publication & Distributors
9. Mani, M.S. Bio-Geography of India, Latest Ed., Springer-Verlag.
10. Mackenzie et al. Ecology, Latest Ed., Viva Books.
11. Gurevitch, J. (et al.), The Ecology of plants, 2002, Sinauer Associates.
12. Kimar, U. & Asija, M.J. Bio-diversity: Principles & Conservation, 2005, Student Edition, Agrobios (India)
13. Krishnamurthy, K.V. An Advanced Text Book on Biodiversity, 2003, Oxford & IBH Publishing Co. Ltd.
14. Mitra, D., Guha, J.K., Chowdhury, S.K. Studies in Botany, Vol. II (7th ed.) Moulik Library.
15. Primack, R.B. Essentials of Conservation Biology, 1993, Sinauer Associates.
16. Lo, C.P. & Yeung, A.K.W. Concepts and Techniques of Geographic Information Systems, 2002, Printice-Hall of India.
17. Cain, Bowman, Hacker. Ecology. 2014. 3rd Ed. Sinauer Associates
18. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
19. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
20. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.
21. Abbasi, S. A. (1998). Environmental Pollution and its Control. Cogent International, Pondicherry.
22. Abbasi, S. A. and Ramasamy, E. V. (1999). Biotechnological Methods of Pollution Control. Universities Press (India) Limited, Hyderabad.
23. Peavy, H. S., Rowe, D. R. and Tchobanoglaus, G. (1985). Environmental Engineering, Mc Graw Hill Book Company, Singapore.
24. Rand, M. C., Greenberg, A. E. and Taras, M. J. (Ed.) (1995). Standard methods for the examination of water and wastewater: 19th edition, American Public Health association (APHA), Washington, D.C.
25. Scragg, A. (1999). Environmental Biotechnology, Addison Wesley Longman, Singapore.
26. Tchobanoglaus, G. (1988). Wastewater Engineering: Treatment, Disposal, Reuse. Tata Mc Graw Hill, New Delhi.
27. Aarve, V. P., William, A. W. and Debra, R. R. (2002). Solid waste engineering. Cengage reading, USA.
28. George, T., Hilary, T. and Samuel, A. V. (1993). Integrated solid Waste Management, Engineering Principles and Management Issues, Mc Graw Hills.
29. George, T. and Frank, K. (2002). Handbook of solid waste management: (Second edition). Mc Graw Hills.
30. Kanthi, L. S. (2000). Basics of Solids and hazardous waste management Technologies. Prentice Hall.
31. Anonymous. 1997. National Gene Bank: Indian Heritage on Plant Genetic Resources (Booklet). National Bureau of Plant Genetic Resources, New York.
32. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries
33. with Policy and Science Considerations. Martinus Nijhoff Publishers.
34. Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.
35. Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.
36. Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.
37. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
38. Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.
39. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. & Sen, K. 2004. Climate Change and India. Universities Press, India.
40. Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2nd edition). Sage Publications.
41. Demers, M.N. 2005. Fundamentals of Geographic Information System. Wiley & Sons.
42. Richards, J. A. & Jia, X. 1999. Remote Sensing and Digital Image Processing. Springer.
43. Sabins, F. F. 1996. Remote Sensing: Principles an Interpretation. W. H. Freeman.
44. Gaston, K J. & Spicer, J.I. 1998. Biodiversity: An Introduction. Blackwell Science, London,
45. Singh, J. S. & Singh, S. P. 1987. Forest vegetation of the Himalaya. The Botanical Review 53:80-192.
46. Sodhi, N.S. & Ehrlich, P.R. (Eds). 2010. Conservation Biology for All. Oxford University Press.
47. Sodhi, N.S., Gibson, L. & Raven, P.H. 2013. Conservation Biology: Voices from the Tropics. Wiley-Blackwell, Oxford, UK.

This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Microbiology, B.Sc. Agriculture, B.A. (Curators), B.A. Archaeology, B.A. Geology

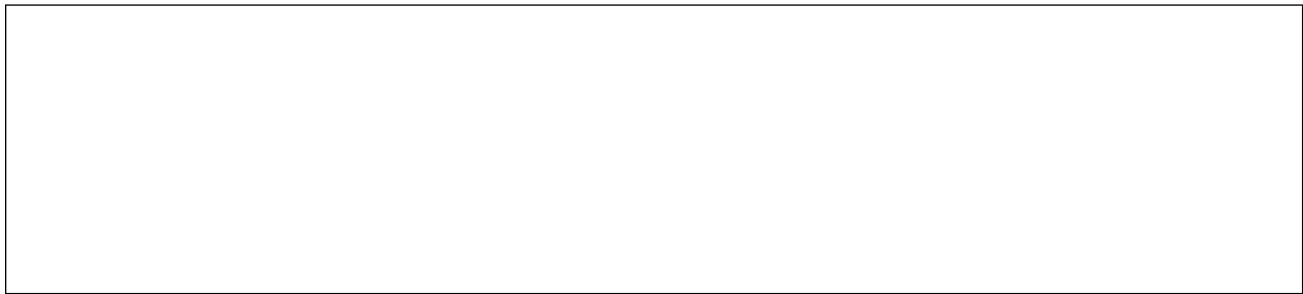
Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	7
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8
	25
<p>Course prerequisites: Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Biotech/ Forestry/ Microbiology/Gardening /biomedical Science. Facilities: Smart and Interactive Class Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts</p> <p>Suggested equivalent online courses: https://community.plantae.org/tags/mooc uturerelearn.com/courses/teaching-biology-inspiring-students-with-plants-in-science https://www.coursera.org/courses?query=plants http://egyankosh.ac.in/handle/123456789/53530</p>	

Programme/Class: <i>Bachelor of Science</i>	Year: III	Semester: VI Paper-III
Subject: Botany		
Course Code: B040603P	Course Title: Lab on Cytogenetics, Conservation & Environment management	
<p>Course outcomes: After the completion of the course the students will be able:</p> <ol style="list-style-type: none"> To perform all experiments related to the semester-i.e. Plant tissue cultured plants, conducting breeding on field, conserving and depolluting the environment. Can be employed in environment impact assessment companies & start his own venture 		
Credits: 2		Core Compulsory
Max. Marks: 25+75		Min. Passing Marks:
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-2		
Unit	Topic	No. of Lectures(60hrs)
I	<p>Cell biology</p> <ol style="list-style-type: none"> Study of plant cell structure with the help of epidermal peel mount of Onion/Rhoeo/Crinum Measurement of cell size by the technique of micrometry. Counting cells per unit volume with the help of haemocytometer (Yeast/pollen grains) Determination of mitotic index and frequency of different mitotic stages in pre-fixed root tips of <i>Allium cepa</i>. 	7

II	Genetics <ol style="list-style-type: none"> 1. Monohybrid cross (Dominance and incomplete dominance) 2. Dihybrid cross (Dominance and incomplete dominance) 3. Gene interactions (All types of gene interactions mentioned in the syllabus) <ol style="list-style-type: none"> a. Recessive epistasis 9: 3: 1. b. Dominant epistasis 12: 3: I c. Complementary genes 9: 7 d. Duplicate genes with cumulative effect 9: 6: 1 e. Inhibitory genes 13: 3 4. Observe the genetic variations among inter and intra specific plants. 5. Demonstration of Breeding techniques-Hybridization, case studies of mutation, polyploidy, emasculation experiment. 	8
III	Biostatistics: <ol style="list-style-type: none"> 1. Univariate analysis of statistical data: Statistical tables, mean, mode, median, standard deviation and standard error (using seedling population / leaflet size). 2. Calculation of correlation coefficient values and finding out the probability. 3. Determination of goodness of fit in Mendelian and modified mono- and dihybrid ratios (3:1, 1:1, 9:3:3:1, 1:1:1:1, 9:7, 13:3, 15:1) by Chi-square analysis and comment on the nature of inheritance. 3. Computer application in biostatistics - MS Excel and SPSS 	7
IV	Plant tissue culture <ol style="list-style-type: none"> 1. Familiarization of instruments and special equipments used in the plant tissue culture experiments 2. Preparation of plant tissue culture medium, and sterilization, Preparation of stock solutions of nutrients for MS Media. 3. Surface sterilization of plant materials for inoculation (implantation in the medium) 4. Micropropagation of potato/tomato/ - Demonstration 5. Protoplast isolation and culturing – Demonstration 	8
V	Ecology & Environment <ol style="list-style-type: none"> 1. Ecological Adaptations: Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites 2. Study of morphological adaptations of hydrophytes and xerophytes (four each). 3. Study of biotic interactions of: Stem parasite (Cuscuta), Root parasite (Orobanchae) Epiphytes, Predation (Insectivorous plants). 4. Observation and study of different ecosystems mentioned in the syllabus. 5. Field visit to familiarize students with ecology of different sites 	8
VI	Soil Formation, Properties & Conservation <ol style="list-style-type: none"> 1. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper) 2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests. 3. Determination of organic matter of different soil samples by Walkley & Black rapid titration method. 4. Soil Profile study 5. Soil types of India-Map 	8
VII	Biodiversity and Phytogeography: <ol style="list-style-type: none"> 1. Study of community structure by quadrat method and determination of (i) Minimal size of the quadrat, (ii) Frequency, density and abundance of components (to be done during excursion/field visit). 2. Marking of vegetation types of India, World & Uttar Pradesh on maps 	7



Course pre-requisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry/ Biotech/ Math/Statistics/Chemistry/ Computer Science)

Facilities: Smart and Interactive Class

Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts

Lab requisites: Biotech instruments, environmental lab instruments.

