Shikshan Haach Dharma
S.A.P.D. Jain Pathashala's
(Jain Minority Institute)

Walchand College of Arts and Science, Solapur

(Autonomous College)

(Affiliated to P.A. H. Solapur University, Solapur)

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Walchand College of Arts and Science, Solapur

Autonomous

Estd. 1962

Name of Faculty: Science and Technology

New Choice Based Credit System
(According to NEP-2020)

Syllabus of
M.Sc. Part I Bioinformatics

w.e.f. 2023-24

Walchand College of Arts & Science, Solapur

(Autonomous)

About National Education Policy (NEP) - 2020

With the directions and guidelines issued by **Government of Maharashtra resolution dated 20th April 2023 and 16th May, 2023** regarding the implementation of NEP at UG and PG level, the Walchand College of Arts & Science (Autonomous), Solapur has taken decision to implement NEP 2020 with Choice Based Credit System (CBCS) at Undergraduate level and Post Graduate level. This has been done to achieve the goals and objectives set in NEP-2020 such as- worldwide recognition, acceptability, horizontal as well as vertical mobility for students completing undergraduate and post-graduate degree.

The CBCS provides an opportunity for the students to select from the prescribed courses comprising core, elective/minor or skill based. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations.

Outline of NEP:

The structure of the Three/Four-year bachelor's degree programme allows the opportunity to the students to experience the full range of holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per their choices and the feasibility of exploring learning in different institutions. The structure allows students to learn various components like:

(a) Major (Core) Subject (DSC): This comprises of Mandatory and Elective Courses that require students to achieve:

- Minimum 50% of total credits corresponding to Three/Four - year UG Degree- Mandatory Courses are offered in all four years;
- 2 credit courses on Major Specific IKS shall be included under Major;
- Elective courses of Major will be offered in the third and/or final year;
- Vocational Skill Courses, Internship/ Apprenticeship, Field Projects, Research Projects are related to Major

(b) Minor Subject (18-20 Credits)

- The Minor subjects may be from the different disciplines of the same faculty of DSC Major (Core) or they can be from different faculty altogether;
- The credits of Minor subjects shall be completed in the first three years of UG Programme

(c) Generic/ Open Elective Courses (OE) (10-12 credits)

- GE/OE are to be offered in I and/or II year;
- Faculty-wise baskets of OE shall be prepared by Autonomous College.
- OE/GE is to be chosen compulsorily from faculty other than that of the Major or as per the directions issued by NEP-Steering Committee

(d) Vocational and Skill Enhancement Courses (VSEC)

i) Vocational Skill Courses (VSC): (8-10 credits): Includes Hands on Training corresponding to the Major and/or Minor Subjects:

- To be offered in first three years;

- Wherever applicable vocational courses will include skills based on advanced laboratory practical's of Major

ii) Skill Enhancement Courses (SEC): (06 credits)

- To be offered in I and II year;
- To be selected from the basket of Skill Courses approved by Autonomous College

(e) Ability Enhancement Courses (AEC), Indian Knowledge System (IKS) and Value Education Courses (VEC): (14 Credits)

i) AEC: (08 credits)

- To be offered in I and II year
- English: 04 Credits
- Modern Indian Language: 04 credits
- To be offered from the Basket approved by Autonomous College; The focus for both languages should be on linguistic and communication skills.

ii) IKS: (2 Credits)

- To be offered in I Year
- Courses on IKS to be selected from the basket of IKS courses approved by Autonomous College

iii) VEC: 04 Credits

- To be offered in I year
- Value Education Courses (VEC) such as Understanding India, Environmental Science/Education, and Digital and Technological Solutions.

(f) Field Projects/ Internship/ Apprenticeship/ Community Engagement and Service corresponding to the Major (Core) Subject, Co-curricular Courses (CC) and Research Project

- Internship/Apprenticeship corresponding to the Major (Core) Subject: (8 Credits)
- Field Projects/Community Engagement and Service (CEP) corresponding to the Major (Core) Subject (minimum 4-6 credits)

-To be offered in II and III years of UG Degree Programmes.

- Co-curricular Courses (CC) such as Health and Wellness, Yoga education, sports and fitness, Cultural Activities, NSS/NCC and Fine/ Applied/Visual/ Performing Arts: (8 credits)

-To be offered in I and/or II year

- Research Projects: (12 credits)

-To be offered in the final year for 4-year Honours with Research UG Degree

- **CREDIT:**

- Credit is a numerical value that indicates students work load (Lectures, Lab work, Seminar, Tutorials, Field work etc.) to complete a course unit. The contact hours are transformed into credits. Moreover, the grading system of evaluation is introduced for B.Sc. course wherein process of Continuous Internal Evaluation is ensured.
- **Theory: '**15 contact hours' for theory course constitute 'one credit'
- **Practical/Tutorial: '**30 contact hours' for practical course constitute 'one credit'.
- **Workshop based activities/Skill based activities:** Minimum 30 contact hours per credit in a semester is required
- **Internship/On-Job Training: '**30 contact hours' per credit in a semester is required (1 credit/week)
- **Community Engagement and Service-CEP/Field Project: '**30 contact hours' per credit in a semester is required

- **Credit Framework under Three/Four Years UG Programme with Multiple Entry and Multiple Exit Options:**

The minimum and maximum credit structure for different levels under three- or four-year UG programme with multiple entry and multiple exit options are as given below:

Levels	Code	Qualification Titles	Credit Requirements		Semester	Year
			Minimum	Maximum		
4.5	100-199	UG Certificate	40	44	2	1
5.0	200-299	UG Diploma	80	88	4	2
5.5	300-399	Three Year Bachelor's Degree	120	132	6	3
6.0	400-499	Bachelor's Degree Honours **OR** Bachelor's Degree-Honours with Research	160	176	8	4
	500-599	First Year PG & or PG Diploma	40	44	2	1
6.5	600-699	PG Degree	80	88	4	2

Multiple Exit Options

Year	Exit Option	Re-entry
First Year	Award of UG Certificate in Major with 40-44 credits and an additional 4 credits core NSQF course/Internship OR Continue with Major and Minor	Students opting for exits at any level 'will have the option to reenter' the programme from where they had left off, in the same or in different higher educational institution 'within three years of exits' and complete the degree program within the stipulated maximum period of 07 years from the date admission of first year of UG.
Second Year	Award of UG Diploma in Major and Minor with 80-88 credits and an additional 4 credits core NSQF Course/Internship OR Continue with Major and Minor	
Third Year	Award of UG Degree in Major with 120-132 credits OR Continue with Major and Minor	
Fourth Year Honours	Four Year UG Honours Degree in Major and Minor with160-176 credits	
Fourth Year Honours with Research	Four Year UG Honours with Research Degree in Major and Minor with160-176 credits	
Post-Graduation Degree		
Post-Graduation: First Year	PG Diploma (44 Credits) after Three Year UG Degree	Re-entry to complete the PG degree after taking exit option will be permissible up to 5 years from the date admission to PG programme

- **Academic Bank of Credit (ABC):**

It is mandatory for all admitted students to get enrolled on ABC Portal and create ABC ID and share ABC-ID with academic institutions where they are enrolled. Credits earned by the students will be reflected in the students ABC account. This will allow students smooth transition during multiple entry and

exit.

