Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya,

Latur(Autonomous)

Department of Biotechnology

Curriculum

For the Academic Year 2022-23

Under CBCS

First Year Degree Programme in Biotechnology

(Six Semester Programme)

UG First Year

Semester I and II

Syllabus Approved by Board of Studies in Biotechnology

With effect from June, 2022

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
Biotechnology

1. Introduction:

Biotechnology is a highly interdisciplinary field that combines biological sciences with engineering technologies to manipulate living organisms and biological systems to produce products that advances healthcare, medicine, agriculture, food, pharmaceuticals and environment control. Biotechnology can be classified into two broad categories: R&D in Biological Sciences and Industrial Processes. The biological sciences aspect deals with research and development in areas such as Microbiology, Cell biology, Genetics, Molecular Biology etc. for understanding the occurrence and treatment of diseases, development of agriculture, food production, protection of the environment and many more. Most of the R&D work in biological sciences is carried out in the laboratory. The industrial processes aspect deals with the production of drugs, vaccines, biofuels and pharmaceuticals on an industrial scale using biochemical processes and techniques.

Some of the best innovations and developments that have come out of Biotechnology and allied fields are: genomic sequencing technology, natural alternatives to pesticides, production of biofuels and developments in stem cell technology.

At its simplest, biotechnology is technology based on biology - biotechnology harnesses cellular and bimolecular processes to develop technologies and products that help to improve our lives and health of our planet. Taking into consideration of the importance of Biotechnology , Rajarshi Shahu Mahavidyalaya, Latur (Autonomous), have taken an initiative to introduce a new emerging field as a undergraduate Programme in biotechnology under the faculty of science. B. Sc. Biotechnology is a Three-year graduate degree program which is started in the academic year 2004-05.

B.Sc. Biotechnology programme has been designed in Accordance with the changing scenario in the field of biological sciences, its demand and necessary needs to uplift betterment of society and environment.

With reference to global changes occurring in higher education in various national and foreign universities, the designed syllabi of B.Sc. Biotechnology is effectively implemented from June, 2017. The committee members of BoS in Biotechnology also took the local need and employability of graduate students while framing the syllabus, keeping

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
Department of Biotechnology
Course Structure of B.Sc. Biotechnology First Year

B. Sc. I [Biotechnology] Semester I

	Code No.	Course Title	Hours/ Week	Marks (50)		Credits	Total
				In Sem	End Sem		
AECC1	U-COE-101	Communicative English-I	04	20	30	02	50
CCT1	U-CEB-187	Cell Biology	04	20	30	03	50
CCT2	U-INP-188	Introduction to Physiology	04	20	30	03	50
CCT3	U-INM-189	Introductory Microbiology	04	20	30	03	50
CCT4	U-BCP-190	Basics of Chemistry and Physics	04	20	30	03	50
CCP1	U-LAC-191	Lab Course I	03	20	30	02	50
CCP2	U-LAC-192	Lab Course II	03	20	30	02	50
CCP3	U-LAC-193	Lab Course III	03	20	30	02	50
CCP4	U-LAC-194	Lab Course IV	O3	20	30	02	50
			32			**22**	**450**

B. Sc. I [Biotechnology] Semester II

	Code No.	Title of the Course	Hours/ Week	Marks (50)		Credits	Total
				In Sem	End Sem		
AECC1	U-COE-201	Communicative English II	04	20	30	02	50
CCT1	U-BIO-287	Bioinstrumentation	04	20	30	03	50
CCT2	U-INB-288	Inheritance Biology	04	20	30	03	50
CCT3	U-IBM-289	Introduction to Biomolecules	04	20	30	03	50
CCT4	U-BBC-290	Biomathematics, Biostatistics and Computer	04	20	30	03	50
CCP1	U-LAC-291	Lab Course V	03	20	30	02	50
CCP2	U-LAC-292	Lab Course VI	03	20	30	02	50
CCP3	U-LAC-293	Lab Course VII	03	20	30	02	50
CCP4	U-LAC-294	Lab Course VIII	O3	20	30	02	50
Generic Elective	U-MOE-235	Moral Education (NCBC)	02	20	30	Grade	
			34			**22**	**450**

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
B.Sc. Biotechnology
I Semester
Course Title: Communicative English I **Course Code: U-COE-101**
Marks: 50 **Lectures: 30** **Credit: 02**

Learning Objectives:

- To train and prepare the students to seek and find employment in the corporate, media, English languageteaching and content writing sectors
- To develop communicative competence in students
- To impart knowledge, ideas and concepts in the technicalities of proper pronunciation, structure,appropriate use and style of the English Language as well as the application areas of English communication
- To expose the students to the employment opportunities, challenges and job roles.

Course Outcomes:

On the successful completion of the course, student will be able to-

- focus a lot on listening style to be the better speaker of English language
- listen to a text and identify specific and global information
- read aloud a text with proper stress and intonation
- enact a dialogue on a specific situation with proper contextual language markers and turn taking speak independently on a given topic

Module I **(04L)**

Communication: Theory and Type I

1. Meaning of Communication
2. Characteristics of Communication
3. Need of Communication
4. Objectives of Communication5 Process of Communication

Module II: **(05L)**

Remedial Grammar I

1. Parts of Speech
2. Use of Tense
3. Direct and Indirect
4. Active and Passive
5. Degrees of Comparison

Module III: **(06L)**

Applied Phonetics I

1. Introduction to linguistics and speech sounds
2. Introduction to phonetic symbols, phonology & minimal pairs
3. Speech Mechanism and Speech Organs
4. Description and classification of vowels
5. Description and classification of Consonants

Module IV: **(06L)**

Conversational English I

1. Greeting
2. Introducing oneself
3. Introducing others and responding to introduction
4. Taking leave of others
5. Wishing others on various occasions

Module V: **(09L)**

Business Communication I

1. Business Communication-Definitions, importance, need
2. Types of business communication
3. Media of business communication
4. Corporate Communication-Definitions-Corporate citizenship and social responsibility
5. Corporate communication strategy –Cross-cultural Communication.
6. Business letters
7. Writing notice
8. Writing CV business emails
9. Writing project proposals
10. Writing project report

Rajarshi Shahu Mahavidyalaya, Latur
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B.Sc. Biotechnology
I Semester

Course Title: Cell Biology **Course Code: U-CEB-187**
Marks: 50 **Lectures: 45** **Credit: 03**

Learning Objectives:

- To understand basic of cell biology and its applications.
- To study Cell organelles and its Function
- To understand transport mechanism in and out of cell
- To understand cell cycle and its regulation events

Course Outcomes:

On the successful completion of the course, student will be able to-

- discuss origin and morphology of cells
- describe physico-chemical composition of organelles and their functional organization.
- explain transport mechanism of cells
- elucidate significance of cell-cell communication

Unit I: (**07L)**

Introduction to Cell biology

Cell – Shapes, morphology, Cell theory, origin of life –Stanley miller Experiment. Origin of Mitochondria, Chloroplast (Endosymbiotic theory), Introduction to prokaryotic and eukaryotic cells, microscopic techniques in cell biology.