Suggested equivalent online courses:

<https://www.cytology-iac.org/educational-resources/virtual-slide-library>

<https://www.asct.com/ASCTWeb/Content/Cytopreparation Online Course.aspx>

<https://www.mooc-list.com/tags/genetics>

<https://www.coursera.org/learn/genetics-evolution>

<https://www.my-mooc.com/en/mooc/introduction-to-genetics-and-evolution/>

Further Suggestions: Access to Statistics, Chemistry, Math and Biotechnology resources will be required

Programme/Class: Bachelor of Science	Year: III	Semester: VI /Project-II/ Paper-IV
Subject: BOTANY		
Course Code: - B040604R	Course Title: Project in Botany for Graduation	
<p>Course outcomes: After completing this course a student will have:</p> <ul style="list-style-type: none"> • Project work will supplement field experimental learning and deviations from classroom and laboratory transactions. • project work will enhance the capability to apply gained knowledge and understanding for selecting, solving and decision-making processes • It will promote creativity and the spirit of enquiry in learners. • They will learn to consult Scientists, libraries, laboratories and herbariums and learn importance of discussions, Botanical & field trips, print and electronic media, internet etc. along with data documentation, compilation, analysis & representation in form of dissertation writing • It will enhance their abilities, enthusiasm, and interest. 		
Credits: 03	Core: Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-3.		
SUGGESTIVE LIST OF PROJECTS		

<p>Prepare beds for growing nursery for herbs, shrubs and trees. Develop Green house facility in college and grow plants Develop hydroponics facility in college and grow plants. Develop botanical garden in the college with labelling Vertical gardens, roof gardens. Culture & art of making bonsai. Computer Aided Designing (CAD) for outdoor and indoor scaping Exposure to CAD (Computer Aided Designing) Phytochemical Analysis of Medicinal plants Bio composting and Vermicomposting. Performing Aromatherapy by essential Oils</p>										
<p>Refer: libraries, journals, Memoirs, encyclopaedias, herbaria, Museums, etc.</p>										
<p>This course can be opted as an elective by the students of following subjects: This course can be opted as an elective by the students of following subjects: Open to all</p>										
<p>Suggested Continuous Evaluation Methods:</p> <table border="1"> <thead> <tr> <th>Internal Assessment</th> <th>Marks</th> </tr> </thead> <tbody> <tr> <td>Class Interaction</td> <td>5</td> </tr> <tr> <td>Seminar</td> <td>10</td> </tr> <tr> <td>Thesis/dissertation</td> <td>10</td> </tr> <tr> <td></td> <td>25</td> </tr> </tbody> </table>	Internal Assessment	Marks	Class Interaction	5	Seminar	10	Thesis/dissertation	10		25
Internal Assessment	Marks									
Class Interaction	5									
Seminar	10									
Thesis/dissertation	10									
	25									
<p>Course prerequisites: Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Biotech/ Forestry/ Microbiology/Gardening /biomedical Science. Facilities: Smart and Interactive Class Other Requisites: All listed under all papers of the course.</p>										
<p>Suggested equivalent online courses: https://ndl.iitkgp.ac.in/ http://heecontent.upsdc.gov.in/Home.aspx (http://epathshala.nic.in/), http://epathshala.gov.in/ nptel.iitm.ac.in https://asiafoundation.org/what-we-do/books-for-asia?gclid=CjwKCAiA7939BRBMEiwA-hX5J-QhBITSyPnyj3r8yeio-L9f5uTy1a6oEoALCLa9Ebu0pyz858yQZxoC5wkQAvD_BwE http://www.dli.ernet.in/, http://www.ulib.org/ http://www.tkdl.res.in/, http://www.vigyanprasar.gov.in/digilib Directory of Open Access Repositories (DOAR)http://www.opendoar.org Registry of Open Access Repositories (ROAR)http://roar.eprints.org/ http://www.iscnagpur.ac.in/knowledge_learning_files/5.7_General_Open_Access_e-Resources.pdf</p>										

**Department of Higher Education
Government of Uttar Pradesh
Lucknow**



National Education Policy-2020

Common Minimum Syllabus for all UP State Universities and Colleges

For First Three Years of Higher Education (UG)

**Proposed Titles for Theory and Practical Papers
Under Graduate Programme
SUBJECT: ZOOLOGY**

Dr. Monisha Banerjee
Professor & Dean Research
Molecular & Human Genetics Lab
Department of Zoology
University of Lucknow, Lucknow

Dr. Samar Vir Singh Rathore
Assistant Professor
Department of Zoology
St. John's College
Agra, UP

Dr. Praveen Ojha
Sr. Assistant Professor
Department of Zoology
Kishori Raman PG College
Mathura, UP

Name	Designation	Affiliation
Steering Committee		
Mrs. Monika S. Garg, (I.A.S.) Chairperson Steering Committee	Additional Chief Secretary	Dept. of Higher Education U.P., Lucknow
Prof. Poonam Tandan	Professor, Dept. of Physics	Lucknow University, U.P.
Prof. Hare Krishna	Professor, Dept. of Statistics	CCS University Meerut, U.P.
Dr. Dinesh C. Sharma	Associate Professor, Dept. of Zoology	K.M. Govt. Girls P.G. College Badalpur, G.B. Nagar, U.P.
Supervisory Committee-Science Faculty		
Dr. Vijay Kumar Singh	Associate Professor, Dept. of Zoology	Agra College, Agra
Dr. Santosh Singh	Dean, Dept. of Agriculture	Mahatma Gandhi Kashi Vidhyapeeth, Varanasi
Dr. Baby Tabussam	Associate Professor, Dept. of Zoology	Govt. Raza P.G. College Rampur, U.P.
Dr. Sanjay Jain	Associate Professor, Dept. of Statistics	St. John's College, Agra

Syllabus Developed by:

S.No.	Name	Designation	Department	College/University
1.	Dr. Monisha Banerjee	Professor & Dean, Research	Zoology	University of Lucknow, Lucknow
2.	Dr. Samar Vir Singh Rathore	Assistant Professor	Zoology	St. John's College, Agra
3.	Dr. Praveen Ojha	Assistant Professor	Zoology	Kishori Raman PG College, Mathura

Semester-wise Titles of the Papers in B.Sc (Zoology)

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
1	I	B050101T	Cytology, Genetics and Infectious Diseases	Theory	04
		B050102P	Cell Biology and Cytogenetics Lab	Practical	02
	II	B050201T	Biochemistry and Physiology	Theory	04
		B050202P/R	Physiological, Biochemical & Hematology Lab	Practical/Field work	02
2	III	B050301T	Molecular Biology, Bioinstrumentation & Biotechniques	Theory	04
		B050302P	Bioinstrumentation & Molecular Biology Lab	Practical	02
	IV	B050401T	Gene Technology, Immunology and Computational Biology	Theory	04
		B050402P/R	Genetic Engineering and Counselling Lab	Practical/Field work	02
3	V	B050501T	Diversity of Non-Chordates, Parasitology and Economic Zoology	Theory	04
		B050502T	Diversity of Chordates and Comparative Anatomy	Theory	04
		B050503P	Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitology	Practical	02
	VI	B050601T	Evolutionary and Developmental Biology	Theory	04
		B050602T	Ecology, Ethology, Environmental Science and Wildlife	Theory	04
		B050603P	Lab on Environmental Science, Behavioral Ecology, Developmental Biology, Wildlife, Ethology	Practical	02

Proposed Year wise Structure of UG Program in Zoology

Programme/Year	Semester	Course Codes	Paper Title	Credits	Teaching Hours
1 Certificate Course in Medical Diagnostics & Public Health	I	B050101T	Cytology, Genetics and Infectious Diseases	04	60
		B050102P	Cell Biology & Cytogenetics Lab	02	60
	II	B050201T	Biochemistry and Physiology	04	60
		B050202P/R	Physiological, Biochemical & Hematology Lab	02	60
2 Diploma in Molecular Diagnostics and Genetic Counselling	III	B050301T	Molecular Biology, Bioinstrumentation & Biotechniques	04	60
		B050302P	Bioinstrumentation & Molecular Biology Lab	02	60
	IV	B050401T	Gene Technology, Immunology and Computational Biology	04	60
		B050402P/R	Genetic Engineering and Counselling Lab	02	60
3 Degree in Bachelor of Science	V	B050501T	Diversity of Non-Chordates, Parasitology and Economic Zoology	04	60
		B050502T	Diversity of Chordates and Comparative Anatomy	04	60
		B050503P	Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitology	02	60
	VI	B050601T	Evolutionary and Developmental Biology	04	60
		B050602T	Ecology, Ethology, Environmental Science and Wildlife	04	60
		B050603P	Lab on Environmental Science, Behavioral Ecology, Developmental Biology, Wildlife, Ethology	02	60

Subject prerequisite	
To study Zoology in undergraduate, a student must have studied Biology, Biotechnology or Life Science in Class 12.	
Programme Objectives (POs)	
<ol style="list-style-type: none"> 1. The programme has been designed in such a way so that the students get the flavour of both classical and modern aspects of Zoology/Animal Sciences. It aims to enable the students to study animal diversity in Indian subcontinent, environmental science and behavioural ecology. 2. The modern areas including cell biology and genetics, molecular biology, biochemistry, physiology followed by biostatistics, Evolutionary biology, bioinformatics and genetic engineering have been included to make the study of animals more interesting and relevant to human studies which is the requirement in recent times. 3. The lab courses have been designed in such a way that students will be trained to join public or private labs. 	
Certificate Course in Medical Diagnostics & Public Health	
B.Sc I Programme Specific Outcomes (PSOs)	
PSO1	This course introduces System Biology and various functional components of an organism. Emphasis will be on physiological understanding abnormalities and anomalies associated with white blood cells and red blood cells. The course emphasizes cell identification, cell differentiation and cell morphology evaluation procedures. This will enhance hematology analytical skills along with skill of using many instruments.
PSO 2	The students will learn the basic principles of genetics and how to prepare karyotypes to study the chromosomes.
PSO 3	How chromosomal aberrations are inherited in humans by pedigree analysis in families.
PSO 4	The students will have hands-on training in the techniques like microscopy, centrifugation and chromatography, and various biochemical techniques, preparation of slides which will help them in getting employment in pathology labs and contribute to health care system.
PSO 5	The Certificate courses will enable students to apply for technical positions in government and private labs/institutes.