Walchand College of Arts and Science, Solapur (Autonomous College)
M.Sc. Bioinformatics Part I Syllabus (NEP 2020)
M.Sc. Bioinformatics Part I, Semester-I and II (STRUCTURE)
w.e.f. 2023-24

M.Sc. BIOINFORMATICS				
SEMESTER-I				
Subject	**Paper Title**	**Credits**	**Hours/weeks**	**Total Contact hours**
Bioinformatics (Mandatory)	Basic Bioinformatics	4	4	60
Bioinformatics (Mandatory)	C Programming language	4	4	60
Bioinformatics (Mandatory)	Cell biology and Genetics	2	2	30
Bioinformatics (Mandatory)	Practical-I: Basic Bioinformatics and C Programming languages	2	4 (hours/week/batch)	60
Bioinformatics (Mandatory)	Practical-II: Cell biology and Genetics	2	4 (hours/week/batch)	60
Bioinformatics-Elective-I Any one	Elective-I: HTML and Biostatistics	2	2	30
	Elective-I: Cytogenetics and Genome organization			
	Practical Elective-I	2	4 (hours/week/batch)	60
Bioinformatics-RM	RM: Bioinformatics	4	4	60
M.Sc. BIOINFORMATICS				
SEMESTER-II				
Bioinformatics (Mandatory)	Advanced Bioinformatics	4	4	60
Bioinformatics (Mandatory)	Object Oriented Programming Languages	4	4	60
Bioinformatics (Mandatory)	Microbiology and Immunology	2	2	30
Bioinformatics (Mandatory)	Practical-III: Advanced Bioinformatics and Object-Oriented Programming Languages	2	4 (hours/week/batch)	60
Bioinformatics (Mandatory)	Practical-IV: Microbiology and Immunology	2	4 (hours/week/batch)	60
Bioinformatics-Elective-II Any one	Elective-II Biochemistry & Biotechnology	2	2	30
	Elective-II: Plant breeding and tissue culture			
	Practical Elective-II	2	4	60

			(hours/week/batch)	
Bioinformatics-OJT/FP	OJT/FP: Bioinformatics	4	8	120
M.Sc. BIOINFORMATICS				
SEMESTER-III				
Bioinformatics (Mandatory)	Biological Database Management System	4	4	60
Bioinformatics (Mandatory)	Computational structure biology and drug designing	4	4	60
Bioinformatics (Mandatory)	Advanced Biophysical techniques	2	2	30
Bioinformatics (Mandatory)	Practical-V: Biological Database Management System and Computational structure biology & drug designing	2	4 (hours/week/batch)	60
Bioinformatics (Mandatory)	Practical-VI: Advanced Biophysical techniques	2	4 (hours/week/batch)	60
Bioinformatics-Elective-III Any one	Elective-III: Advanced Molecular Biology	2	2	30
	Elective-III: Advanced pharmaceuticals			
	Practical Elective-III:	2	4 (hours/week/batch)	60
Bioinformatics-RP-I	RP-I: Bioinformatics Based Research Project	4	8	120
M.Sc. BIOINFORMATICS				
SEMESTER-IV				
Bioinformatics (Mandatory)	Biological Simulation and Modeling	4	4	60
Bioinformatics (Mandatory)	Clinical Bioinformatics	4	4	60
Bioinformatics (Mandatory)	Practical-VII: Biological Simulation and Modeling	2	4 (hours/week/batch)	60
Bioinformatics (Mandatory)	Practical-VIII: Clinical Bioinformatics	2	4 (hours/week/batch)	60
Bioinformatics-Elective-IV Any one	Elective-IV: Emerging Areas of Bioinformatics	2	2	30
	Elective-IV: Medical Biotechnology and Bio-nanotechnology			
	Practical Elective-IV	2	4 (hours/week/batch)	60
Bioinformatics-RP-II	RP-II: Bioinformatics Based Research Project	6	12	180

**RM=Research methodology

**FP=Field project
**OJT/FP=On Job Training/Field Project
**4 Credits of Theory=4 Hours of teaching per week
**2 Credits of Practical=4 Hours per week
**RP=Research Project

Walchand College of Arts and Science, Solapur (Autonomous College)
Faculty of Science: Choice Based Credit System (CBCS)
(w.e.f.2023-24)

Preamble:

Recent developments of the sciences have produced a wealth of experimental data of sequences and three-dimensional structures of biological macro molecules. With the advances of computer and information science, these data are available to the public from a variety of databases on the Internet. This course will provide the knowledge of bioinformatics to interpret the rapidly expanding amount of biological information. It will discuss the basic concepts of bioinformatics and focus how to identify, seek, establish, maintain, and exchange research information in biology. It will review the major scientific databases needed for research problems in biology. Students will learn Bioinformatics tools.

Objectives of the course:

- To equip the students with the requisite background in areas of modern biology (biochemistry, cell biology, genetics, and molecular biology) and computer science (programming languages, databases, algorithms, graphics, data mining, data security, etc.).
- Gain familiarity with computational methods in order to address problems in molecular biology.
- Become knowledge able about the storage, retrieval, sharing and use of biological data, information, and tools.
- To launch the students into core areas of Bioinformatics like multiple sequence alignment, phylogenetic trees, genomics, proteomics etc.
- To explore the students to applied areas of Bioinformatics like Protein-protein interaction, drug design, metabolic path way engineering etc.
- To provide practical experience to students by giving them an opportunity to pursue project work in an identified area of Bioinformatics.
- Students should gain substantial competency in content, skills, and awareness within the field of bioinformatics.

Eligibility and Admission:

Candidates who have passed (a) 10+2 with science and (b) Bachelor's degree in any Science/Engineering/Technology/Agriculture/Medicine/VeterinaryScience/Pharmaceutics from recognized University and as per the eligibility criteria lay down by Punyashlok Ahilyadevi Holkar Solapur University, Solapur will be eligible for admission to M.Sc. course in Bioinformatics.

Candidates who have passed the entrance examination conducted by the Walchand (Autonomous) College of Arts and Science; Solapur (WCAS) shall be held eligible for admission to M.Sc. Course in Bioinformatics. Students from other University with B.Sc. General Degree and who have passed the entrance examination conducted by the WCAS, Solapur is also eligible. Merit list based on average of B.Sc. aggregate and entrance exam conducted by Walchand (Autonomous) College of Arts and Science, Solapur.

Duration: The course will be of two years duration and shall be completed in four semesters.