Unit II: **(15L)**

Cell organelle structure and Function

Biological membrane structure, organization, membrane proteins, and lipids. Structure-function relationship including organelles (e.g., Cell wall, Endoplasmic reticulum, Mitochondria, Chloroplast, Golgi body, nucleus and nuclear membrane, Microbodies: Glyoxysome, Peroxisome, Melanosome, lysosomes, vacuoles) Cytoskeleton, Extracellular matrix, Cell junctions.

Unit III: (**13L)**

Membrane transport structure and function

Membrane transport, Transport across cell membrane, simple diffusion, passive transport, active transport, Na/K ion channel, vesicular transport, concept of ETC Membrane Role of high energy compound. Membrane potential, Depolarization, hyperpolarization of membrane (neuronal). Generation of action potential. Types of biopotentials. Biopotential measurement instrument.

Unit IV: (**10L)**

Cell cycle and Cell-cell communication

The mechanism of cell division , Cell division cycle and its regulation, Cell Signaling; G-Protein coupled receptor, Nitrous oxide, Calcium as secondary messenger and its role in plant and animals. Cell differentiation, Neoplasia & Cell death, Brief introduction to stem cells

Recommended Textbooks and References:

1. Molecular Cell Biology (2004) Lodish et al " (Scientific American Book)
2. Manual of Laboratory Expts in Cell Biol . (2005) Eduard Gasque " "(W. C. Wilson Pub)
3. The Biology of the Cell (2002) 5th Edition, Alberts et al.
4. A Molecular Approach (2004) the Cell –4th Edition, Cooper & Hausman
5. Cell and Molecular Biology (2007) - 4th Edition, Gearld carp
6. Medical Physiology (2009) - Eleventh Edition-(Elsevier) Guyton & Hall

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
B.Sc. Biotechnology
I Semester

Course Title: Lab Course I **Course Code: U-LAC-191**
Marks: 50 **Credit: 02**

Learning Objectives:

- To study cell diversity.
- To design experiments on karyotyping
- To study different stages of cell cycle
- To provide hands-on Cell Separation Techniques

Course Outcomes:

On the successful completion of the course, student will be able to-

- perform separation of subcellular components of cells.
- identify and describe the cellular structure of organs and tissues from prepared slides, and outline the principles of histochemical staining.
- interpret the chromosome structure, cell division events in cells.
- acquaint hands on training on isolation of chloroplast.

Practicals:

1. To Study Cell Diversity
2. To study Permeability Change in erythrocyte using Osmosis
3. Separation of cells using sedimentation and velocity Centrifugation
4. Staining of mitochondria, Vacuoles using suitable staining method
5. Study of Karyotyping
6. Study of Mitosis using Onion Root
7. Study of Meiosis Using Onion Flower
8. Cell harvesting and cell lysis- methodology
9. Study of Tissue by Microtomy
10. Isolation of Chloroplast

Rajarshi Shahu Mahavidyalaya, Latur
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B.Sc. Biotechnology
I Semester

Course Title: Introduction to physiology Course Code: U-INP-188
Marks: 50 Lectures: 45 Credit: 03

Learning Objectives:

- To understand basics of plant transport and nutrition and apply this knowledge in practical work in agriculture to enhance the yield of field crops.
- To know the basics of plant reproduction and significance of plant hormones in plant growth and development.
- To understand the basics of structure and functions of circulatory system, respiratory system, energy production, homeostasis and its significance in mammalian life processes.
- To understand organization and role of digestive, endocrine, nervous and reproductive systems in humans.

Course Outcomes:

On the successful completion of the course, students will be able to-

- interpret the understandings of the basics of plant anatomy, tissue organization and its function in transport and nutrition.
- understand differences between different reproductive methods in plants and the role of each plant hormone in different life processes in plants including growth and development.
- elaborate their concepts about mammalian organ systems, its organization and functions, especially the transport system, respiratory system and mechanism of homeostasis.
- explain the significance of process of digestion, organization of digestive system, endocrine system, nervous system and reproductive system.

Unit I: [12L]

Plant physiology -I

Transport in plants

The transport needs of plants, two systems: xylem and phloem, Structure of stems, roots and leaves. The transport of water, Transport of mineral ions, Translocation, Differences between sieve tubes and xylem vessels

Plant Nutrition: Photosynthesis, Anatomy of Dicotyledonous and Monocotyledonous leaf.

Chloroplast structure and function, Cyclic photophosphorylation, non-cyclic photophosphorylation, Mineral requirements and products of photosynthesis, C3, C4 and CAM plants, Factors affecting photosynthesis

Unit II: **[07L]**

Plant Physiology – II

Reproduction in plants

Asexual reproduction and vegetative propagation in plants, Sexual reproduction in plants; Plant hormones and regulation of physiology in plants; Auxin, Gibberellin, Cytokinin, Abscisic acid, ethylene and other hormones, Seed germination and dormancy, Senescence in plants

Unit III: **[13L]**

Animal physiology – I

Transport in mammals

Transport systems in animals, the mammalian cardiovascular system, Blood vessels Blood plasma and tissue fluid, Lymph, Blood, Hemoglobin, Problems with oxygen transport, the heart, the cardiac cycle, Control of the heartbeat.