Diploma in Molecular Diagnostics and Genetic Counselling	
B.Sc II Programme Specific Outcomes (PSOs)	
PSO1	The student at the completion of the course will be able to have a detailed and conceptual understanding of molecular processes viz. DNA to trait. The differential regulation of genes in prokaryotes and eukaryotes leads to the development of an organism from an embryo.
PSO 2	The students will be able to understand and apply the principles and techniques of molecular biology which prepares students for further career in molecular biology. Independently execute a laboratory experiment using the standard methods and techniques.
PSO 3	The principles of genetic engineering, gene cloning, immunology and related technologies will enable students to play an important role in applications of biotechnology in various fields like agriculture, forensic sciences, industry and human health and make a career out of it. Students can have their own start-ups as well.
PSO 4	The basic tools of bioinformatics will enable students to analyze large amount of genomic data and its application to evolutionary biology. Apply knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics existing software effectively to extract information from large databases and to use this information in computer modeling.
PSO 5	The Diploma courses will ensure employability in Hospitals/Diagnostics and Pathology labs with good hands-on training. It will also enable students to take up higher studies and Research as their career and work in renowned labs in the country and abroad.

Degree in Bachelor of Science	
B.Sc III Programme Specific Outcomes (PSOs)	
PSO1	<ul style="list-style-type: none"> This programme aims to introduce students to animal diversity of invertebrates and vertebrates. The students will be taught about invertebrates and vertebrates using observational strategies, museum specimens and field reports.
PSO 2	<ul style="list-style-type: none"> A variety of interacting processes generate an organism's heterogeneous shapes, size, and structural features.
PSO 3	<ul style="list-style-type: none"> Inclusion of ecology and environmental sciences will enrich students with our world which is crucial for human well being and prosperity. This section will provide new knowledge of the interdependence between people and nature that is vital for food production, maintaining clean air and water, and sustaining biodiversity in a changing climate.
PSO 4	<ul style="list-style-type: none"> Students will also come to know about the basic principle of life, how a cell divides leading to the growth of an organism and also reproduces to form new organisms.
PSO 5	<ul style="list-style-type: none"> The basic concepts of biosystematics, evolutionary biology and biodiversity will enable students to solve the biological problems related to environment.
PSO 6	<ul style="list-style-type: none"> At the end of the course the students will be capable enough to comprehend the reason behind such a huge diversity of animals and reason out why two animals are grouped together or remain separate due to similarities and differences which exist at many levels along with ecological, environmental and cellular inputs.
PSO 7	<ul style="list-style-type: none"> The Degree courses will enable students to go for higher studies like Masters and Ph.D in Zoology and Allied subjects.

Programme/Class: Certificate	Year: First	Semester: First
Subject: ZOOLOGY		
Course Code: B050101T	Course Title: Cytology, Genetics and Infectious Diseases	
Course outcomes: The student at the completion of the course will be able to: <ul style="list-style-type: none"> • Understand the structure and function of all the cell organelles. • Know about the chromatin structure and its location. • To be familiar with the basic principle of life, how a cell divides leading to the growth of an organism and also reproduces to form new organisms. • How one cell communicates with its neighboring cells? • Understand the basic principles of genetics and how genes (earlier called factors) are inherited from one generation to another. • Understand the Mendel's laws and the deviations from conventional patterns of inheritance. • Comprehend how environment plays an important role by interacting with genetic factors. • How to detect chromosomal aberrations in humans and study the pattern of inheritance by pedigree analysis in families. 		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	Min. Passing Marks: as per rules	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:4-0-0		
Unit	Topics	Total No. of Lectures (60)
I	Structure and Function of Cell Organelles I <ul style="list-style-type: none"> • Plasma membrane: chemical structure—lipids and proteins • Cell-cell interaction: cell adhesion molecules, cellular junctions • Endomembrane system: protein targeting and sorting, endocytosis, exocytosis <p>Introduction to all national and international Biologists (Zoologists) who have contributed/contributing to Zoological and Life Sciences as a mark of tribute to ancient and modern biology will be included as part of the Continuous Internal Evaluation (CIE)</p>	6
II	Structure and Function of Cell Organelles II <ul style="list-style-type: none"> • Cytoskeleton: microtubules, microfilaments, intermediate filaments • Mitochondria: Structure, oxidative phosphorylation • Peroxisome and ribosome: structure and function 	6
III	Nucleus and Chromatin Structure <ul style="list-style-type: none"> • Structure and function of nucleus in eukaryotes • Chemical structure and base composition of DNA and RNA • DNA supercoiling, chromatin organization, structure of chromosomes • Types of DNA and RNA 	8

IV	Cell cycle, Cell Division and Cell Signalling <ul style="list-style-type: none"> • Cell division: mitosis and meiosis • Cell cycle and its regulation, apoptosis • Signal transduction: intracellular signaling and cell surface receptors, via G-protein linked receptors, JAK-STAT pathway 	8
V	Mendelism and Sex Determination <ul style="list-style-type: none"> • Basic principles of heredity: Mendel's laws, monohybrid and dihybrid crosses • Complete and Incomplete Dominance • Penetrance and expressivity • Genic Sex-Determining Systems, Environmental Sex Determination, Sex Determination in <i>Drosophila</i>, Sex Determination in Humans • Sex-linked characteristics and Dosage compensation 	8
VI	Extensions of Mendelism, Genes and Environment <ul style="list-style-type: none"> • Extensions of Mendelism: Multiple Alleles, Gene Interaction • The Interaction Between Sex and Heredity: Sex-Influenced and Sex-Limited Characteristics • Cytoplasmic Inheritance, Genetic Maternal Effects • Genomic Imprinting, Anticipation • Interaction Between Genes and Environment: Environmental Effects on Gene Expression, Inheritance of Continuous Characteristics 	8
VII	Human Chromosomes and Patterns of Inheritance <ul style="list-style-type: none"> • Human karyotype • Chromosomal anomalies: Structural and numerical aberrations with examples • Pedigree analysis • Patterns of inheritance: autosomal dominant, autosomal recessive, X-linked recessive, X-linked dominant 	8
VIII	Infectious Diseases <ul style="list-style-type: none"> • Introduction to pathogenic organisms: viruses, bacteria, fungi, protozoa, and worms. • Structure, life cycle, pathogenicity, including diseases, causes, symptoms and control of common parasites: <i>Trypanosoma</i>, <i>Giardia</i> and <i>Wuchereria</i> 	8

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).
5. Lewin B. Genes VIII. Pearson (2004).
6. Watson et al. Molecular Biology of the Gene. Pearson (2004).
7. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis KubyKuby Immunology. W H Freeman (2007).
8. Delves Peter J., Martin Seamus J., Burton Dennis R., Roitt Ivan M. Roitt's Essential Immunology, 13th Edition. Wiley Blackwell (2017).
9. Shetty Nandini Immunology Introductory Textbook. New Age International. (2005)

Course Books published in Hindi may be prescribed by the Universities and Colleges

Course prerequisites: To study this course, a student must have had the subject biology in class/12th

Suggested Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Certificate	Year: First	Semester: First
Subject: ZOOLOGY		
Course Code: B050102P	Course Title: Cell Biology & Cytogenetics Lab	
Course outcomes: At the completion of the course students will learn Hands-on: <ol style="list-style-type: none"> To use simple and compound microscopes. To prepare slides and stain them to see the cell organelles. To be familiar with the basic principle of life, how a cell divides leading to the growth of an organism and also reproduces to form new organisms. The chromosomal aberrations by preparing karyotypes. How chromosomal aberrations are inherited in humans by pedigree analysis in families. The antigen-antibody reaction. 		
Credits: 2	Core: Compulsory	
Max. Marks: 25+75	Min. Passing Marks: as per rules	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4		
Unit	Topics	Total No. of Lectures (60)
I	<ol style="list-style-type: none"> To study different cell types such as buccal epithelial cells, neurons, striated muscle cells using Methylene blue. To study the different stages of Mitosis in root tip of onion. To study the different stages of Meiosis in grasshopper testis. To prepare molecular models of nucleotides, amino acids, dipeptides using bead and stick method. To check the permeability of cells using salt solution of different concentrations. 	15
II	<ol style="list-style-type: none"> Study of parasites (eg. Protozoans, helminths etc.) from permanent slides. To learn the procedures for preparation of temporary and permanent stained/unstained slides. 	15
III	<ol style="list-style-type: none"> Study of mutant phenotypes of <i>Drosophila</i>. Preparation of polytene chromosomes. Study of sex chromatin (Barr bodies) in buccal smear and hair bud cells (Human). Preparation of human karyotype and study the chromosomal aberrations with respect to number, translocation, deletion etc. from the pictures provided. To prepare family pedigrees. 	15
IV	Virtual Labs (Suggestive sites) https://www.vlab.co.in https://zoologysan.blogspot.com www.vlab.iitb.ac.in/vlab www.onlinelabs.in www.powershow.com https://vlab.amrita.edu https://sites.dartmouth.edu	15

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).
5. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis KubyKuby Immunology. W H Freeman (2007).
6. Kesar, Saroj and Vashishta N. (2007). Experimental Physiology: Comprehensive Manual. Heritage Publishers, New Delhi

Course Books published in Hindi may be prescribed by the Universities and Colleges

Course prerequisites: To study this course, a student must have had the subject biology in class/12th
The eligibility for this paper is 10+2 from Arts/ Commerce/ Science

Suggested Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

Further Suggestions: None

At the End of the whole syllabus any remarks/suggestions: University must ensure incorporation of all 04 units including virtual labs in practical evaluation.