Medium of instruction: English

Pattern of the Course: The Autonomous College follows Semester pattern

Outline of Examination

THEORY

1) **Internal Evaluation (IE):** Internal evaluation will consist of **40 % marks** per semester per paper. It may be held as **per the following scheme** per semester **(Annexure: I& II)**

Credits	Marks for Attendance	Classroom Test	Home Assignment	Marks for Presentation/Group Discussion/ Participation/Field work/Study visit	Total Marks
02	05	10	05	---	20
04	05	20	05	10	40

2) End Semester Examination (ESE): The detailed question paper pattern (**60% marks per paper)** is given as in **Annexure- IV; Annexure- V**

PRACTICAL

1) **Internal Evaluation (IE):** Internal evaluation will carry **40 % marks** and may consist of (**Annexure-III**):

Credits	Marks for Attendance	Internal Practical Exam	Journal	Total Marks
02	05	10	05	20

2) **End Semester Examination (ESE):** Practical examination **60 % marks** shall be conducted at the end of each semester. **Annexure- VI**

M.Sc. BIOINFORMATICS (SEMESTER–I)

BIOINFORMATICS (MANDATORY) PAPER: BASIC BIOINFORMATICS

Marks: 100	**4 Credits-(Contact hours 60)**	
UNIT	**CONTENT**	**CONTACT HOURS**
I	**Introduction to Biological Databases** Goal and scope of Bioinformatics, Biological databases- NCBI, GenBank, EMBL and DDBJ, Sequence file formats (Plain, GenBank, FASTA, MSF, EMBL), Protein database- UniProt-KB, Primary, composite, and secondary databases. Specialized databases (Genome databases) and structured database (NDB, PDB, CATH and SCOP), Literature database (PubMed and PMC), Search engines.	15
II	**Sequence analysis** Algorithms, Types of Algorithms- Dynamic algorithm (Needleman-Wunsch and Smith-Waterman), Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues and xenologues. Sequence analysis, pairwise alignment, dot plot, dynamic programming-global and local alignment, Scoring matrices - PAM and BLOSUM, Tools- BLAST and FASTA, Clustal omega and Clustal X, Muscle.	15
III	**Phylogenetic analysis** Introduction to taxonomy and phylogeny, Types of Phylogenetics tree, Phylogenetic Tree Construction Methods- Distance-based: UPGMA and Neighbour Joining and Character-based: Maximum likelihood and maximum Parsimony, Bootstrapping and Jackknife, Phylogenetic software (Phylip and MEGA).	15
IV	**Applications of Bioinformatics** Open Reading frame (ORF) prediction**,** prediction of restriction sites in genes, *In-silico* restriction digestion, mutation prediction, *In-silico* RFLP, *In-silico* primer designing and PCR, plasmids construction, mRNA predictions and Protein translation, Bio-Edit.	15

REFERENCE BOOKS:

1. Claverie, J.M. and Notredame C.2003 Bioinformatics for Dummies. Wiley Editor.
2. Letovsky, S.I.1999 Bioinformatics. Kluwer Academic Publishers.
3. Baldi, P. and Brunak, S.1998 Bioinformatics. The MIT Press.
4. Setubal, J. and Meidanis, J. 1996 Introduction to Computational Molecular Biology. PWS Publishing Co., Boston.
5. Lesk, A.M. 2002 Introduction to Bioinformatics. Oxford University Press.
6. Rastogi, S.C., Mendiratta, N. and Rastogi, P.2004 Bioinformatics: Concepts, Skills & Applications. CBS Publishers & Distributors, New Delhi.
7. Fogel, G.B. and Corne, D.W., Evolutionary Computation in Bioinformatics.
8. Patterson, B.K., Techniques in Quantification and Localization of Gene Expression.
9. Mont, D.W., Bioinformatics: Sequence and Genome Analysis.
10. Evens, W.J. and Grant, G.R., Statistical Methods in Bioinformatics: An Introduction

About the course:

The course introduces students to the new branch of Bioinformatics with the historical perspectives, the advent of the branch as a new discipline, its scope, and applications. It also highlights the basic components of biological data, resources and tools for a beginner and deals with skills for management and analysis of sequence data.

Learning outcomes:

After successfully completing the course, the students will be able to:

- The primary goal of this course is to uncover the basic tools and biological databases to the students and make them familiar with the same.
- At the end of this course students will be able to classify the molecular data in the respective data and file formats.
- Students will gain the knowledge of bioinformatics and its applications in various fields.
- Students will gain the knowledge of molecular phylogenetics to study evolutionary relationships among the diverse species.

BIOINFORMATICS (MANDATORY) PAPER: C PROGRAMMING LANGUAGE

Marks: 100	**4 Credits-(Contact hours 60)**	
UNIT	**CONTENT**	**CONTACT HOURS**
I	**Introduction to the C Language** Algorithm, Pseudo code, Flow chart, Background, C Programs, Identifiers, Data Types, Variables, Constants, Input / Output, Operators (Arithmetic, relational, logical, bitwise), Expressions, Precedence and Associatively, Expression Evaluation, Type conversions. Library and Directories.	15
II	**Statements** Selection Statements (making decisions) – if and switch statements, Repetition statements (loops)-while, for, do-while statements, Loop examples, other statements related to looping – break, continue, go to, Simple C Program examples.	15
III	**Functions** Functions- Introduction to Structured Programming, Functions- basics, user defined functions, inter function communication (call by value, call by reference), Standard functions. Storage classes-auto, register, static, extern, scope rules, arrays to functions, recursive functions, example C programs. File handling.	15
IV	**Arrays** Basic concepts, one-dimensional arrays, two – dimensional arrays, multidimensional arrays, C programming examples Pointers – Introduction (Basic Concepts), pointers to pointers, compatibility, Pointer Applications, Arrays and Pointers, Pointer Arithmetic, memory allocation functions, array of pointers, pointers to void, pointers to functions, command –line arguments, Introduction to structures and unions. Strings – Concepts, C Strings, String Input / Output functions, string manipulation functions, string/data conversion.	15

REFERENCE BOOKS:

1. Sethi, R.,1996, Programming Languages, Addison-Wesley.
2. Appleby, D. and Vandkopple, J.J.,1991, Programming Languages, Tata McGraw-Hill.
3. Kernighan, B.W., and Ritchie, D.M., The C Programming Language, PHI.
4. Hutchinson, R.C. and Just, R. B., Programming using the C Language, McGraw-Hill.
5. Gottfried, B.S., Schaum's Outline of Theory and Problems of Programming with C, McGraw-Hill.
6. Schildt, H., C Made Easy, Osborne McGraw-Hill.
7. Tisdall, J.D.2001 Beginning Perl for Bioinformatics. O'Reilly and Associates.

About the course:

The course introduces students to the new avenue of computer science dealing with the basic aspects of computer components and programming in computers. It covers the essential components of basic programming Language C and its applications to the field of Bioinformatics.

Learning out comes:

After successfully completing the course, the students will be able to

- The course will also impart programming skills with basic programming languages.
  The course will introduce students to windows and Linux Operating System with commands

BIOINFORMATICS (MANDATORY) PAPER: CELL BIOLOGY AND GENETICS

Marks: 50		**2 Credits - (Contact hours 30)**
UNIT	**CONTENT**	**CONTACT HOURS**
I	**Biology of Cells** Cells as a unit of life, structure of prokaryotic and eukaryotic cells. Cellular membrane: structure, transport, channels, carriers, receptors, endocytosis, membrane potentials. An overview of organelles. Cell cycle- Cell division (Mitosis & Meiosis), Molecular events in cell cycle and regulation. Cell senescence and death: molecular basis and pathways of cell aging and programmed cell death (Apoptosis). Cell-cell interactions and signal transductions: Intercellular junctions, signaling by hormones (insulin) and neurotransmitters (dopamine); receptors, G-proteins, protein kinases (Ras-MAP pathway).	15
II	**Mendel's Laws of Inheritance and Central Dogma** Monohybrid and dihybrid cross, extrachromosomal inheritance. Prokaryotic and eukaryotic genome organization, C-Value paradox, repetitive DNA. Structure of gene-intron, exon, and their relationships. Chromosomal aberrations and their implications. Introduction to cancer genetics, epigenetics, and genetic disorders. **Central Dogma-** Introduction to central dogma, Replication in prokaryotes and eukaryotes. Replication inhibitors. Transcription- features of promoters and enhancers, transcription factors, transcription in prokaryotes and eukaryotes, inhibitors, and RNA editing. Concept and general characteristics of genetic code, Translation- ribosomes, initiation factors, translation in prokaryotes and eukaryotes, posttranslational modifications and protein trafficking and targeting in cells.	15