Gas exchange and smoking; Gas exchange, Lungs, Trachea, bronchi and bronchioles, Alveoli, Smoking, Tobacco smoke, lung diseases

Energy and respiration; The need for energy in living organisms, Work ATP, Respiration, Mitochondrial structure and function, Respiration without oxygen, Respiratory substrates, Adaptations of rice for wet environments

Homeostasis; Internal environment, Control of homeostatic mechanisms, The control of body temperature, Excretion, The structure of the kidney and a nephron, Control of water content, The control of blood glucose, Urine analysis

Unit IV: **[13L]**

Animal physiology – II

Digestive system of human; Structure and function of human digestive system, Assimilation of nutrients in human, Human nutrition and health. Endocrine system in human**;** Endocrine glands, their hormonal secretions and function in regulation of human, physiology. Nervous system of human; Human brain and spinal cord, Central nervous system, Autonomous nervous system, Peripheral nervous system

Reproduction in human; Male reproductive system, Female reproductive system, Reproductive cycle in human female, Lactation and Parturition in human

Recommended Textbooks and References:

1. Biology, (2009) 7th edition, Campbell, Neil A., Reece, Jane B. [Benjamin Cummings] Pearson education
2. Life the science of biology (2011), , Eighth edition, Sadava, Hillis, Heller, Berenbaum, W H Freeman
3. Botany: An Introduction to Plant Biology (2009) 4th edition, James. D. Mauseth, Jones and Bartlett
4. An Introduction to Zoology -Investigating the Animal World (2013), ,2nd edition, Joseph springer, Dennis Holley,Jones and Bartlett
5. Human Body Systems, Structure, function and environment (2012) 2nd edition, Daniel D. Chiras, Jones and Bartlett
6. Reproductive biology (2007) 1st edition, Gayatri Prakash, Alpha science international limited
7. Class XI and class XII Biology NCERT (2012), Bijnan Sutar, Shashi Chadha National Council of Educational Research and Training, 2010

Rajarshi Shahu Mahavidyalaya, Latur
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B.Sc. Biotechnology
I Semester

Course Title: Lab Course II **Course Code: U-LAC-192**
Marks: 50 **Credit: 02**

Learning Objectives:

- To know the types and levels of organization of a variety of plant tissues.
- To understand stomata, the mechanism of transpiration, and factors affecting transpiration in plants.
- To understand significance of light in photosynthesis, processes of respiration in plants and sexual reproduction in plant.
- To analyze food materials such as sugars, proteins and lipids qualitatively.

Course Outcomes:

On the successful completion of the course, students will be able to-

- prepare anatomical slides of stem, root to understand levels of organization in plants.
- understand the position and structure of stomata on leaves, process of transpiration and factors affecting transpiration.
- understand the significance of light and other physiological processes in plant growth and development.
- qualitatively analyze the presence or absence of sugars, proteins and lipids in different food types.

Practicals:

1. Study of tissues and diversity in shapes and sizes of plant cells.
2. To study anatomy of stem and root of monocots and dicots
3. To study the distribution of stomata on the upper and lower surfaces of leaves.
4. To investigate and measure factors affecting rate of transpiration using a photometer.
5. To detect the presence of carbohydrates like glucose, sucrose and starch
6. To detect the presence of proteins.
7. To detect the presence of fats (lipid) in different plants and animal materials
8. To detect the presence of urea in the given sample of urine
9. To test the presence of sugar in the given sample of urine.
10. To show that light is essential for photosynthesis.
11. To show that carbon dioxide is essential for photosynthesis.
12. To study the liberation of carbon dioxide gas during aerobic respiration.
13. To study the liberation of carbon dioxide gas during fermentation
14. To study the reproductive parts of commonly available flowers

Rajarshi Shahu Mahavidyalaya, Latur
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B.Sc. Biotechnology
I Semester

Course Title: Lab Course III **Course Code: U-LAC-193**
Marks:50 **Credit: 02**

Learning Objectives:

- To educate students in a variety of important microbiological disciplines
- To promote and develop skills in the use of tools, technologies and methods common to microbiology.
- To understand pure culture techniques and media required for microbial growth.
- To study and understand the microbial world and its diversity.

Course Outcomes:

On the successful completion of the course, students will be able to-

- acquaint the knowledge about isolation and characterization of bacteria.
- identify microbes using microscopic and biochemical tests.
- determine, interpret and discuss the growth kinetics of microbes growing in batch culture.
- act in accordance with safe laboratory practice in terms of conduct, attire, risk minimization and appropriate waste disposal.

Practicals:

1. Introduction of Microbiology laboratory.
2. Study of Microscope
3. Sterilization techniques.
4. Preparation of culture media.
5. Isolation of bacteria [Streak plate, spread plate, pour plate, serial dilution]
6. Identification of microorganisms from the habitats [simple staining, differential staining, acid fast staining, capsule staining, spore staining and motility]
7. Observation of morphology - shape and arrangement of cells.
8. Methods of inoculation of different microbes in selective media.
9. Microscopic measurements, micrometer (ocular and stage), haemocytometer.
10. Sampling and quantification of microorganisms in air, soil and water.

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B.Sc. Biotechnology
I Semester

Course Title: Lab Course III **Course Code: U-LAC-193**
Marks:50 **Credit: 02**

Learning Objectives:

- To educate students in a variety of important microbiological disciplines
- To promote and develop skills in the use of tools, technologies and methods common to microbiology.
- To understand pure culture techniques and media required for microbial growth.
- To study and understand the microbial world and its diversity.

Course Outcomes:

On the successful completion of the course, students will be able to-

- acquaint the knowledge about isolation and characterization of bacteria.
- identify microbes using microscopic and biochemical tests.
- determine, interpret and discuss the growth kinetics of microbes growing in batch culture.
- act in accordance with safe laboratory practice in terms of conduct, attire, risk minimization and appropriate waste disposal.

Practicals:

11. Introduction of Microbiology laboratory.
12. Study of Microscope
13. Sterilization techniques.
14. Preparation of culture media.
15. Isolation of bacteria [Streak plate, spread plate, pour plate, serial dilution]
16. Identification of microorganisms from the habitats [simple staining, differentialstaining, acid fast staining, capsule staining, spore staining and motility]
17. Observation of morphology - shape and arrangement of cells.
18. Methods of inoculation of different microbes in selective media.
19. Microscopic measurements, micrometer (ocular and stage), haemocytometer.
20. Sampling and quantification of microorganisms in air, soil and water.