Programme/Class: Certificate	Year: First	Semester: Second
Subject: ZOOLOGY		
Course Code: B050201T	Course Title: Biochemistry and Physiology	
Course outcomes:		
The student at the completion of the course will learn:		
<ul style="list-style-type: none"> • To develop a deep understanding of structure of biomolecules like proteins, lipids and carbohydrates • How simple molecules together form complex macromolecules. • To understand the thermodynamics of enzyme catalyzed reactions. • Mechanisms of energy production at cellular and molecular levels. • To understand systems biology and various functional components of an organism. • To explore the complex network of these functional components. • To comprehend the regulatory mechanisms for maintenance of function in the body. 		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	Min. Passing Marks: as per rules	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:4-0-0		
Unit	Topics	Total No. of Lectures (60)
I	Structure and Function of Biomolecules <ul style="list-style-type: none"> • Structure and Biological importance of carbohydrates (Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates) • Lipids (saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids) • Structure, Classification and General properties of α-amino acids; Essential and non-essential α-amino acids, Levels of organization in proteins; Simple and conjugate proteins. 	8
II	Enzyme Action and Regulation <ul style="list-style-type: none"> • Nomenclature and classification of enzymes; Cofactors; Specificity of enzyme action • Isozymes; Mechanism of enzyme action • Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of K_m and V_{max}, Lineweaver-Burk plot; Enzyme inhibition; • Allosteric enzymes and their kinetics; Regulation of enzyme action 	8
III	Metabolism of Carbohydrates and Lipids <ul style="list-style-type: none"> • Metabolism of Carbohydrates: glycolysis, citric acid cycle, gluconeogenesis, phosphate pentose pathway • Glycogenolysis and Glycogenesis • Lipids --- Biosynthesis of palmitic acid; Ketogenesis, 	8

	<ul style="list-style-type: none"> • β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms 	
IV	Metabolism of Proteins and Nucleotides <ul style="list-style-type: none"> • Catabolism of amino acids: Transamination, Deamination, Urea cycle • Nucleotides and vitamins • Review of mitochondrial respiratory chain, Oxidative phosphorylation, and its regulation 	6
V	Digestion and Respiration <ul style="list-style-type: none"> • Structural organization and functions of gastrointestinal tract and associated glands • Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Histology of trachea and lung • Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood Respiratory pigments, Dissociation curves and the factors influencing it; Control of respiration 	7
VI	Circulation and Excretion <ul style="list-style-type: none"> • Components of blood and their functions • Haemostasis: Blood clotting system, Blood groups: Rh factor, ABO and MN • Structure of mammalian heart • Cardiac cycle; Cardiac output and its regulation, Electrocardiogram, Blood pressure and its regulation • Structure of kidney and its functional unit; Mechanism of urine formation 	8
VII	Nervous System and Endocrinology <ul style="list-style-type: none"> • Structure of neuron, resting membrane potential • Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers • Types of synapse • Endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them • Classification of hormones; Mechanism of Hormone action 	8
VIII	Muscular System Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation and tetanus	7
Suggested Readings: <ol style="list-style-type: none"> 1. Nelson & Cox: Lehninger's Principles of Biochemistry: McMillan (2000) 2. Zubayet <i>al</i>: Principles of Biochemistry: WCB (1995) 3. Voet&Voet: Biochemistry Vols 1 & 2: Wiley (2004) 4. Murray <i>et al</i>: Harper's Illustrated Biochemistry: McGraw Hill (2003) Elliott and Elliott: Biochemistry and Molecular Biology: Oxford University Press 		

5. Guyton, A.C. & Hall, J.E. Textbook of Medical Physiology. XI Edition. Hercul Asia PTE Ltd. /W.B. Saunders Company. (2006).
6. Tortora, G.J. & Grabowski, S. Principles of Anatomy & Physiology. XI Edition John Wiley & sons (2006).
7. Christopher D. Moyes, Patricia M. Schulte. Principles of Animal Physiology. 3rd Edition, Pearson Education (2016).
8. Hill, Richard W., et al. Animal physiology. Vol. 2. Sunderland, MA: Sinauer Associates, (2004).
9. Chatterjee C C Human Physiology Volume 1 & 2. 11th edition. CBS Publishers(2016).

Course Books published in Hindi may be prescribed by the Universities and Colleges

Course prerequisites: To study this course, a student must have had the subject biology in class/12th

Suggested Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Certificate	Year: First	Semester: Second
Subject: ZOOLOGY		
Course Code: B050202P/R	Course Title: Physiological, Biochemical & Hematology Lab	
Course outcomes: The student at the completion of the course will be able to: <ul style="list-style-type: none"> • Understand the structure of biomolecules like proteins, lipids and carbohydrates • Perform basic hematological laboratory testing, • Distinguish normal and abnormal hematological laboratory findings to predict the diagnosis of hematological disorders and diseases. 		
Credits: 2	Core: Compulsory	
Max. Marks: 25+75	Min. Passing Marks: as per rules	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:0-0-4		
Unit	Topics	Total No. of Lectures (60)
I	<ol style="list-style-type: none"> 1. Estimation of haemoglobin using Sahli's haemoglobinometer 2. Preparation of haemin and haemochromogen crystals 3. Counting of RBCs and WBCs using Haemocytometer 4. To study different mammalian blood cell types using Leishman stain. 5. Recording of blood pressure using a sphygmomanometer 6. Recording of blood glucose level by using glucometer 	20
II	<ol style="list-style-type: none"> 1. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid 2. Recording of simple muscle twitch with electrical stimulation (or Virtual) 3. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex) 	15
III	<ol style="list-style-type: none"> 1. Ninhydrin test for α-amino acids. 2. Benedict's test for reducing sugar and iodine test for starch. 3. Test for sugar and acetone in urine. 4. Qualitative tests of functional groups in carbohydrates, proteins and lipids. 5. Action of salivary amylase under optimum conditions. 	10
IV	Virtual Labs (Suggestive sites) <ol style="list-style-type: none"> 1. https://www.vlab.co.in 2. https://zoologysan.blogspot.com 3. www.vlab.iitb.ac.in/vlab 4. www.onlinelabs.in 5. www.powershow.com 6. https://vlab.amrita.edu 7. https://sites.dartmouth.edu 	15

Suggested Readings:		
<ol style="list-style-type: none"> 1. Cox, M.M and Nelson, D.L. (2008). Lehninger’s Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York. 2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York. 3. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company. 4. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons 5. Victor P. Eroschenko. (2008). diFiore’s Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins. 6. Arey, L.B. (1974). Human Histology. IV Edition. W.B. Saunders. 7. Kesar, Saroj and Vashishta N. (2007). Experimental Physiology: Comprehensive Manual. Heritage Publishers, New Delhi 		
Course Books published in Hindi may be prescribed by the Universities and Colleges		
Course prerequisites: To study this course, a student must have had the subject biology in class/12 th The eligibility for this paper is 10+2 from Arts/ Commerce/ Science		
Suggested Continuous Evaluation Methods:		
Total Marks: 25		
House Examination/Test: 10 Marks		
Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks		
Class performance/Participation: 5 Marks		
Further Suggestions: None		

At the End of the whole syllabus any remarks/ suggestions: University must ensure incorporation of all 04 units including virtual labs in practical evaluation.

Programme/Class: Diploma	Year: Second	Semester: Third
Subject: ZOOLOGY		
Course Code: B050301T	Course Title: Molecular Biology, Bioinstrumentation & Biotechniques	
Course outcomes: The student at the completion of the course will be able to have: <ul style="list-style-type: none"> • A detailed and conceptual understanding of molecular processes viz. DNA to trait. • A clear understanding of the processes of central dogma viz. transcription, translation etc. underlying survival and propagation of life at molecular level. • Understanding of how genes are ultimately expressed as proteins which are responsible for the structure and function of all organisms. • Learn how four sequences (3 letter codons) generate the transcripts of life and determine the phenotypes of organisms. • How genes are regulated differently at different time and place in prokaryotes and eukaryotes. 		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	Min. Passing Marks: as per rules	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:4-0-0		
Unit	Topic	Total No. of Lectures (60)
I	Process of Transcription <ul style="list-style-type: none"> • Fine structure of gene • RNA polymerases • Transcription factors and machinery • Formation of initiation complex • Initiation, elongation and termination of transcription in prokaryotes and eukaryotes 	7
II	Process of Translation <ul style="list-style-type: none"> • The Genetic code • Ribosome • Factors involved in translation • Aminoacylation of tRNA, tRNA-identity, aminoacyltRNAsynthetase • Initiation, elongation and termination of translation in prokaryotes and eukaryotes 	7
III	Regulation of Gene Expression I <ul style="list-style-type: none"> • Regulation of gene expression in prokaryotes: <i>lac</i> and <i>trp</i> operons in <i>E. coli</i> • Regulation of gene expression in eukaryotes: Role of chromatin in gene expression • Regulation at transcriptional level, Post-transcriptional 	8