REFERENCE BOOKS:

1. Alberts *et. al.,* 2002, Molecular Biology of the Cell. Garland.
2. Lewin 2004, Genes VIII. Pearson.
3. Lodish *et. al.,* 2004, Molecular Cell Biology. Freeman.
4. Karp 2002, Cell and Molecular Biology. John Wiley.
5. Pollard & Earnshaw 2002, Cell Biology. Saunders.
6. Tobin & Morcel 1997, Asking about Cells. Saunders.
7. Watson *et. al*.,2004, Molecular Biology of the Gene. Pearson.
8. Atherly *et. al.*,1999, The Science of Genetics. Saunders.
9. Griffiths *et. al*.,2004, An Introduction to Genetic Analysis.
10. Hartl and Jones 1998, Genetics - Principles & Analysis. Jones & Bartlett.
11. Snustad *et. al.*,1998, Principles of Genetics. Wiley & Sons.
12. Russell 2002, Genetics. Benjamin.

About the course:

The course deals with the basic understanding of the cell as a basic unit of life with the thorough knowledge of structural and functional elements and types. It introduces the students to all the cellular processes with basic and specialized functions. The course also introduces to the genetic material DNA with its importance and provides detailed knowledge of all the molecular processes essential for the sustenance of life.

Learning outcomes:

- After successfully completing the course, the students will be able to:
- This course will focus on different basic attributes of living cells, cell formation, cell-cell interaction along with the cell adhesion and cellular signaling.
- The course will introduce the basic concepts of genetics, genetic material, types, their structure, and organization.
- The course also introduces to all the basic molecular process including central dogma of molecular biology.
- It also introduces the concepts of molecular basis of cancer, epigenetics, chromosomal, genetic disorders and applied techniques for detection and diagnosis.

BIOINFORMATICS ELECTIVE PAPER- I: INTRODUCTION TO HTML AND BIOSTATISTICS

Marks: 50		**2 Credits-(Contact hours 30)**
UNIT	**CONTENT**	**CONTACT HOURS**
I	**Introduction to Web Designing** History, Basics of Web Designing, Web Technologies, Computer Graphics, Web browsers, Web Standards, HTML Page structure, CSS, HTML Versions (HTML1.0, 2.0,3.0, 4.0, 5.0), HTML editors (HTML-Kit, PS Pad, Ultra Edit), documents (Web pages, URLs), HTML elements (Nested, Attribute, Text), Hyperlinks, Images and Multimedia, Forms, frameset, Table, Marquee, Lists. Domains and Hosting.	15
II	**Fundamentals of Biostatistics** Introduction, history, applications and Scope of biostatistics, population and sample, collection and organization of data, Presentation of data, Frequency distribution, Cumulative frequency, Graphical representation of data (Histogram, Pie-chart, Bar Graph), MATLAB, Measures of central tendency, Measures of dispersion, Correlation, and regression.	15

REFERENCE BOOKS:

1. Thomas Powell, The Complete Reference HTML and XHTML
2. Devore, J.L., 2002 Probability and Statistics, 5th edition, Thomson Asia. Hoel, Port and Stone.
3. Miller and Freund: Probability and Statistics for Engineers, 7th Edition.
4. Chung, Kai Lai, Elementary Probability Theory with Statistical Processes (Student Edition) Springer International.
5. Warren J.J., Ewens Warren, Ewens Gregory Grant, Statistical Methods in Bioinformatics: An Introduction, Springer-Verlag.
6. Gupta, S. C. and Kapoor, V.K.: Fundamentals of Mathematical Statistics, Sultan Chand and Sons.

About the course:

The course deals with the basics of HTML programming language with its historical insights, versions currently in use, documents, and elements. It introduces students with all the basic types of HTML tags and importance of tags for designing different types of forms, tables, and web pages. The course also highlights the role of statistics in solving biological problems using the fundamental methods of data collection, representation, and analysis.

Learning outcomes:

After successfully completing the course, the students will be able to

- The course will introduce students to different types of data, collection, and representation.
- The course will also highlight the basic sampling techniques with measures of central tendency.
- Students will also gain the knowledge of web designing using HTML tags.
- Students will gain the knowledge of MATLAB.

BIOINFORMATICS ELECTIVE PAPER I: CYTOGENETICS AND GENOME ORGANIZATION

Marks: 50	**2 Credits-(Contact hours 30)**	
UNIT	**CONTENT**	**CONTACT HOURS**
I	**Structure and types of chromosomes** History, Chromosome structure and types based on centromere, Chromatin structure, heterochromatin and euchromatin, telomere and its maintenance, Special types of chromosomes, Chromosome banding, painting, and karyotyping, FISH and GISH, Extra chromosomal inheritance: Mitochondrial, chloroplast and plasmids, Mechanism of sex determination in plants, animals, and *Drosophila*.	15
II	**Genome mapping** Fine structure of gene, Genome organization in Prokaryotes and eukaryotes, organization of nuclear and organelle genomes, genome mapping: physical maps and functional genomics, repetitive DNA satellites and its significance, LINES and SINES, Transposable elements in prokaryotes and eukaryotes, Alu family, Multigene families, C value paradox.	15

REFERENCE BOOKS:

1. Essential Cell Biology -Alberts B. *et al.*, Garland
2. Molecular Biology of The Cell- Alberts B *et al.*, Garland
3. The Eukaryotic Chromosome- T Bostock C. J. and Summer A. T.T Elsevier
4. 5. Advanced Genetic Analysis- Hawley and Walker Blackwell
6. Structure and Function of Eukaryotic Chromosomes- Hennig Springer
7. Genes IX- Lewin B. Pearson
8. Molecular Cell Biology -Lodish, H. *et al.*, Freeman
9. Cell and Molecular Biology- De Robertis and De Robertis Lippincott and Wilkins
10. Genome 3 -Brown T. A. Garland.

About the course

The purpose of the course is to provide a working knowledge of cytogenetics, the preparation of materials for study, and the importance of chromosomal variations in structure and number in such fields as plant and animal breeding and the medical sciences.

Learning outcomes

After successfully completing the course, the students will be able to

- Acquire knowledge regarding genetic analysis and heredity.
- Understand that how genetics information is expressed and it affect son organism structure.
- Highlights the need to integrate genomic and cytogenetic data to know about inheritance pattern.
- Advantage of genetics mapping to identify the relative position of genes based on their phenotypic effect.

Genetics can help to identify certain conditions in peoples using various techniques to minimize the risk in future.