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B.Sc. Biotechnology
I Semester

Course Title: Introductory Microbiology **Course Code: U-INM-189**
Marks: 50 **Lectures: 45** **Credit: 03**

Learning Objectives:

- To learn and understand the contributions of various scientists in microbiology
- To study physical and chemical methods of sterlization
- To understand apply pure culture technique for isolation of microorganisms
- To observe, understand and measure microbial growth

Course Outcomes:

On the successful completion of the course, students will be able to-

- interpret the structural similarities and differences among microorganisms and the unique structure/function relationships of prokaryotic cells.
- acquire the knowledge about types of media and their components
- acquaint hands on training on the isolation and characterization of microorganisms
- interpret the environmental factors affecting microbial growth

Unit I: **(11L)**

History and Overview of Microbiology

Biogenesis and abiogenesis Contributions of Redi, Spallanzani, Needham, Tyndal, Joseph Lister, Pasteur, Koch [Germ Theory], Scope of Microbiology. General classification of microorganisms as Bacteria, Fungi, Algae, Protozoa

Structure and organization of bacteria: Capsule, cell wall, cytoplasmic membrane, nucleoid, Ribosome, endospores, cytoplasmic inclusions, flagellum, Pilli, protoplast and spheroplast.

Unit II: **(12L)**

Microbial Media and Sterilization Techniques

Major and minor media components, types of media Viz. Basal, Selective, Differential and Enrichment media. Mode of nutrition. Definition of sterilization, dry and moist heat, pasteurization, tyndalization; radiation, ultrasonication, filtration. Physical and Chemical methods of sterilization; disinfection sanitization, antisepsis sterilants and fumigation.

Determination of phenol coefficient of disinfectant.

Unit III: (13L)

Isolation and Identification Techniques

Isolation, cultivation and identification techniques for microorganisms, aerobic and anaerobic cultivation, biochemical methods for identification, pure culture techniques and preservation of pure cultures. Definition of auxochrome, chromophores, Classification of stains, Theories of staining, Mechanism of gram staining, acid fast staining, negative staining, capsule staining, flagella staining, endospore staining.

Unit IV: (09L)

Bacterial Growth

Different types of bacterial culture (Batch, Synchronous, Diauxic, Axenic) – Definition and brief description. Growth Curve, Calculation of duration of Phases and generation time, Growth yields, Methods of growth determination, Environmental factors affecting growth - temperature, pH, osmotic pressure and nutrient concentration per cell.

Recommended Textbooks and References:

2. Elementary Microbiology Volume I and II – H. A. Modi

3. General Microbiology- Powar and Daginawala- Himalya Publication

4. Fundamental Principles of Bacteriology- A.J.Salle- TATA-McGraw Hill

5. General Microbiology-Pelczar- Tata McGraw Hill

6. Text-book of Microbiology- Anantnarayan, C.K. Jayram, Panikar, Orient Longman.

7. General Microbiology- Stanier R.-. Macmillan Press Ltd.

8. Text Book of Microbiology- R.C. Dubey- S. Chand

9.Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education limited.

Determination of phenol coefficient of disinfectant.

Unit III: (13L)

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Isolation, cultivation and identification techniques for microorganisms, aerobic and anaerobic cultivation, biochemical methods for identification, pure culture techniques and preservation of pure cultures. Definition of auxochrome, chromophores, Classification of stains, Theories of staining, Mechanism of gram staining, acid fast staining, negative staining, capsule staining, flagella staining, endospore staining.

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14. Text-book of Microbiology- Anantnarayan, C.K. Jayram, Panikar, Orient Longman.
15. General Microbiology- Stanier R.-. Macmillan Press Ltd.
16. Text Book of Microbiology- R.C. Dubey- S. Chand
17. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education limited.

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B.Sc. Biotechnology
I Semester

Course Title: Basics of Chemistry and Physics Course Code: U-BCP-190
Marks: 50 Lectures: 45 Credit: 03

Learning Objectives:

- To understand basic chemical concepts and the basics of organic chemistry.
- To get idea about the Laws of Thermodynamics and its significance
- To understand the difference between work and power and calculate the power for physical situations.
- To study the role of light in special reference to bioinstrumentation design

Course Outcomes:
On the successful completion of the course, students will be able to-

- explain the concept of valency can account for, and predict the formulas of compounds.
- interpret the role of the internal energy, enthalpy, entropy, temperature, pressure and specific volume thermodynamic properties.
- Define role of mechanical energy and relate it to the amount of kinetic energy and potential energy.
- Analyze and calculate interference between plane waves and spherical waves, reflection and transmission of plane waves, and optical waves guiding within thin plates and optical fibers.

Unit I: (15 L)

Basic concepts of Chemistry and General Organic Chemistry
Bohr's model and its limitations, Chemical bonding- various theories (Valence bond theory and Valence Shell Electron Pair Repulsion (VSEPR) theory), Type of Chemical bonds, Acids & Bases, Buffer solutions, Molarity, Normality, Molality, Formality, Colligative properties.
General Organic Chemistry: Hydrocarbons; Alkyl halides; Alcohols; Aldehydes; Ketones; Carboxylic acids; Amines and their derivatives; Aromatic hydrocarbons, halides, nitro and amino compounds, phenols, diazonium salts, carboxylic and sulphonic acids; Soaps and detergents; IUPAC nomenclature of organic compounds.

Unit II: (09L)
Reaction Kinetics & Thermodynamics

Reaction Kinetics: Rate constant, Order of reaction & Molecularity of reactions, Activation Energy, Zero, First & Second order kinetics, Thermodynamics: Definition & terms involved in thermodynamics, Laws of thermodynamics, Hess law, Heat of formations, free energy, work function & Kirchhoff's equations.

Unit III: (12 L)
Electricity and Magnetism

Units and measurements; Motion in one and two dimensions; Laws of motion; Work and kinetic energy; Conservation of energy; System of particles and rotational motion; Mechanical properties of solids and fluids; Current, resistance and simple circuits; Moving charges and magnetic field; Magnetism and matter; Electromagnetic induction; Electromagnetic waves; Alternating currents.

Unit IV: (09 L)
Optics

Geometrical Optics – Reflection by spherical mirrors, Refraction at spherical surfaces and lenses, Total internal reflection and Optical instruments; Wave optics – Reflection and refraction of plane waves, Interference, Diffraction, Polarization, and Young's experiment: Dual nature of radiation and matter.

Recommended Textbooks and References:

1. Principles of Physical Chemistry (2017) 4th edition, S.H. Marron and C.F. Prutton, CBS Publishers And Distributors Pvt Ltd.
2. Physical Chemistry (2020) Puri Sharma and Pathania, Vishal Publishing Company
3. Advanced Organic Chemistry(2015) 7th Edition J. March, Wiley Publication.
4. Concise Inorganic Chemistry, 5th Edition (2016) J. D. Lee., Wiley Publication.
5. Principles of Inorganic Chemistry, 32nd edition (2014)Puri Sharma and Kalia, Milestone publishers & distributors.
6. Organic Chemistry, 5th Edition (1987) Morrison, Prentice Hall of India Pvt. Ltd. Boyd, New Delhi.
7. Guidebook to Mechanism in Organic Chemistry (2003) 6th Edition, Peter Sykes, Orient Longman.
8. Physics, (Vol-I and Vol-II) (2001) Devid Hallday Roberet Resnik, Wiley Eastern limited
9. Fundamentals of optics (2017) Jenkins white, McGraw Hill Publication.
10. Text book of optics, N. Subrahmanyan Brijlal, S. Chand and Company Limited.