	<ul style="list-style-type: none"> modifications: Capping, Splicing, Polyadenylation • RNA editing. 	
IV	Regulation of Gene Expression II <ul style="list-style-type: none"> • Regulation of gene expression in eukaryotes: • Regulation at translational level, Post- translational modifications: protein folding etc. • Intracellular protein degradation • Gene silencing, RNA interference (RNAi) 	8
V	Principle and Types of Microscopes <ul style="list-style-type: none"> • Principle of Microscopy and Applications • Types of Microscopes: light microscopy, dark field microscopy, phase-contrast microscopy, • Fluorescence microscopy, confocal microscopy, electron microscopy 	6
VI	Centrifugation and Chromatography <ul style="list-style-type: none"> • Principle of Centrifugation • Types of Centrifuges: high speed and ultracentrifuge • Types of rotors: Vertical, Swing-out, Fixed-angle etc. • Principle and Types of Chromatography: paper, ion-exchange, gel filtration, HPLC, affinity 	8
VII	Spectrophotometry and Biochemical Techniques <ul style="list-style-type: none"> • Biochemical techniques: Measurement of pH, Preparation of buffers and solutions • Principle of Colorimetry/Spectrophotometry: Beer-Lambert law • Measurement, applications and safety measures of radio-tracer techniques 	8
VIII	Molecular Techniques <ul style="list-style-type: none"> • Detection of nucleic acid by gel electrophoresis • DNA sequencing DNA fingerprinting, RFLP • Polymerase Chain Reaction (PCR) • Detection of proteins, PAGE, ELISA, Western blotting 	8

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002).
5. Watson et al. Molecular Biology of the Gene. Pearson (2004).
6. Lewin. Genes VIII. Pearson (2004).
7. Pierce B. Genetics. Freeman (2004).
8. Sambrook et al. Molecular Cloning Vols I, II, III. CSHL (2001).
9. Primrose. Molecular Biotechnology. Panima (2001).
10. Clark & Switzer. Experimental Biochemistry. Freeman (2000)

Course Books published in Hindi may be prescribed by the Universities and Colleges

This course can be opted as an elective by the students of following subjects:

The eligibility for this paper is 10+2 with Biology as one of the subject

Suggested Continuous Evaluation Methods:

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

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Programme/Class: Diploma	Year: Second	Semester: Third
Subject: ZOOLOGY		
Course Code: B050302P	Course Title: Bioinstrumentation & Molecular Biology Lab	
Course outcomes: The student at the completion of the course will be able to <ul style="list-style-type: none"> • Understand the basic principles of microscopy, working of different types of microscopes • Understand the basic techniques of centrifugation and chromatography for studying cells and separation of biomolecules • Understand the principle of measuring the concentrations of macromolecules in solutions by colorimeter and spectrophotometer and use them in Biochemistry. • Learn about some of the commonly used advance DNA testing methods. 		
Credits: 2	Core: Compulsory	
Max. Marks: 25+75	Min. Passing Marks: as per rules	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4		
Unit	Topic	Total No. of Lectures (60)
I	<ol style="list-style-type: none"> 1. To study the working principle and Simple, Compound and Binocular microscopes. 2. To study the working principle of various lab equipments such as pH Meter, Electronic balance, use of glass and micropipettes, Laminar flow, Incubator, Waterbath, Centrifuge, Chromatography apparatus, etc. 	15
II	<ol style="list-style-type: none"> 1. To prepare solutions and buffers. 2. To measure absorbance in Colorimeter or Spectrophotometer. 3. Demonstration of differential centrifugation to fractionate different components in a mixture. 	15
III	<ol style="list-style-type: none"> 1. To prepare dilutions of Riboflavin and verify the principle of spectrophotometry. 2. To identify different amino acids in a mixture using paper chromatography. 3. Demonstration of DNA extraction from blood or tissue samples. 4. To estimate amount of DNA using spectrophotometer. 	15
IV	Virtual Labs (Suggestive sites) www.labinapp.com www.uwlax.edu www.labster.com www.onlinelabs.in www.powershow.in https://vlab.amrita.edu	15

	info@premiereducationaltechnologyies.com https://li.wsu.edu	
<p>Suggested Readings:</p> <ol style="list-style-type: none"> 1. Sambrook <i>et al</i> .Molecular Cloning Vols I, II, III. CSHL (2001). 2. Primrose. Molecular Biotechnology. Panima (2001). 3. Clark & Switzer. Experimental Biochemistry. Freeman (2000) <p style="text-align: center;">Course Books published in Hindi may be prescribed by the Universities and Colleges</p>		
<p>This course can be opted as an elective by the students of following subjects:</p> <p style="text-align: center;">The eligibility for this paper is 10+2 from Arts/Commerce/Science</p>		
<p>Suggested Continuous Evaluation Methods:</p> <p>House Examination/Test: 10 Marks</p> <p>Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks</p> <p>Class performance/Participation: 5 Marks</p>		
Further Suggestions: None		

At the End of the whole syllabus any remarks/ suggestions: University must ensure incorporation of all 04 units including virtual labs in practical evaluation.

Programme/Class: Diploma	Year: Second	Semester: Fourth
Subject: ZOOLOGY		
Course Code: B050401T	Course Title: Gene Technology, Immunology and Computational Biology	
Course outcomes: The student at the completion of the course will be able to: <ul style="list-style-type: none"> • Understand the principles of genetic engineering, how genes can be cloned in bacteria and the various technologies involved in it. • Know the applications of biotechnology in various fields like agriculture, industry and human health. • To have an in depth understanding about Immune System & its mechanisms. • Get introduced to DNA testing and utility of genetic engineering in forensic sciences. • Get introduced to computers and use of bioinformatics tools. • Enable students to get employment in pathology/Hospital. • Take up research in biological sciences. 		
Credits: 4		Core: Compulsory
Max. Marks: 25+75		Min. Passing Marks: as per rules
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		
Unit	Topic	Total No. of Lectures (60)
I	Principles of Gene Manipulation <ul style="list-style-type: none"> • Recombinant DNA Technology • Selection and identification of recombinant cells • Restriction Enzymes, DNA modifying enzymes, Cloning Vectors, Ligation • Gene transfer techniques, Gene therapy 	10
II	Applications of Genetic Engineering <ul style="list-style-type: none"> • Single cell proteins • Biosensors, Biochips • Crop and live stock improvement, development of transgenics • Development of DNA drugs and vaccines 	8
III	DNA Diagnostics <ul style="list-style-type: none"> • Genetic analysis of human diseases, detection of known and unknown mutations • Concept of pharmacogenomics and pharmacogenetics 	4
IV	Immune System and its Components <ul style="list-style-type: none"> • Historical perspective of Immunology, Innate and Adaptive Immunity, clonal selection, complement system • Structure and functions of different classes of immunoglobulins, Hypersensitivity • Humoral immunity and cell mediated immunity • HLA complex: organization, class I and II HLA molecules 	10
V	Biostatistics I <ul style="list-style-type: none"> • Calculations of mean, median, mode, variance, standard deviation • Concepts of coefficient of variation, Skewness, Kurtosis • Elementary idea of probability and application 	7

VI	Biostatistics II <ul style="list-style-type: none"> • Data summarizing: frequency distribution, graphical presentation- pie diagram, histogram • Tests of significance: one and two sample tests, t-test and Chi-square test 	7
VII	Basics of Computers <ul style="list-style-type: none"> • Basics (CPU, I/O units) and operating systems • Concept of homepages and websites, World Wide Web, URLs, using search engines 	6
VIII	Bioinformatics <ul style="list-style-type: none"> • Databases: nucleic acids, genomes, protein sequences and structures, Bibliography • Sequence analysis (homology): pairwise and multiple sequence alignments-BLAST, CLUSTALW • Phylogenetic analysis 	8
<p>Suggested Readings:</p> <ol style="list-style-type: none"> 1. Primrose & Twyman. Principles of Genome Analysis and Genomics. Blackwell (2003). 2. Hartl & Jones. Genetics: principles & Analysis of Genes & Genomes. Jones & Bartlett (1998). 3. Sambrook <i>et al.</i> Molecular Cloning Vols I, II, III. CSHL (2001). 4. Primrose. Molecular Biotechnology. Panima (2001). 5. Clark & Switzer. Experimental Biochemistry. Freeman (2000) 6. Sudbery. Human Molecular Genetics. Prentice-Hall (2002). 7. Wilson. Clinical Genetics-A Short Course, Wiley (2000). 8. Pasternak. An Introduction to Molecular Human Genetics. Fitzgerald (2000). 9. Biostatistical Analysis (Fourth Edition) by Jerrold H. Zarr, Pearson Education Inc., Delhi. 10. Statistical Methods (Eighth Edition) by G. W. Snedecor and W. G. Cochran, Wiley Blackwell 11. Biostatistics (Tenth Edition) by W.W. Daniel and C. L. Cross, Wiley 12. Introductory Biological Statistics (Fourth Edition) by John E. Havel, Raymond E. Hampton and Scott J. Meiners 13. Westhead <i>et al</i> Bioinformatics: Instant Notes. Viva Books (2003). <p style="text-align: center;">Course Books published in Hindi may be prescribed by the Universities and Colleges</p>		
<p>This course can be opted as an elective by the students of following subjects:</p> <p>The eligibility for this paper is 10+2 with Biology as one of the subject</p>		
<p>Suggested Continuous Evaluation Methods:</p> <p>House Examination/Test: 10 Marks</p> <p>Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks</p> <p>Class performance/Participation: 5 Marks</p>		
Further Suggestions: None		