M.Sc.-I-BIOINFORMATICS (SEMESTER–I)
PRACTICAL COURSE

PRACTICAL COURSE PAPER I- BASIC BIOINFORMATICS AND C PROGRAMMING LANGUAGE **Marks: 50** **2 Credit-(Contact hours 60)**
1. Accessing Biological Databases – Sequence databases, Genome databases and Structural databases.
2. Sequence analysis tools- BLAST, FASTA, Clustal X, Clustal omega.
3. Protein Structure prediction- ProtParam, SOPMA and Swiss-Model.
4. Phylogenetic analysis –MEGA
5. *In silico* tools used in molecular biology-NEB cutter and REbase.
6. C program using operators, conditional statements, and looping
7. C program using Iterative Statements (while, do while, for loop, star pattern)
8. C program using Arrays and String.
PRACTICAL COURSE PAPER II: CELL BIOLOGY AND GENETICS **Marks: 50** **2 Credit-(Contact hours 60)**
1. Study of Mitosis and Meiosis.
2. Analysis of monohybrid and dihybrid ratio.
3. Cell counting using Heamocytometer.
4. Study of micrometry and measurement of given sample
5. Isolation of cell organelles (Mitochondria/Chloroplast)
6. Problems related to Sex Linked inheritance

PRACTICAL COURSE ELECTIVE-I: HTML AND BIOSTATISTICS **Marks: 50** **2 Credit-(Contact hours 60)**
1. Webpage designing using basic HTML tags.
2. Create student registration form using HTML.
3. Create login page using HTML.
4. Create University website by using HTML tags.
5. Study of sampling techniques using biological data: Central tendency
6. Study of sampling techniques using biological data: Measure of Dispersion.
7. Graphical representation of data using MS-Excel.
8. Chi- square test.
PRACTICAL COURSE ELECTIVE-I: CYTOGENETICS AND GENOME ORGANIZATION **Marks: 50** **2 Credit-(Contact hours 60)**
1. Preparation of polytene chromosome
2. *Drosophila* genetic crosses
3. Study of different morphology of nucleus
4. Identification of inactivated X chromosome as Barr body
5. Karyotyping analysis
6. Quantitative analysis of DNA using DPA method.
7. Chromosome binding techniques.
8. Study and calculation of melting temperature of DNA.

About the practical courses (Semester-I):

The practical courses offered for Semester I, provide essential hands-on skills for the students in basic biotechnology, bioinformatics and information technology which includes basic and advanced tools and techniques of bioinformatics, biological databases, sequence analysis tools and techniques.

Practical Course outcome:

- The courses will introduce students to different biological databases, software tools and data analysis.
- The students will be able gain the basic practical knowledge of working with cells and DNA.
- Will provide the practical applications of HTML and statistics in Biology.
- Students will be able to perform basic C programming with applications.
- Gain the practical insights of cytogenetics and genome organization by working with genes and genomes.

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BIOINFORMATICS-RM: RESEARCH METHODOLOGY IN BIONFORMATICS

Marks:100	**4 Credits- (Contact Hours-60)**	
UNIT	**CONTENT**	**CONTACT HOURS**
I	**Research** Definition, Importance and Meaning of Research, Objectives, Characteristics, Types of Research. Steps in Research; Identification, Selection and Formulation of Research Problem, Research Design, Formulation of Hypothesis.	10
II	**Thesis and Manuscript writing** Abstract, Introduction, Review of literature, Materials and Methods, Results and Discussion, Summary and Conclusion, References. **Manuscript writing:** citation index, h-index, i10-index, ISSN, and ISBN. Author instructions, Criteria for publication. Preparation & presentation of Oral and Poster for conferences. Concept of plagiarism, Scientific proposal writing for funding agencies (UGC, CSIR, DBT, DST, ICMR and DRDO). Use of tools in Research report writing-Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism.	20
III	**IPR and Patents** Intellectual property, Protection of Intellectual property, WIPO, Forms of protection-patent, copyright, trademark, trade secrets, geographical indications. Criteria for patent and procedure of patenting-India and PCT. Patenting of biological materials with examples and case studies, IP Infringement.	15
IV	**Plant breeder's right** Traditional knowledge, Biopiracy, International Union for the Protection of New Varieties of Plants (UPOV), Breeders exemption, Plant variety protection in India. Farmer's right, advantages, and disadvantages of PBR**.** Technology transfer-Introduction, types of technology transfer and Indian scenario.	15

About course:

The main objective of this course is to introduce the basic concepts in research methodology in social science. This course addresses the issues inherent in selecting a research problem and discuss the techniques and tools to be employed in completing a research project. This will also enable the students to prepare report writing and framing Research proposals.

Students who complete this course will be able to understand and comprehend the
basics in research methodology and applying them in research/ project work.

- This course will help them to select an appropriate research design.
- With the help of this course, students will be able to take up and implement a research project/ study.
- The course will also enable them to collect the data, edit it properly and analyse it accordingly.
- Thus, it will facilitate students' prosperity in higher education.
- The students will develop skills in qualitative and quantitative data analysis and presentation.
- Students will be able to demonstrate the ability to choose methods appropriate to research objectives.

Suggested Readings:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Publications. 2 volumes.
4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
5. Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.
6. Text book of Biotechnology, P K Gupta Text book of Biotechnology, B D Singh.

M.Sc. BIOINFORMATICS (SEMESTER–II)

BIOINFORMATICS (MANDATORY) PAPER: ADVANCED BIOINFORMATICS

Marks: 100	**4 Credits-(Contact hours 60)**	
UNIT	**CONTENT**	**CONTACT HOURS**
I	**Genomics** Introduction – Organization and structure of genomes, Structural genomics, functional genomics. Overview of comparative genomics, Genome size, Sequence complexity, Introns and Exons, Genome structure in various model organisms. Gene prediction tools, identifying the function of a new gene, gene ontology, identification of regulatory regions. Identification of disease genes, OMIM database Analysis of RNA expression, applications of genome analysis and genomics.	15
II	**Proteomics** Introduction to Proteomics, Hierarchical organization of protein structure – Primary, Secondary, Super secondary, Tertiary and Quaternary structure; Hydrophobicity of amino acids, pacing of protein structure, van der Waal and Solvent accessible surface, Internal coordinates of proteins; Ramachandran Map, protein folding. Protein Sequence analysis tools- Primary, secondary, and tertiary. Protein structure validation and visualization. Computational methods for identification of polypeptides from mass spectrometry. Protein arrays: bioinformatics-based tools for analysis of proteomics data (Tools available at ExPASy Proteomics server: 2DGEL, ITRAQ); databases (such as InterPro).	15
III	**System Biology** Introduction, History, Associated disciplines, Reaction kinetics, non-linear dynamics and its biological examples, Metabolic networks and flux analysis, System Biology Markup Language (SBML) Generation of regulatory network using WGCNA, Molecular interaction networks, gene expression profiles, Generation of protein interaction network, Cytoscape, Pathway and regulatory network, relevance of system biology to synthetic biology and other applications.	15
IV	**Big Data Analytics and Machine learning** Data mining, techniques used in data mining, Components of Data Science, use of data science and technology in bioinformatics, Hadoop, google cloud, On demand computing, scalable distributed computing, map reduce, docker, setting up secured accounts, pipeline creation and automation for large scale analysis. Introduction to Machine learning, Supervised (classification methods, algorithms SVM, decision tree, random forest, KNN, ANN) and unsupervised learning (Clustering methods), Hidden Markov Model, Markov chain, application of HMM in sequence, pattern recognition, Basics of Artificial Intelligence.	15

REFERENCE BOOKS:

1. Ruchi Singh (2014). Bioinformatics: Genomics and Proteomics. Vikas Publications. New Delhi.
2. Suhai, Sandor (2002). Genomics and Proteomics. Springer publications.
3. Metin Akay (2007). Genomics and Proteomics Engineering in Medicine and Biology. Wiley Publications.UK.
4. Kitano *et al.,* Systems Biology: A Brief Overview, Science, (2002), 295, 1662-1664.
5. Ross *et al.,* Complex Systems: From Chemistry to Systems Biology, PNAS, (2009), 106, 6433–6434.
6. Sachi Nandan Mohanty, G. Nalini priya, Om Prakash Jena, Achyuth Sarkar (2021): Machine Learning for Healthcare Applications, Scrivener Publishing LLC;
7. Pierre Baldi and Soren Brunak, Bioinformatics: The Machine Learning Approach.
8. Nils J. Nilsson (1998): Introduction to Machine learning; Robotics Laboratory Department of Computer Science Stanford University Stanford, CA 94305
9. Jin Xiong (2006): Essential Bioinformatics; Cambridge University Press the Edinburgh Building, Cambridge, UK.