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
B.Sc. Biotechnology
I Semester

Course Title: Lab Course IV **Course Code: U-LAC-194**
Marks:50 **Credit: 02**

Learning Objectives:

- To understand basic chemical concepts with application related to safety measures in a Chemical laboratory, preparation of standard solutions etc.
- To aware students about different uses of chemicals, its handling and the safety precautions.
- To determine the concentration of an acid or base by exactly neutralizing it with a standard solution of base or acid having known concentration with the help of titration method.
- To demonstrate conceptual understanding of fundamental principles of physics.

Course Outcomes:

On the successful completion of the course, students will be able to-

- prepare a buffer solution at a given pH and concentration.
- analyze the titration curve for the titration of Weak acid with a strong base.
- be skillful in problem solving, critical thinking and analytical reasoning in interdisciplinary research.
- demonstrate the ability to apply knowledge/skills of physics in reference to bioinstrumentation design

Practicals:

1. Safety Measures in Laboratory, care of Glassware, Handling of Instruments.
2. Preparation of Standard Solutions, Molar, Normal Percent, Buffer Preparations (Millimoles and Micromoles).
3. Determination of pKa of weak acid (Acetic acid / Amino acid) by pH meter.
4. Determine the Strength and Normality of an acid.
5. Study of kinetics of cooling of Hot water
6. Synthesis of aniline from Nitrobenzene by reduction with Sn/Hcl
7. Synthesis of Congo Red Dye/ P-amino azobenzene/orange-II.
8. Preparation of Standard Solution of $K_2Cr_2O_7$ and standardization of given $FeSO_4$ solution.
9. Preparation of Standard Solution of Na_2CO_3 and standardization of given HCl solution and estimate the amount of NaOH in the given solution
10. Determination of Physical constant of organic compounds M.P. - Naphthalene, m-dinitrobenzene, acetanilide, Benzoic acid.
11. Determination of Physical constant of organic compounds B.P.- Aniline, Acetophenone, Benzaldehyde, Acetone.
12. To determine angle of minimum deviation for a given prism by plotting a graph between angle of incidence and angle of deviation.
13. Measuring the diameter of a small spherical or cylindrical body by vernier calipers.

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(Autonomous)
B.Sc. Biotechnology
I Semester

Course Title: Communicative English I **Course Code: U-COE-201**

Marks: 50 **Lectures: 30** **Credit: 02**

Learning Objectives:

- To train and prepare the students to seek and find employment in the corporate, media, English languageteaching and content writing sectors
- To develop communicative competence in students
- To impart knowledge, ideas and concepts in the technicalities of proper pronunciation, structure,appropriate use and style of the English Language as well as the application areas of English communication
- To expose the students to the employment opportunities, challenges and job roles.

Course Outcomes:

On the successful completion of the course, student will be able to-

- focus a lot on listening style to be the better speaker of English language
- listen to a text and identify specific and global information
- read aloud a text with proper stress and intonation
- enact a dialogue on a specific situation with proper contextual language markers and turn taking speak independently on a given topic

Module I **(05L)**

Communication: Theory and Type II

1. Forms of Communication
2. Rules for Effective Communication
3. Differences between Formal and Informal Communication
4. Differences between Verbal and Non-verbal Communication
5. Differences between Oral and Written Communication

Module II: **(05L)**

Remedial Grammar II

1. Phrases
2. Clauses
3. SVOCA structure
4. Types of Sentence
5. Punctuation

Module III: **(07L)**

Applied Phonetics II

1. English speech patterns: stress and intonation, intonation and meaning
2. Syllabic system and stress pattern: English syllabic structures
3. Content words and stress
4. Intonation: intonation groups, structure of the tone unit; functions of intonation: attitudinal function,accentual function, grammatical function, discourse function.
5. Transcription of Words and Sentences

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
B.Sc. Biotechnology (Semester Pattern)
II Semester

Course Title: Bioinstrumentation **Course Code: U-BIO-287**

Marks: 50 **Lectures: 45** **Credit: 03**

Learning Objectives:

The main objectives of this course:

- To understand the analytical techniques and equipment used in Biological science.
- To understand the basic principle and applications of microscopy and centrifugation.
- To acquire knowledge on the Chromatographic and electrophoretic method for the separation of biological molecules.
- To use scientific understanding of analytical techniques and detailed interpretation of results.

Course Outcomes :

On the successful completion of the course, student will be able to-

- explain the use and applications of microscopy and centrifugation.
- interpret the mechanism of bio-molecular separation and purification using chromatography
- understand the separation of nucleic acids and proteins by electrophoresis.
- understand the uses and applications of radioactivity in biological sciences.

Unit I: **(12L)**

Microscopy and Centrifugation

Microscopy: Microscopy Concepts - Resolving power. Construction and working principles of the following microscopes– Stereo zoom (Dissecting), Compound , Light microscopy, Bright & Dark Field microscopy, Inverted, Phase contrast, Electron microscopy (TEM and SEM)

Centrifugation: Centrifuge (RCF, sedimentation concept), different types of centrifuges. different rotors, differential and density gradient centrifugation, analytical ultracentrifugation, determination of molecular weights and other applications

Unit II: **(10L)**

Chromatography and Biosensors

Chromatography: Principle and types of chromatography. Paper chromatography, thin layer chromatography, column chromatography: Ion exchange and Gas chromatography. Biosensors: Principle and its applications- Electrochemical, Thermometric, Potentiometric- Optical,Piezo-electric and Amperometric Biosensors.

Unit III: **(12L)**

Electrophoresis and Radioactivity

Electrophoresis: General Principle, Electrophoretic Mobility, Factors Affecting electrophoretic Mobility Example: Agarose Electrophoresis, PAGE and its types
Radioactivity: Atomic Nucleus. Properties. Nuclear forces. Radioactive nucleus. Types of Radioactive decay. Half-life- period. Handling and standardization of alpha and beta emitting isotopes. Radiopharmaceuticals and their application. Dosimetry and its types.