At the End of the whole syllabus any remarks/ suggestions:

Programme/Class: Degree	Year: Second	Semester: Fourth
Subject: ZOOLOGY		
Course Code: B050402P/R	Course Title: Genetic Engineering and Counselling Lab	
Course outcomes: The student at the completion of the course will be able to: <ul style="list-style-type: none"> • Understand the principles of genetic engineering with hands-on experiments in mutation detection, testing of infectious diseases like Covid 19. • Get introduced to DNA testing and utility of genetic engineering in forensic sciences. • Apply knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics existing software effectively to extract information from large databases and to use this information in computer modeling. • Use bioinformatics tools to find out evolutionary/phylogenetic relationship of organisms using gene sequences. • Get employment in Hospitals/Diagnostic and forensic labs/Counsel families with genetic disorders. • Enable students to take up research in biological sciences. 		
Credits: 2	Core: Compulsory	
Max. Marks: 25+75	Min. Passing Marks: as per rules	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:0-0-4		
Unit	Topic	Total No. of Lectures (60)
I	1. Measure the pre and post clitellar lengths of earthworms and calculate mean, median, mode, standard deviation etc. 2. Measure the height and weight of all students in the class and apply statistical measures.	10
II	1. Determination of ABO Blood group 2. To perform bacterial culture and calculate generation time of bacteria. 3. To study Restriction enzyme digestion using teaching kits. 4. To detect genetic mutations by Polymerase Chain Reaction (PCR) using teaching kits. 5. Demonstration of agarose gel electrophoresis for detection of DNA. 6. Demonstration of Polyacrylamide Gel Electrophoresis (PAGE) for detection of proteins. 7. To calculate molecular weight of unknown DNA and protein fragments from gel pictures.	20
III	1. To learn the basics of computer applications 2. To learn sequence analysis using BLAST 3. To learn Multiple sequence alignment using CLUSTALW 4. To learn about Phylogenetic analysis using the programme PHYLIP. 5. To learn how to perform Primer designing for PCR	15

	using available softwares etc.	
IV	Virtual Labs (Suggestive sites) <ol style="list-style-type: none"> 1. Gel Documentation System- https://youtu.be/WPpt3-FanNE 2. Colorimeter- https://youtu.be/v4aK6G0bGuU 3. PCR Part 1- https://youtu.be/CpGX1UFSI4A 4. PCR Part 2- https://youtu.be/6lcHAYPTAEw 5. DNA isolation Part 1- https://youtu.be/QE7UI0JnY9A 6. DNA isolation part 2- https://youtu.be/-efr_HFeHxM 7. DNA curve- https://youtu.be/ubL8QxTeuG4 8. Spectrophotometer- https://youtu.be/ubL8QxTeuG4 9. Agarose Part 1- https://youtu.be/7gvHPFww--g 10. Agarose part 2- https://youtu.be/j_bOZCHNsSg 11. Use softwares like Primer3, NEB cutter 12. NCBI, BLAST, CLUSTAL W, PHYLIP 	15
Suggested Readings: <ol style="list-style-type: none"> 1. Primrose & Twyman. Principles of Genome Analysis and Genomics. Blackwell (2003). 2. Hartl & Jones. Genetics: principles & Analysis of Genes & Genomes. Jones & Bartlett (1998). 3. Sambrook <i>et al.</i> Molecular Cloning Vols I, II, III. CSHL (2001). 4. Primrose. Molecular Biotechnology. Panima (2001). <p style="text-align: center;">Course Books published in Hindi may be prescribed by the Universities and Colleges</p>		
This course can be opted as an elective by the students of following subjects: <p style="text-align: center;">The eligibility for this paper is 10+2 from Arts/Commerce/Science</p>		
Suggested Continuous Evaluation Methods: House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks		
Further Suggestions: None		

At the End of the whole syllabus any remarks/ suggestions: University must ensure incorporation of all 04 units including virtual labs in practical evaluation.

Programme/Class: Degree	Year: Third	Semester: Fifth
Subject: ZOOLOGY		
Course Code: B050501T	Course Title: Diversity of Non-Chordates and Economic Zoology	
Course outcomes: The student at the completion of the course will be able to: The student at the completion of the course will be able to: <ul style="list-style-type: none"> • demonstrate comprehensive identification abilities of non-chordate diversity • explain structural and functional diversity of non-chordate • explain evolutionary relationship amongst non-chordate groups • Get employment in different applied sectors • Students can start their own business i.e. self employments. • Enable students to take up research in Biological Science 		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	Min. Passing Marks: as per rules	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		
Unit	Topic	Total No. of Lectures (60)
I	Protozoa to Coelenterate <ul style="list-style-type: none"> • Protozoa – <i>Paramecium</i> (Morphology and Reproduction) • Porifera – <i>Sycon</i>(Canal System) • Coelenterata – <i>Obelia</i> (Morphology and Reproduction) 	7
II	Ctenophora to Nemathelminthes <ul style="list-style-type: none"> • Ctenophora - Salient features • Platyhelminthes - <i>Taenia</i> (Tape worm) (Morphology and Reproduction) • Nemathelminthes –<i>Ascaris lumbricoides</i> (Morphology and Reproduction) 	7
III	Annelida <ul style="list-style-type: none"> • Annelida –<i>Hirudinaria</i> (Leech) (Morphology and Reproduction) 	8
IV	Arthropoda <ul style="list-style-type: none"> • Arthropoda – <i>Palaemon</i> (Prawn) (Morphology, Appendages, Nervous System and Reproduction) 	8
V	Mollusca to Hemichordata <ul style="list-style-type: none"> • Mollusca – <i>Pila</i>(Morphology, Shell, Respiration, Nervous System and Reproduction) • Echinodermata –<i>Pentaceros</i> (Morphology and Water Vascular System) 	8

VI	Vectors and pests Life cycle and their control of following pests: Gundhi bug, Sugarcane leafhopper, Rodents. Termites and Mosquitoes and their control	8
VII	Economic Zoology-1 Animal breeding and culture: Pisciculture	7
VIII	Economic Zoology- 2 Sericulture, Apiculture, Lac-culture, Vermiculture	7
Suggested Readings:		
<ol style="list-style-type: none"> 1. Barnes et al (2009). The Invertebrates: A synthesis. Wiley Backwell 17 2. Hunter: Life of Invertebrates (1979, Collier Macmillan) 3. Marshall: Parker & Haswell Text Book of Zoology, Vol. I (7th ed 1972, Macmillan) 4. Moore: An Introduction to the Invertebrates (2001, Cambridge University Press) 5. Brusca and Brusca (2016) Invertebrates. Sinauer 6. Jan Pechenik (2014) Biology of the invertebrates. McGraw Hill 7. Neilsen (2012). Animal Evolution: Interrelationships amongst living Phyla. Oxford 8. Parasitology- Chatterjee 9. Parasitology- Chakraborty 10. Thomas C. Chung. General Parasitology. Hardcourt Brace and Co. Ltd. Asia, New Delhi. 11. Gerard D. Schmidt and Larry S Roberts. Foundations of Parasitology. McGraw Hill. 12. Bisht. D.S., <i>Apiculture</i>, ICAR Publication. 13. Singh S., <i>Beekeeping in India</i>, Indian council of Agricultural Research, New Delhi. 14. Jhingran. V.G. Fish and fisheries in India., 15. Khanna. S.S, An introduction to fishes 16. Boyd. C.E. & Tucker. C.S, Pond aquaculture water quality management, 17. Biswas. K.P, Fish and prawn diseases, 18. Pedigo, L.P. (2002). <i>Entomology and Pest Management</i>, Prentice Hall. 19. Lee, Earthworm Ecology 20. Stevenson, Biology of Earthworms 21. Destructive and Useful Insects by C. L. Metcalf 22. Sericulture for Rural Development : Hanumappa (1978), Himalaya Publication, 23. Sericulture in India Sarkar, D.C. (1988), CSB, Bangalore. <p style="text-align: center;">Course Books published in Hindi may be prescribed by the Universities and Colleges</p>		
This course can be opted as an elective by the students of following subjects:		
The eligibility for this paper is 10+2 with Biology as one of the subject		
Suggested Continuous Evaluation Methods:		
House Examination/Test: 10 Marks		
Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks		
Class performance/Participation: 5 Marks		
Further Suggestions: None		

At the End of the whole syllabus any remarks/ suggestions:

Programme/Class: Degree	Year: Third	Semester: Fifth
Subject: ZOOLOGY		
Course Code: B050502T	Course Title: Diversity of Chordates and Comparative Anatomy	
Course outcomes: The student at the completion of the course will be able to: <ul style="list-style-type: none"> • Demonstrate comprehensive identification abilities of chordate diversity • Explain structural and functional diversity of chordates • Explain evolutionary relationship amongst chordates • Take up research in biological sciences. 		
Credits: 4	Core Compulsory/Elective	
Max. Marks: 25+75	Min. Passing Marks: as per rules	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		
Unit	Topic	Total No. of Lectures (60)
I	Origin of Chordates & Hemichordata <ul style="list-style-type: none"> • Origin of Chordates. Classification of Phylum Chordata upto the class. • Hemichordata: General characteristics, classification and detailed study of <i>Balanoglossus</i>(Habit and Habitat, Morphology, Anatomy, Physiology and Development). 	6
II	Cephalochordata and Urochordata <ul style="list-style-type: none"> • Cephalochordata : General characteristics, classification and detailed study of <i>Branchiostoma (Amphioxus)</i> (Habit and Habitat, Morphology, Anatomy, Physiology). • (ii)Urochordata : General characteristics, classification and detailed study of <i>Herdmania</i>(Habit and Habitat, Morphology, Anatomy, Physiology and Post Embryonic Development). 	6
III	Classification and General Characteristics of Vertebrates <ul style="list-style-type: none"> • General characters and Classification of different classes of vertebrates (Pisces, Amphibia, Reptilia, Aves, Mammalia) up to the order with examples. • Poisonous and Non Poisonous Snakes and biting mechanism. • Neoteny and Paedogenesis • Migration in birds • Dentition in Mammals 	8
IV	Comparative Anatomy and Physiology of Vertebrates Integumentary System Structure, functions and derivatives of integument Skeletal System Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches	8
V	Digestive System Alimentary canal and associated glands, dentition	