About the course:

The aim of the course is to provide the detailed insights of the bioinformatics branch by next level of data analysis with additional resources and software tools. It also introduces to the specialized branches of Bioinformatics including genomics and proteomics with the advanced bioinformatics tools and databases for clustering of molecular data by analysis and interpretation.

Learning outcomes:

After successfully completing the course, the students will be able to

- The course will introduce students to advanced tools and resources in bioinformatics.
- The course will also impart new skill-based training in genomics and proteomics.
- It will also provide the scope for understating the concept of big data and its analysis.
- At the end of this course students will be able to classify the molecular data in the respective data and file formats with machine learning approach.

BIOINFORMATICS MANDATORY PAPER: OBJECT ORIENTED PROGRAMMING LANGUAGES

Marks: 100		**4 Credits-(Contact hours 60)**
UNIT	**CONTENT**	**CONTACT HOURS**
I	**Introduction of C++** How C++ differs from C, Variables Declaration, Function overloading, Optional Parameters, Reference Variables, Operator overloading, Basics of Console Input and Output, Constant Pointers, Dynamic Memory Allocation. Number system. **OOPs Concepts:** Overview of OOPs Principles, Introduction to classes & objects, Creation & destruction of objects, Data Members, Member Functions, this Pointer, Constructor & Destructor, Static class member, Friend class and functions, Namespace.	15
II	**Inheritance:** Introduction and benefits, Access Specifier, Base and Derived class Constructors, Types of Inheritance, Down casting and up casting, Function overriding, Virtual functions, Destructor overriding. **Polymorphism:** Definition of Polymorphism, Pure virtual functions, Virtual Base Class. **I/O Streams:** C++ Class Hierarchy, File Stream, Text File Handling, Binary File Handling, Error handling during file operations, Overloading << and >> operators, Exception Handling, Templates.	15
III	**Introduction to Java** Introduction to java, History, Features in Java, Java and the Internet, Java an-OOP Language, C++ Vs. Java, Java tools, Application programming, Data types and variables, Keywords and identifiers, Operators, Decision Making, Arrays, Strings, Basic concepts of OOP's, Methods in Java, Constructors, Inheritance, Polymorphism, Interfaces, Packages.	15
IV	**Applets** Introduction to Applets: Applications of applet, applet lifecycle, loading applets. Introduction to AWT, Event handing: Action Event: Event; Introduction to JDBC, connecting to databases using JDBC; creating and executing statements; working with result sets, String Builder Class Java Drivers, java, SQL Packages.	15

REFERENCE BOOKS:

1. Object Oriented Programming through C++, E. BALAGURUSWAMY McGrawa Hill.
2. Let us C++, Yeswanth Kanetkar, BPB publications.
3. Tisdall, J.D. 2001Beginning Perl for Bioinformatics. O'Reilly and Associates.
4. Hutchinson, R.C. and Just, R. B. Programming using the C++Language, McGraw-Hill.
5. Gottfried, B.S., Schaum's Outline of Theory and Problems of Programming with C++, McGraw-Hill.
6. Schildt, H., C++ Made Easy, Osborne McGraw-Hill.
7. The Complete Reference in C++, McGraw-Hill.
8. Object oriented Programming through Java, E. BALAGURUSWAMY McGrawa Hill.
9. Simon Cozens and Peter Wain wright, "Beginning Perl", Shroff publishers, Mumbai,2005.
10. Perl By Examples, Ellie Quigley.
11. James Tisdall, "Beginning Perl for Bioinformatics", Fourth Indian reprint, O' Reilly Publications, USA,2005.

About the course:

The course provides the extended knowledge of object-oriented programming languages dealing with concepts of Java and Bio-Java. It highlights the importance of Perl language for Bioinformatics with the basic understanding of Bio-Perl and its applications. It emphasizes the applications of these programming languages in development of advanced tools and resources for management and analysis of biological data at critical stage.

Learning outcomes:

After successfully completing the course, the students will be able to:

- The course will introduce students to basic concepts of Java and Bio-Java.
- The course will also impart programming skills in Perl and Bio-Perl.
- It will also provide the scope for applications of Java and Perl in Bioinformatics.

BIOINFORMATICS (MANDATORY) PAPER: MICROBIOLOGY AND IMMUNOLOGY

Marks: 50	**2 Credits-(Contact hours 30)**	
UNIT	**CONTENT**	**CONTACT HOURS**
I	**Biology of Bacteria and Viruses** General structure of prokaryotic cell- bacteria and viruses, Normal bacterial flora, zoonoses, epidemiology and transmission. Growth kinetics- batch and continuous cultures. Bacterial toxins, Role of antimicrobial agents, Genetic recombination in bacteria: Transformation, Conjugation and Transduction. Mutations. Properties, epidemiology, and transmission of Gram-Positive Cocci: *Staphylococcus*, *Streptococcus* and, *Pneumococcus*. Gram Negative Cocci: *Neisseria*, Gram Positive Bacilli: *Bacillus* and *Clostridium*. Gram Negative Bacilli: *Enterobacteriaceae*, *Vibrio* and *Pseudomonas*. Multiple Drug Resistant Strains (MDRS) and Super bugs. General characteristics, mechanism of viral infection – HIV, Covid-19, Hepatitis, influenza, Viroids and Prions. Role of antiviral agents. Methods in Microbiology – staining, sterilization method culture media, pure culture methods.	15
II	**Introduction to Immunology** Immunology: Immunity, Immune system in Human: Active and Passive Immunity, Antigens, Antibodies, Classes of Immunoglobulins, Antigen – Antibody reaction, Humoral and cell- mediated immunity, antigen processing and presentation, Cytokines, and their function. Autoimmunity. Hypersensitivity and its types. Immunity to infectious agents; AIDS and other immunodeficiencies, Vaccines, Hybridoma Technology and Monoclonal antibodies, Gene Therapy.	15

REFERENCE BOOKS:

1. Microbiology by Pelezer, Chan & Krieg – Tata McGraw Hill.
2. Textbook of Microbiology by D.R. Arora
3. Textbook of Microbiology by Ananthanarayanan & Paniker
4. Microbiology – 7th edition (Prescott, Harley, Klein) by Willey, Sherwood, Woolverton.
5. Textbook of Microbiology by D.R. Arora
6. Roitt *et. al.,* 2003 Essential Immunology. Blackwell.
7. Kuby, 2003 Immunology. Freeman.
8. Abbas *et. al.,* 2001 Cellular and Molecular Immunology. Saunders.
9. Microbiology by Pelezer, Chan & Krieg – Tata McGraw Hill.
10. Textbook of Microbiology by Ananthanarayanan & Paniker
11. Immunology by Nandini Shetty

About the course:

The purpose of this course is to impart basic knowledge of microorganisms and highlights the common techniques for isolation, culturing, and characterization of microbes. It also introduces students the basic aspects of immunology with types, system organization and functioning at cellular and molecular level, hence proving essential before entering the level of specialization in Bioinformatics.