Unit IV: **(10L)**

Spectroscopy

Spectroscopy: Definition. Electromagnetic spectrum. Applications of each region of the electromagnetic spectrum for spectroscopy. Excitation. Absorption. Emission. Rotational spectra. Vibrational spectra. Beer Lambert's law Principle, construction and working of colorimeter, UV- Visible Spectrophotometer, Application to biomolecules (Proteins, DNA, Hb, Chlorophyll).

Recommended Textbooks and References:

1. Biophysical Chemistry- Upadhyay, Upadhyay and Nath – (Himalaya Pub. House, Delhi)
2. Practical Biochemistry- principles and techniques; (5th edition), Keith Wilson and John Walker. Cambridge University press, London, UK.
3. Principles and Techniques of Biochemistry and Molecular Biology (6th edition), Keith Wilson and John Walker. Cambridge University press, London, UK.
4. Essentials of Biophysics (2nd edition)- P.Narayanan,New Age International Publications
5. Biophysics-G.R.Chatwal (Himalaya Publishing House)
6. Biophysics-Mohan P Arora (Himalaya Publishing House)

Module IV: **(05L)**

Conversational English II

1. Congratulating
2. Thanking and responding to thanks
3. Regretting and responding to regret
4. Offering and accepting
5. Expressing likes and dislikes

Module V: **(08L)**

Business Communication II

2. Media Strategy and Planning
3. Techniques of Branding
4. Advertising as a Tool of Marketing
5. Marketing Mix-Sales Promotion
6. Impact of Advertising: Social Impact and Economic Effects
7. Common errors
8. Placement interview
9. Presentation skills
10. Group Discussion
11. Mock interview

Rajarshi Shahu Mahavidyalaya, Latur
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B.Sc. Biotechnology (Semester Pattern)
II Semester

Course Title: Inheritance Biology **Course Code: U-INB-288**
Marks: 50 **Lectures: 45** **Credit: 03**

Learning Objectives:

- To learn basics or fundamentals of classical genetics including, mendelian genetics, gene interactions, sex determination etc.
- To understand concepts of cytogenetic and microbial genetics including chromosome mapping.
- To learn the concepts of mutation, mutagens, mutagenesis, point mutations and chromosomal aberrations.
- To understand advanced and applied concepts of population and quantitative genetics.

Course Outcomes:

On the successful completion of the course, students will be able to-

- interpret the distinct features of various patterns of inheritance in plants and animals and be able to solve the genetics problems based on it.
- understand morphological, molecular features of chromosomes, phenomenon of linkage, crossing over, and microbial genetics.
- understand the concept of mutations, its beneficial applications and harmful effects on living organisms.
- get the details of population and quantitative genetics and its applications in studying life and improvements of crops in agriculture.

Unit I: **(15L)**

Transmission genetics /Classical genetics

History of Genetics: Pre- Mendelian genetic concepts: Preformation, Epigenesis, Inheritance of acquired characters and Mutation theory. Heredity and Environment: Concepts of Phenotype, Genotype, Heredity, variation, Pure lines and Inbred lines.
Biography of Mendel and his experiments on pea plants.Law of Segregation: Monohybrid cross, back cross and Test cross,Law of Independent Assortment: Dihybrid cross in pea plant, back cross and Test. Multiple Alleles: Definition, ABO blood groups and Rh factor in humans.

Gene Interaction: Deviations from Mendelism: Incomplete inheritance and Codominance .Inter allelic interactions: Complementary gene interaction (9:7) Ex: Lathyrus odoratus Supplementary gene interaction (9:3:4) Ex: Grain color in Maize. Epistasis - Dominant Ex.: Fruit color in Cucurbita pepo, Recessive - Ex.: Coat color in Mice. Duplicate gene interaction: Ex: Shepherd's purse plant

Sex influenced inheritance and sex-limited inheritance, Sex determination in animals and plants: Chromosome theory of Sex determination: XX- XY, XX-XO, ZZ-ZW, Genic balance theory of Bridges, Intersexes and Super sexes in Drosophila, Y chromosome in sex

determination of Melandrium. Environment and sex determination. Hormonal control of Sex determination (Free martins). Gynandromorphs, Dosage compensation in Drosophila, Caenorhabditis elegans and Man (Lyon's hypothesis).

Unit II: (15L)

Cytogenetics and Microbial genetics

Physical Basis of Inheritance: Definition, Description of chromatin structure, Chromosome theory of inheritance. Eukaryotic Chromosome: Macro-molecular organization. Primary and Secondary Constriction, Sat-bodies, Telomeres, Histones, DNA, Nucleosome, Heterochromatin and Euchromatin and its significance. Ultra-structure of Chromosome - Nucleosome model, Karyotype and Idiogram.

Linkage: Definition of Linkage, Coupling and Repulsion hypothesis, Linkage group-Drosophila, maize and man, Types of linkage-complete linkage and incomplete linkage, Factors affecting linkage- distance between genes, age, temperature, radiation, sex, chemicals and nutrition, Significance of linkage

Crossing over- definition and types of crossing over,Mechanism of crossing over: Chiasma type theory,Molecular mechanism of crossing over - Holiday model, Crossing over in Drosophila. Interference and coincidence, Steps in Construction of genetic map (Drosophila). **Sex linkage:** Definition of sex linkage, Sex linkage in Drosophila, Sex linked inheritance in man (Colour-blindness, Haemophilia)

Extra Chromosomal Inheritance / Cytoplasmic Inheritance: Characteristic features of Cytoplasmic Inheritance. Inheritance of: Mitochondrial DNA, Chloroplast DNA, Kappa articles in Paramecium, Shell coiling in snail. pedigree analysis in human

Microbial genetics: Conjugation and conjugation mapping, Transformation and Transformation mapping, Transduction and Transduction mapping

Unit III: (10L)

Molecular genetics and mutation

Genome organization Fine structure of the Gene- Cistron, muton and recon

Introduction and Types of Gene mutations/point mutations - Base substitution (Transition and transversion), Frame shift mutation, insertion, deletion, missense, nonsense, reverse, suppressor and lethal mutations). Pleiotropy- definition and examples.

Mutagens – Physical (ionizing and non- ionizing radiations) and chemical (Base analogs, Alkylating agents, Acridine dyes, Deaminating agents, Hydroxylating agents, Tobacco carcinogens); Oncogenic Viruses.