		8
VI	Respiratory System Skin, gills, lungs and air sacs; Accessory respiratory organs	8
VII	Circulatory System General plan of circulation, evolution of heart and aortic arches Urinogenital System Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri	8
VIII	Nervous System Comparative account of brain Autonomic nervous system, Spinal cord, Cranial nerves in mammals Sense Organs Classification of receptors Brief account of visual and auditory receptors in man	8
Suggested Readings:		
<ol style="list-style-type: none"> 1. Harvey et al: The Vertebrate Life (2006) 2. Colbert et al: Colbert's Evolution of the Vertebrates: A history of the backboned animals through time (5th ed 2002, Wiley - Liss) 3. Hildebrand: Analysis of Vertebrate Structure (4th ed 1995, John Wiley) 4. Kenneth V. Kardong (2015) Vertebrates: Comparative Anatomy, Function, Evolution McGraw Hill 5. McFarland et al: Vertebrate Life(1979, Macmillan Publishing) 6. Parker and Haswell: TextBook of Zoology, Vol. II (1978, ELBS) 7. Romer and Parsons: The Vertebrate Body (6th ed 1986, CBS Publishing Japan) 8. Young: The Life of vertebrates (3rd ed 2006, ELBS/Oxford) 9. Weichert C.K and William Presch (1970). Elements of Chordate Anatomy, Tata McGraw Hills 		
Course Books published in Hindi may be prescribed by the Universities and Colleges		
This course can be opted as an elective by the students of following subjects:		
The eligibility for this paper is 10+2 with Biology as one of the subject		
Suggested Continuous Evaluation Methods:		
House Examination/Test: 10 Marks		
Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks		
Class performance/Participation: 5 Marks		
Further Suggestions: None		

At the end of the whole syllabus any remarks/suggestions:

Programme/Class: Degree	Year: Third	Semester: Fifth
Subject: ZOOLOGY		
Course Code: B050503P	Course Title: Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitology	
Course outcomes: The student at the completion of the course will be able to: <ul style="list-style-type: none"> • demonstrate comprehensive identification abilities of chordate and non- chordates diversity • explain structural and functional diversity of chordates and non- chordates • explain evolutionary relationship amongst chordates and non- chordates • Generate self employment • Enable students to take up research in biological sciences. 		
Credits: 2	Core: Compulsory	
Max. Marks: 25+75	Min. Passing Marks: as per rules	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4		
Unit	Topic	Total No. of Lectures (60)
I	Study of animal specimens of various animal phyla. 1.To prepare permanent stained slide of septal nephridia of earthworm. 2.To take out the nerve ring of earthworm. 3.To take out hastate plate from <i>Palaemon</i> .	15
II	1.Study of animal specimens of various animal phyla 2. Study on use and ethical handling of model organisms (Mice, rats, rabbit and pig). 3. To prepare stained/unstained slide of placoid scales. 1. Comparative study of bones of different vertebrates. 2. Comparative study of histological slides of different tissues of vertebrates.	15
III	1. Permanent Preparation of: <i>Euglena</i> , <i>Paramecium</i> 2. Study of prepared slides/specimens of <i>Entamoeba</i> , <i>Giardia</i> , <i>Leishmania</i> , <i>Trypanosoma</i> , <i>Plasmodium</i> , <i>Fasciola</i> , <i>Cotugnia</i> , <i>Taenia</i> , <i>Rallietina</i> , <i>Polystoma</i> , <i>Schistosoma</i> , <i>Echinococcus</i> , <i>Enterobius</i> , <i>Ascaris</i> and <i>Ancylostoma</i> 3. Permanent Preparation of <i>Cimex</i> (bed bug)/ <i>Pediculus</i> (Louse), <i>Haematopinus</i> (cattle louse), fresh water annelids, arthropods; and soil arthropods. 4. Larval stages of helminths and arthropods. 5. Permanent mount of wings, mouth parts and developmental stages of mosquito and house fly. Permanent preparation of ticks/ mites, abdominal gills of aquatic insects viz. Chironomus larva, dragonfly and mayfly nymphs, preparation of antenna of housefly. 6. Identification of pests. 7. Life history of silkworm, honeybee and lac insect. 8. Different types of important edible fishes of India.	15

	<p>9. Slides of plant nematodes.</p> <p>10. Study of an aquatic ecosystem, its biotic components and food chain.</p> <p>11. Project Report/ model chart making.</p> <p>12. Dissections : through multimedia / models</p> <p>13. Cockroach : Central nervous system</p> <p>14. Wallago: Afferent and efferent branchial vessels, Cranial nerves, Weberian ossicles.</p>	
IV	<p>Virtual Labs (Suggestive sites)</p> <p>https://www.vlab.co.in</p> <p>https://zoologysan.blogspot.com</p> <p>www.vlab.iitb.ac.in/vlab</p> <p>https://www.vlab.co.in</p> <p>https://zoologysan.blogspot.com</p> <p>www.vlab.iitb.ac.in/vlab</p> <p>www.onlinelabs.in</p> <p>www.powershow.com</p> <p>https://vlab.amrita.edu</p> <p>https://sites.dartmouth.edu</p>	15
<p>Suggested Readings:</p> <ol style="list-style-type: none"> 1. Harvey et al: The Vertebrate Life (2006) 2. Colbert et al: Colbert's Evolution of the Vertebrates: A history of the backboned animals through time (5th ed 2002,Wiley - Liss) 3. Hildebrand: Analysis of Vertebrate Structure (4th ed 1995, John Wiley) 4. Kenneth V. Kardong (2015) Vertebrates: Comparative Anatomy, Function, Evolution McGraw Hill 5. McFarland et al: Vertebrate Life (1979, Macmillan Publishing) 6. Parker and Haswell: TextBook of Zoology, Vol. II (1978, ELBS) 7. Romer and Parsons: The Vertebrate Body (6th ed 1986, CBS Publishing Japan) 8. Young: The Life of vertebrates (3rd ed 2006, ELBS/Oxford) 9. Barnes et al (2009). The Invertebrates: A synthesis. Wiley Backwell 17 10. Marshall: Parker &Haswell Text Book of Zoology, Vol. I (7th ed 1972, Macmillan) 11. Moore: An Introduction to the Invertebrates (2001, Cambridge University Press) 12. Brusca and Brusca (2016) Invertebrates. Sinauer 13. Jan Pechenik (2014) Biology of the invertebrates. McGraw Hill 14. Boradale, L.A. and Potts, E.A. (1961). Invertebrates: A Manual for the use of Students. Asia Publishing Home 15. Robert Leo Smith Ecology and field biology Harper and Row publisher 16. Handbook of Practical Sericulture :Ullal, S.R. and Narasimhanna, M.N. (1987),Central Silk Board Publication, Bangalore. 17. Prost, P. J. (1962). <i>Apiculture</i>. Oxford and IBH, New Delhi. 18. Bisht. D.S., <i>Apiculture</i>, ICAR Publication. 19. Singh S., <i>Beekeeping in India</i>, Indian council of Agricultural Research, New Delhi. 20. Ullal S.R. and Narasimhanna, M.N. Handbook of Practical Sericulture: CSB,Bangalore 21. Jolly. M. S. Appropriate Sericultural Techniques; Ed., Director, CSR & TI, Mysore. 22. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. 23. Santanam, B. <i>et al</i>, A manual of freshwater aquaculture 24. Boyd. C.E. &Tucker.C.S, Pond aquaculture water quality management 25. Pedigo, L.P. (2002). <i>Entomology and Pest Management</i>, Prentice Hall. 26. Ranganathan L.S, Vermicomposting technology- soil health to human health 		

Course Books published in Hindi may be prescribed by the Universities and Colleges
<p>This course can be opted as an elective by the students of following subjects: The eligibility for this paper is 10+2 from Arts/Commerce/Science</p>
<p>Suggested Continuous Evaluation Methods:</p> <p>House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks</p>
Further Suggestions: None

At the end of the whole syllabus any remarks/ suggestions: University must ensure incorporation of all 04 units including virtual labs in practical evaluation.