Learning outcomes:

- After successfully completing the course, the students will be able to:
- Understand the detailed lifecycle and features of major microbes.
- It will also provide the scope for understanding all the components of immune system.
- Students will gain the insights of functions and disorders of immune system.

BIOINFORMATICS ELECTIVE PAPER II: BIOCHEMISTRYAND BIOTECHNOLOGY

Marks: 50	**2 Credits-(Contact hours 30)**	
UNIT	**CONTENT**	**CONTACT HOURS**
I	**BIOMOLECULES AND BIOENERGETICS** Amino Acids-general structure, classification, Proteins: Primary, Secondary, Tertiary and Quaternary, Enzymes: Classification, nomenclature, mechanism of action, Binding sites and factors controlling enzyme activity. Introduction, classification, basic structures, and functions of Carbohydrates & Lipids. Nucleic acids - structure, diversity, and function. General classification and importance Vitamins. Laws of Thermodynamics and its Applications; Concept of free energy- Gibbs free energy, Cellular metabolism and ATP, hydrolysis of ATP.	15
II	**BIOTECHNOLOGY** Plant and animal cell & tissue culture-General introduction, aseptic techniques & tissue culture media. Industrial Biotechnology- Bioreactors, Production strains and Fermentation medium, Production of industrially important molecules by microbes (Antibiotics and Vaccines). r-DNA technology-Types of cloning vectors [pUC18, pBR322, Cosmids, expression vectors, bacterial artificial chromosomes (BACs) and yeast artificial chromosomes (YACs)]. Enzymes used in rDNA technology, Applications of recombinant DNA Technology-Crop and live-stock improvement and GMOs.	15

REFERENCE BOOKS:

1. Murray *et. al.,* 2003 Harpers Illustrated Biochemistry. Prentice Hall Int.
2. Nelson, D.L. & Cox, M.M., 2004 Lehninger's Principles of Biochemistry 4th Edition. Macmillan UK, Worth Publishers, USA.
3.Lodish, H., Berk, A., Matsudaira, P., Kaiser, C.A., Krieger, M., Scott, M.P., Zipurskey, S.L., Darnell, J., 2004 Molecular Cell Biology 5th Edition, Freeman.
4. Voet, Donald & Voet, J.G.., 2004 Biochemistry 3rd Edition. John Wiley & Sons Inc., USA.
5. Jackson, J.F. and Linskens 2003 Genetic Transformation of Plants. Springer.
6. Butler 2004 Animal Cell Culture and Technology.
7. Bhojwani, S.S. and Rajdan, M.K. 2004 Plant Tissue Culture. Elswea.

About the course:

The course deals with the detailed study of different types of biomolecules with their significant role played in functioning of the cell. It also introduces the advanced tools and techniques in the field of Biotechnology and their potential applications in management of human health and diseases including commercial applications in crop and livestock improvements.

Learning Outcomes:

After successfully completing the course, the students will be able to:

- The course will introduce students to types of biomolecules with classification and functions.
- The students will be able gain basic knowledge of small molecules with their importance.
- It will also provide the scope for exploring different aspects of plant and animal tissue culture.
- Students will be able to understand tools, techniques, and wide applications of r-DNA technology.

BIOINFORMATICS ELECTIVE PAPER II: PLANT BREEDING AND TISSUE CULTURE

Marks: 50	**2 Credits-(Contact hours 30)**	
UNIT	**CONTENT**	**CONTACT HOURS**
I	**Plant Breeding** History of plant breeding, Definition and Objective, disciplines to be known by breeder, Mode of reproduction (Vegetative reproduction – cuttings, grafting, layering, apomixes and its classification), of plant breeding. Diversity and origin of crop plants, Law of Homologous variation. Breeding methods for self-pollinated, crosspollinated and clonally propagated crops. Hybrid breeding and genetic basis of heterosis. Ideotype breeding. Mutation breeding. Plant Breeding for Stress Resistance and Nutritional Quality, Breeding for vertical and horizontal resistance to diseases. Role of molecular markers in stress resistance breeding: MAS, MARS and MABB.	15
II	**Plant Tissue Culture** Plant regeneration pathways - Organogenesis and Somatic embryogenesis; Anther and pollen culture, and production of haploid and doubled haploid plants; Protoplast culture and fusion, Somatic hybrids; Micropropagation, In vitro mutagenesis and mutant selection. Cryopreservation. Transgenic crops for resistance against biotic and abiotic stresses; Transgenic plants -Edible vaccine, Golden rice. GM crops for nutritional quality and quantity; RNAi- mediated crop improvement; Molecular pharming.	15

REFERENCE BOOKS:

1. Principles of Plant Breeding, Allard RW – Wiley
2. Plant Breeding Theory and Practice, Stoskopf NC, Tomes DT and Christie BR – Westview Press
3. Quantitative Genetics, Genomics and Plant Breeding, Kang MS – CABI Publishing
4. Biotechnology- H.S. Chawla
5. Plant Cells in liquid culture (1991), Payne Shuler Hanser Publishers.
6. Introduction to plant tissue culture- M.K. Razdan
7. Plant tissue culture-Theory and practice-S.S. Bhojwani and M.K. Razdan

About the course

Plant breeding techniques are used for creating variability, by breeding new plants from two different parents, or by causing mutations to occur. Plant Tissue culture is an important tool for both basic and applied aspects of plant biotechnology as well as its commercial applications. As a technique widely known to produce large numbers of genetically identical plantlets, this technology exhibits several advantages over conventional propagation techniques.

Learning outcomes

After successfully completing the course, the students will be able:

- To understand growth, reproduction in plants as well as understand the physiological and metabolic changes happening along with environmental impact.
- Know the theoretical and practical about techniques and proper procedures which are included in plant breeding and tissue culture.
- Able to learn about plant tissue culture in crop improvement.
- Know the applications various technologies in plant breeding and tissue culture.