Chromosomal aberrations: Numerical: Euploidy (Monoploidy, Haploidy and Polyploidy) Polyploidy- Autopolyploidy and Allopolyploidy. Aneuploidy- Monosomy, Nullisomy and Trisomy.

Structural - Deletions (Terminal, Interstitial), Duplication (Tandem, Reverse tandem and Displaced), Translocation (Simple, Isochrome, Reciprocal, Displaced) and Inversions (Pericentric and Paracentric). Significance of chromosomal aberrations. Advantages and disadvantages of mutation

Unit IV: **(05L)**

Basics of Population genetics and quantitative genetics

Gene and genotype frequency, Hardy-Weinberg law and equation and its application in the study of population genetics. Quantitative genetics, application of quantitative genetics in agriculture.

Recommended Textbooks and References:

1. Principles of Genetics (2002), Seventh Edition, Robert H. Tamarin, Tata-McGraw Hill,.
2. Genetics, Principles and Analysis (1998), 4th Edition; Daniel Hartl & E.W. Jones, Jones & Bartlett Publication.
3. The science of Genetics (1999), 1st edition, Atherly, A. G. Girton, J. R & MC Donald, J. F., Saunders College Publications / Harcourt Brace.
4. Genetics, (1995),, 3rd edition, M.W. Strickberger, Macmillan Publications ,New York.
5. Principles of Genetics (1997), 4th edition, Snustad D P, M J Simmons and J P Jenkins, John Wiley and Sons, INC.
6. An introduction to genetic analysis (2000). 6th edition, Griffiths A J F, H. J. Muller, D. T. Suzuki, R. C. Lewontin and W. M. Gelbart, W. H. Greeman. New York
7. Genetics: a molecular approach (2016), 3rd edition, Peter J. Russell,Pearson
8. Concepts of genetics (2003), ,7 th edition, William S. Klug, and Micheal R. Cummings , Pearson.

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
B.Sc. Biotechnology (Semester Pattern)
II Semester

Course Title: Lab Course VI **Course Code: U-LAC-292**
Marks:50 **Credit: 02**

Learning Objectives:

- To solve problems based on monohybrid and dihybrid cross.
- To solve problems related with interaction of genes, probability, student's t test and chi square test.
- To Understand Pedigree analysis of humans and to solve problems related with hardy-weinberg law.
- To test the blood group of given blood samples and understand human traits and their inheritance.

Course Outcomes:

On the successful completion of the course, students will be able to-

- solve genetics problems based on monohybrid cross, dihybrid cross and interaction of genes.
- understand inheritance patterns in human pedigree about inheritance of genetic diseases and other human traits.
- solve problems related with application of biostatistics in genetics and hardy-weinberg law.
- understand the blood group test and properly interpret the results of blood group test.

Practicals:

1. Problems based on monohybrid and dihybrid cross.
2. Problems based on interaction of genes
3. To solve problems of genetics by using probability test.
4. To apply Chi-square test and student's t- test to solve genetics problems.
5. Problems based on pedigree analysis.
6. To solve problems based on chromosome / gene mapping .
7. Problems based on Hardy-Weinberg equilibrium.
8. To study the human blood group by using a given blood sample.
9. Analysis and interpretation of karyotype and ideogram by using charts / diagrams.
10. Study of Human traits, Animal traits and plant traits for its diversity in phenotype.

Rajarshi Shahu Mahavidyalaya, Latur
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B. Sc. Biotechnology (Semester Pattern)
II Semester
Course Title: Introduction to Biomolecules Course Code: U-IBM-289
Marks: 50 Lectures: 45 Credit: 03

Learning Objectives:

- To understand the basic concepts in formation and function of nucleic acids.
- To discuss the benefits of simple carbohydrates and to describe the structures of saturated and unsaturated fatty acids and outline their roles and importance in the human body.
- To understand the significance of domains in protein function and how they have arisen.
- To understand that sodium, potassium, calcium and chloride ions are important in maintaining the correct composition of cells and of the tissue fluids around them.

Course Outcomes:
On the successful completion of the course, students will be able to-

- interpret the properties of nucleotides, how they contribute to secondary and tertiary structures of nucleic acids at the molecular level.
- distinguish between monosaccharides, disaccharides, and polysaccharides.
- correlate the structural and functional role of amino acids and proteins in construction of life forms
- develop the ability to identify both deficiency and toxicity symptoms of each micronutrient, and determine how these may occur.

Unit I: (12 L)

Nucleic acids and Hormones

Nucleic acids: Discovery and historical aspects, Nucleosides, nucleotides, Polynucleotide, DNA and its different forms [A, B, C, D, E and Z], RNA and its types, mRNA, tRNA, SiRNA, microRNA with function. Forces stabilizing nucleic acid structure, Denaturation and renaturation of DNA. Endocrine gland and Hormones: definition, Function of Hormones, Hormone types: peptides, steroids and other. Anterior and posterior pituitary gland hormones, Hormone deficiency.

Unit II: (10 L)

Carbohydrates and Lipids

Carbohydrates: Introduction, biological importance. Definition, stereochemistry of carbohydrates, Classification, Monosaccharides other than glucose, glycosidic bond, disaccharides, polysaccharides: homopolysaccharides and heteropolysaccharides. [Starch, glycogen].

Lipids: Introduction, Classes, Fatty acids: Physical properties, Chemical properties, Saponification value, acid value, iodine number, rancidity. Phospholipids, Sphingolipids, Glycolipids.

Unit III: (13 L)

Amino acids and Proteins

Amino acids: Structure and / classification. Properties and functions of amino acids, Acid base behavior/color reactions/Zwitterions. Isoelectric point of amino acids.

Protein structure: Classification, Conformation of proteins (primary, secondary, super secondary, quaternary domains) Peptide bond. Biological function of protein. Secondary structure – α-helix, β-sheet, triple helical structure. Quaternary structure – Hemoglobin, myoglobin.

Unit IV: (10 L)

Vitamins and Minerals

Introduction of vitamins: Classification, Water soluble vitamins (Vit-B1, B2, B3, B5, B6, B7, B9, B12 & Vit-C), Fat soluble vitamins (Vit-A, D, E & K), Function, RDA of vitamins. Food sources, Deficiency & toxicity vitamins.

Minerals: Introduction of Macro (Na, K, Ca, Mg, P) minerals, micro minerals (Fe, I, F, Zn, Cu, Co, Se, Cr. Mn, Mo, Ni, Sn, Si, V), trace elements (Pb, Hg, B, Bo, Al), Functions of micro, macro & trace elements, Food Sources & RDA, Deficiency & toxicity.