Programme/Class: Degree	Year: Third	Semester: Sixth
Subject: ZOOLOGY		
Course Code: B050601T	Course Title: Evolutionary and Developmental Biology	
Course outcomes: The student at the completion of the course will be able to: <ul style="list-style-type: none"> • Understand that by biological evolution we mean that many of the organisms that inhabit the earth today are different from those that inhabited it in the past. • Understand that natural selection is one of several processes that can bring about evolution, although it can also promote stability rather than change. • Understand how the single cell formed at fertilisation forms an embryo and then a full adult organism. • Integrate genetics, molecular biology, biochemistry, cell biology, anatomy and physiology during embryonic development. • Understand a variety of interacting processes, which generate an organism's heterogeneous shapes, size, and structural features. • Understand how a cell behaves in response to an autonomous determinant or an external signal, and the scientific reasoning exhibited in experimental life science. 		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	Min. Passing Marks: as per rules	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		
Unit	Topic	Total No. of Lectures (60)
I	Theories of Evolution <ul style="list-style-type: none"> • Origin of Life • Historical review of evolutionary concept: Lamarckism, Darwinism (Natural, Sexual and Artificial selection) • Modern synthetic theory of evolution • Patterns of evolution (Divergence, Convergence, Parallel, Coevolution) 	8
II	Population Genetics <ul style="list-style-type: none"> • Microevolution and Macroevolution: allele frequencies, genotype frequencies, Hardy-Weinberg equilibrium and conditions for its maintenance • Forces of evolution: mutation, selection, genetic drift 	8
III	Direct Evidences of Evolution Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse	7
IV	Species Concept and Extinction <ul style="list-style-type: none"> • Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric) 	7

	<ul style="list-style-type: none"> • Mass extinction (Causes, Names of five major extinctions) 	
V	Gamete Fertilization and Early Development <ul style="list-style-type: none"> • Gametogenesis, Fertilization • Cleavage pattern • Gastrulation, fate maps • Developmental mechanics of cell specification • Morphogenesis and cell adhesion 	6
VI	Developmental Genes <ul style="list-style-type: none"> • Genes and development • Molecular basis of development • Differential gene expression 	8
VII	Early Vertebrate Development <ul style="list-style-type: none"> • Early development of vertebrates (fish, birds & mammals) • Metamorphosis, regeneration and stem cells • Environmental regulation of development 	8
VIII	Late Developmental Processes <ul style="list-style-type: none"> • The dynamics of organ development • Development of eye, kidney, limb • Metamorphosis: the hormonal reactivation of development in amphibians, insects • Regeneration: salamander limbs, mammalian liver, Hydras • Aging: the biology of senescence 	8

Suggested Readings:

1. Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing
2. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). *Evolution*. Cold Spring, Harbour Laboratory Press.
3. Hall, B. K. and Hallgrímsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett Publishers
4. Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings.
5. Douglas, J. Futuyma (1997). *Evolutionary Biology*. Sinauer Associates.
6. Developmental Biology: T. Subramaniam, (Reprint), Narosa Publishing House Pvt. Ltd., New Delhi (2013).
7. Essential Developmental Biology: Jonathan M. W. Slack, (3rd ed.), Wiley-Blackwell. (2012).
8. Developmental Biology: From a Cell to an Organism (Genetics & Evolution) eBook: Russ Hodge, Infobase Publishing. (2009).
9. Current Topics in Developmental Biology: Roger A. Pedersen, Gerald P. Schatten, Elsevier. (1998).
10. Developmental biology: Werner A. Müller, Springer Science & Business Media. (2012).
11. Human Embryology and Developmental Biology E-Book: Bruce M. Carlson, Elsevier Health Sciences. (2018).
12. Developmental Biology: Michael J. F. Barresi, Scott F. Gilbert, Oxford University Press. (2019).

Course Books published in Hindi may be prescribed by the Universities and Colleges

This course can be opted as an elective by the students of following subjects: The eligibility for this paper is 10+2 with Biology as one of the subject

Suggested Continuous Evaluation Methods:

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks

Class performance/Participation:5 Marks

Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Degree	Year: Third	Semester: Six
Subject: ZOOLOGY		
Course Code: B050602T	Course Title: Ecology, Ethology, Environmental Science and Wildlife	
Course outcomes: The student at the completion of the course will learn: <ul style="list-style-type: none"> • Complexities and interconnectedness of various environmental levels and their functioning. • Global environmental issues, their causes, consequences and amelioration. • To understand and identify behaviours in a variety of taxa. • The proximate and ultimate causes of various behaviours. • About the molecules, cells, and systems of biological timing systems. • Conceptualizing how species profitably inhabit in the temporal environment and space out their activities at different times of the day and seasons. • To interpret the cause and effect of lifestyle disorders contributing to public understanding of biological timing. • To understand the importance of wildlife conservation. 		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	Min. Passing Marks: as per rules	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		
Unit	Topic	Total No. of Lectures (60)
I	Introduction to Ecology <ul style="list-style-type: none"> • History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors 	4
II	Organization of Ecosystem <ul style="list-style-type: none"> • Levels of organization, Laws of limiting factors, Study of physical factors, • Population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion ,Exponential and logistic growth, • Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, , Food web, Energy flow through the ecosystem, • Ecological pyramids and Ecological efficiencies, Nutrient and biogeochemical cycle with one example of Carbon cycle 	12
III	Community Ecology Community characteristics: species richness, dominance, diversity, abundance, Ecological succession with one example	7

IV	Environmental Hazards <ul style="list-style-type: none"> • Sources of Environmental hazards • Climate changes • Greenhouse gases and global warming • Acid rain, Ozone layer destruction 	7
V	Effects of Climate Change <ul style="list-style-type: none"> • Effect of climate change on public health • Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, • Nuclear waste handling and disposal, Waste from thermal power plants, • Case histories on Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and Three Mile Island accident and their aftermath. 	6
VI	Behavioural Ecology and Chronobiology <ul style="list-style-type: none"> • Origin and history of Ethology, • Instinct vs. Learnt Behaviour • Associative learning, classical and operant conditioning, Habituation, Imprinting, • Circadian rhythms; Tidal rhythms and Lunar rhythms • Chronomedicine 	8
VII	Introduction to Wild Life <ul style="list-style-type: none"> • Values of wild life - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies. 	8
VIII	Protected areas <ul style="list-style-type: none"> • National parks & sanctuaries, Community reserve; Important features of protected areas in India; Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve 	8

Suggested Readings:

1. Ecology: Theories & Applications. Peter D. Stiling, 2001, Prentice Hall.
2. Ecological Modeling. 2008. Grant, W.E. and Swannack, T.M., Blackwell.
3. Ecology: The Experimental Analysis of Distribution and Abundance. Charles J. Krebs, 2016, Pearson Education Inc.
4. Elements of Ecology. T.M. Smith and R.L. Smith, 2014, Pearson Education Inc.
5. Environmental Chemistry. 2010. Stanley and Manahan, E. CRC, Taylor & Francis. London.
6. Environment. Raven, Berg, Johnson, 1993, Saunders College Publishing.
7. Essentials of Ecology. G.T. Miller, Jr. & Scott. E. Spoolman, 2014, Brooks/Cole, Cengage Learning.
8. Freshwater Ecology: A Scientific Introduction. 2004. Closs, G., Downes, B. and Boulton, A. Wiley-Blackwell publisher, Oxford.
9. Fundamental Processes in Ecology: An Earth system Approach. 2007. Wilkinson, D.M. Oxford

University Press, UK.

10. Fundamentals of Ecology. E.P. Odum & Gray. W. Barrett, 1971, Saunders
11. Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.
12. Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Co-existence? Cambridge University.
13. Bookhout, T.A. (1996). Research and Management Techniques for Wildlife and Habitats, 5 th edition. The Wildlife Society, Allen Press.
14. Sutherland, W.J. (2000). The Conservation Handbook: Research, Management and Policy. Blackwell Sciences
15. Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing.

Course Books published in Hindi may be prescribed by the Universities and Colleges

This course can be opted as an elective by the students of following subjects:

The eligibility for this paper is 10+2 with Biology as one of the subject

Suggested Continuous Evaluation Methods:

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks

Class Performance/Participation: 5 Marks

Further Suggestions: None

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At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Degree	Year: Third	Semester: Sixth
Subject: ZOOLOGY		
Course Code: B050603P	Course Title: Lab on Ecology, Environmental Science, Behavioral Ecology & wildlife	
Course outcomes: The student at the completion of the course will be able to: <ul style="list-style-type: none"> To understand the basic concepts, importance, status and interaction between organisms and environment. Get employment in forest services, sanctuaries, conservatories etc. Enable students to take up research in wildlife. 		
Credits: 2	Core: Compulsory	
Max. Marks: 25+75	Min. Passing Marks: as per rules	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4		
Unit	Topic	Total No. of Lectures (60)
I	1.Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided. 2.Study of population dynamics through numerical problems. 3.Study of circadian functions in humans (daily eating, sleep and temperature patterns).	26
II	Report on a visit to National Park/Biodiversity Park/Wild life sanctuary	4
III	<ol style="list-style-type: none"> Demonstration of basic equipments needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses) Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers etc. Demonstration of different field techniques for flora and fauna 	15
IV	Virtual Labs (Suggestive sites) https://www.vlab.co.in https://zoologysan.blogspot.com www.vlab.iitb.ac.in/vlab	15

Suggested Readings:

1. Ecology: The Experimental Analysis of Distribution and Abundance. Charles J. Krebs, 2016, Pearson Education Inc.
2. Fundamentals of Ecology. E.P. Odum & Gray. W. Barrett, 1971, Saunders.
3. Robert Leo Smith Ecology and field biology Harper and Row publisher
4. Bookhout, T.A. (1996). Research and Management Techniques for Wildlife and Habitats, 5th edition. The Wildlife Society, Allen Press.
5. Methods and Practice in biodiversity Conservation by David Hawks worth, Springer publication.

Course Books published in Hindi may be prescribed by the Universities and Colleges

This course can be opted as an elective by the students of following subjects:

The eligibility for this paper is 10+2 from Arts/Commerce/Science

Suggested Continuous Evaluation Methods:

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

Further Suggestions: None

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At the end of the whole syllabus any remarks/ suggestions: University must ensure incorporation of all 04 units including virtual labs in practical evaluation.