M.Sc.-I-BIOINFORMATICS (SEMESTER–II)

PRACTICAL COURSE

PRACTICAL COURSE PAPER III: ADVANCED BIOINFORMATICS AND OBJECT ORIENTED PROGRAMMING LANGUAGES **Marks: 50** **2 Credit-(Contact hours 60)**
1. Prediction of genes and regulatory regions.
2. Protein structure prediction- ProtParam, SOPMA and Swiss Model.
3. Genome analysis and comparison of genome using UCSC and ENSEMBLE browser.
4. Disease gene identification using OMIM and SNP database.
5. Big data analysis by using DOCKER and online tool.
6. C++ program using class & object.
7. C++ program using inheritance, polymorphism, and virtual function.
8. Java Program using operators.
9. Java Program using vector class and applet
10. Program to store a DNA sequence and convert DNA to RNA
PRACTICAL COURSE PAPER IV: MICROBIOLOGY AND IMMUNOLOGY **Marks: 50** **2Credit-(Contact hours 60)**
1. Isolation of bacteria from given sample (water, soil & air).
2. Differential staining technique.
3. Determination of bacteria sensitivity to antibiotics.
4. Differential WBC count.
5. Differential RBC count.
6. Determination of blood grouping and blood clotting time.
7. Differential leucocyte count.
PRACTICAL COURSE ELECTIVE-II: BIOCHEMISTRY & BIOTECHNOLOGY **Marks: 50** **2Credit-(Contact hours 60)**
1. Quantitative estimation of carbohydrates.
2. Quantitative estimation of nucleic acids.
3. Quantitative estimation of proteins.
4. Preparation of stock solution for tissue culture
5. Determination of activity of given enzyme.
6. Preparation of standard curve.
7. Isolation of plasmid DNA and Agarose gel electrophoresis
8. Preparation of MS Medium & explant inoculation.
9. Restriction Digestion.
PRACTICAL COURSE ELECTIVE-II: PLANT BREEDING AND TISSUE CULTURE **Marks: 50** **2 Credit-(Contact hours 60)**
1. Induction of polyploidy using colchicines. (Root Tip)
2. Study of Pollen fertility
3. Media preparation and sterilization
4. Callus culture and Induction.
5. Isolation of protoplast by chemical and mechanical methods
6. Synthetic seeds preparation.
7. Study of Floral Biology of any suitable flower.
8. Study of emasculation and hybridization techniques in any suitable plant.

About the practical courses (Semester-II):

The practical courses offered for Semester II provide essential hands-on skills for the student's experiments involving study of cells, cell division, counting, isolation of DNA, basics of karyo typing, concepts of microorganism isolation, staining, techniques of immunology, biochemistry and biotechnology with plant breeding, tissue culture, basics techniques of genetic engineering and practical concepts of basic and advanced programming languages.

Practical Course outcome:

- Students will also gain the advanced practical skills in bioinformatics area of genomics and proteomics.
- The courses will introduce students to acquire the skills of isolation and handling of microbes and basic immunology
- Students will be able to perform basic qualitative and quantitative biomolecular estimations using standard methods and basic tissue culture and other biotechnology experiments.
- The courses will impart the skills of working with enzymes; isolation, characterization, and purification with qualitative and quantitative estimations of the activity.
- Students will gain the skills of working with programming platforms of Java, Bio-Java, Perl, and Bio-Perl.
- Students will be introduced to basic skills of plant breeding with techniques and applications.

Walchand College of Arts and Science, Solapur
M.Sc. Bioinformatics Part-I Syllabus (NEP) Semester-II
On Job Training/Field Project

Credits: 4 **Contact Hours: 120**

Note:

1) OJT or Internship: Credits for internship shall be one credit per one week or 120 hours of engagement. The internship shall be monitored jointly by the faculty and Industry/Organization Mentor

OR

2) Field Project: Students are expected to participate in field-based learning/projects generally under the supervision of faculty. A minimum of 120 hours of learning activities/credit in a Semester is required.

Annexure: I
Walchand College of Arts and Science, (Autonomous) Solapur
M. Sc. Part – I Semester I & II Bioinformatics
(w.e.f. 2023-24)

Question Paper for Class Room Test (IE)
(02 Credit Theory Course)

Marks: 10

Q.No.1 Multiple choice questions **- 04 marks.**

i)

a) b) c) d)

ii)

iii)

iv)

Q.No.2 Attempt any two **- 06 marks.**

a)

b)

c)

Annexure: II

Walchand College of Arts and Science, (Autonomous) Solapur

M. SC. Part – I Semester I & II Bioinformatics

(w.e.f. 2023-24)

Question Paper for Class Room Test (IE)

(<u>04 Credit</u> Theory Course)

Marks: 20

Q.No.1 Multiple choice questions **- 08 marks.**

i)

a) b) c) d)

ii)

iii)

iv)

v)

vi)

vii)

viii)

Q.No.2 Attempt any two **- 12 marks.**

a)

b)

c)

Annexure-III
Scheme of Marking for Internal Examination (IE)
M. Sc. Part – I Semester I &II Bioinformatics
(w.e.f. 2023-24)
(02 Credit Practical Course)

Time: 2 hours **Total Marks: 20**

Q.1. Proceed to perform _____10

OR

Q.1. Proceed to perform _____10

Q.2. Laboratory Record (Certified Journal) 05

Q.3. Attendance 05

Annexure: IV

Walchand College of Arts and Science (Autonomous), Solapur
M. Sc Bioinformatics (Semester I & II)
Theory question paper Pattern for 4 credit courses as per NEP 2020 (ESE)
w. e. f. 2023-24

Examination: _____

Class: M.Sc. Semester:
Subject: Paper:
Time: 2.5 hrs Marks: 60

Instructions:

1) All questions are compulsory
2) Figures to the right indicate full marks
3) Draw neat labelled drawings wherever necessary

Q. No.1 Rewrite the following sentences by choosing correct alternative given below 08

i)

a) b) c) d)

ii)
iii)
iv)
v)
vi)
vii)
viii)

Q. No.2 Answer the following questions (Any three) 12

i)
ii)
iii)
iv)
v)

Q. No.3 Answer the following questions 12

i)
ii)

OR

Q. No.3 Answer the following questions 12

i)
ii)

Q. No.4 Answer the following questions 12

i)
ii)

OR

Q. No.4 Answer the following questions 12

i)
ii)

Q. No.5 Answer the following question 16

i)
ii)

Annexure: V

Walchand College of Arts and Science (Autonomous), Solapur

Theory question paper Pattern for 2 credit courses as per NEP 2020 (ESE)

w. e. f. 2023-24

Examination: _____

Class: M.Sc. Semester:

Subject: Paper:

Time: 1.5 Hrs Marks: 30

Instructions:

1) All questions are compulsory
2) Figures to the right indicate full marks
3) Draw neat labelled drawings wherever necessary

Q. No.1 Rewrite the following sentences by choosing correct alternative given below **06**

i)

a) b) c) d)

ii)

iii)

iv)

v)

vi)

Q. No.2 Answer the following questions (Any three) **06**

i)

ii)

iii)

iv)

Q. No.3 Answer the following questions **06**

i)

ii)

OR

Q. No.3 Answer the following questions **06**

i)

ii)

Q. No.4 Answer the following questions **06**

i)

ii)

OR

Q. No.4 Answer the following questions **06**

i)

ii)

Q. No.5 Answer the following question **06**

i)

Annexure-VI
Scheme of Marking for End Semester Examination (ESE)
(02 Credit Practical Course)
Semester-I & II

Time: 2 hours **Total Marks: 30**

Q.1.	Proceed to perform _____	15
	OR	
Q.1.	Proceed to perform _____	15
	OR	
Q.1.	Proceed to perform _____	15
	OR	
Q.1.	Proceed to perform _____	15
Q.2.	Write the principle of_____	05
	OR	
Q.2.	Write the principle of _____	05
Q.3.	Laboratory Record (Certified Journal)	05
Q.4.	Viva Voce	05