Recommended Textbooks and References:

1. Outlines of Biochemistry (2006), , 5th Edition, Conn and Stumpf. Wiley Publication.
2. Principles of Biochemistry (1995), Jeffory Zubey, WCB Publishers.
3. Biochemistry (2015), L. Stryer ,WH Freeman Publication.
4. Principles of biochemistry, Lehninger , Nelson, Cox., , CBS Publishers.
5. Principles of Biochemistry (1995), Geoffrey Zubay, McGraw Hill Publishers.
6. Fundamentals of Biochemistry (2016), 5th Edition, Voet et al., Wiley Publication.
7. Biochemistry, 3rd Edition, Donald J. Voet and Judith G. Voet., John Wiley and Sons.

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
B.Sc. Biotechnology (Semester Pattern)
II Semester

Course Title: Lab Course VII **Course Code: U-LAC-293**
Marks:50 **Credit: 02**

Learning objectives:

- To develop skill and proficiency in preparation of laboratory reagents, normal and molar solutions.
- To apply the properties of functional groups of organic compounds to carry out selective organic reactions.
- To understand the various methods of quantitative and qualitative estimation of different biomolecules.
- Demonstration of basic oxidation and reduction reactions.

Course outcomes:

On the successful completion of the course, students will be able to-

- prepare different standard solutions, Buffer etc.
- skillfully estimate concentration of proteins, lipids, nucleic acids, and carbohydrates
- determine presence of biomolecules like carbohydrates, proteins, lipids, etc. in known and unknown samples.
- acquire skills to determine saponification value and iodine value of oil and different types of fats.

Practicals:

1. Preparation of solutions, buffer sensitivity, specificity accuracy, Molarities, molality, normality.
2. Preparation of acetate, phosphate and citrate buffer.
3. Titration of Oxalic acid and amino acid
4. Qualitative test for carbohydrates and lipids.
5. Determination of Acid value of fat
6. Determination of Saponification of Fat
7. Determination of iodine number of oil.
8. Estimation of Amino acids by Ninhydrin method
9. Estimation of Protein by Biuret and Lowry Method
10. Estimation of total sugar by anthrone method.
11. Estimation of Total reducing Sugar by DNSA method
12. Estimation of DNA by DPA method
13. Estimation of RNA by Orcinol Method
14. Estimation of Ascorbic Acid by volumetric method.
15. Mohr's salt Titration with Potassium Dichromate.

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
B.Sc. Biotechnology (Semester Pattern)
II Semester

Course Title: Lab Course VII **Course Code: U-LAC-293**
Marks:50 **Credit: 02**

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- To apply the properties of functional groups of organic compounds to carry out selective organic reactions.
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- prepare different standard solutions, Buffer etc.
- skillfully estimate concentration of proteins, lipids, nucleic acids, and carbohydrates
- determine presence of biomolecules like carbohydrates, proteins, lipids, etc. in known and unknown samples.
- acquire skills to determine saponification value and iodine value of oil and different types of fats.

Practicals:

16. Preparation of solutions, buffer sensitivity, specificity accuracy, Molarities, molality, normality.
17. Preparation of acetate, phosphate and citrate buffer.
18. Titration of Oxalic acid and amino acid
19. Qualitative test for carbohydrates and lipids.
20. Determination of Acid value of fat
21. Determination of Saponification of Fat
22. Determination of iodine number of oil.
23. Estimation of Amino acids by Ninhydrin method
24. Estimation of Protein by Biuret and Lowry Method
25. Estimation of total sugar by anthrone method.
26. Estimation of Total reducing Sugar by DNSA method
27. Estimation of DNA by DPA method
28. Estimation of RNA by Orcinol Method
29. Estimation of Ascorbic Acid by volumetric method.
30. Mohr's salt Titration with Potassium Dichromate.

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
B.Sc. Biotechnology (Semester Pattern)
II Semester
Course Title: Biomathematics, Biostatistics, and Computer
Course Code: U-BBC-290
Marks: 50 Lectures: 45 Credit: 03

Learning Objectives:

- To perform the operations of union, intersection, complement, and difference of sets in set theory using proper mathematical notation.
- To understand the representation of data in interactive graphical representation
- To understand the central tendency of various types of frequency distribution with correlation and regression
- To navigate and perform common tasks in Word, such as opening, viewing, editing, saving, and printing documents, and configuring the application.

Course Outcomes:
On the successful completion of the course, students will be able to-

- enhance knowledge and understanding of mathematical modelling and statistical methods in the analysis of biological systems.
- communicate key statistical concepts to non-statisticians and they will gain proficiency in using statistical software for data analysis.
- calculate the range of a data set, and recognize its limitations in fully describing the behavior of a data set.
- perform repetitive operations efficiently using tools such as Find and Replace, Format Painter, and Styles.

Unit I: (12L)
Biomathematics

Set Theory: Definition, Types of representation of sets, types of sets, operation on sets, difference set, complement of a set, union of set, intersection of set, cardinality, and its properties. Basic Probability: Concept of probability, sample space, types of events, factorial, permutation & combination, conditional probability, addition theorem of probability. Determinant: introduction, The value of determinant, properties of determinants. Matrices: calculation, types of matrices, addition & Multiplication of matrices

Unit II: (13L)
Biostatistics

Basics Statistics: Introduction, classification of data, presentation of statistical data, presentation of statistical data, values of variable and frequency, cumulative frequency distribution, diagrammatic presentation of statistical data, type of graphs, charts and diagrams, Histogram Bar chart, pie chart, frequency polygon, OGIVE, quartiles, deciles and percentiles

Unit III: **(09L)**

Central Tendency

Measures of central Tendency: Introduction, mean, properties of arithmetic mean, Short cut method of calculating A.M for discrete series, Calculation of arithmetic mean for grouped frequency, Distribution: continuous series, calculation of arithmetic mean from grouped frequency distribution with open end class, geometric mean, Harmonic mean, advantages and disadvantages of A.M, G.M and H.M., Median, Mode and Correlation and Regression

Unit IV: **(11L)**

Microsoft Office & R Language

Introduction, Downloading, Installation, Activation

Microsoft Word: Creating, editing, saving and printing text documents, Font and paragraph formatting Simple character formatting, inserting tables, smart art, page breaks, using lists and styles, working with images, Using Spelling and Grammar check

Microsoft Excel: Spreadsheet basics: creating, editing, saving and printing spreadsheets, working with functions & formulas, modifying worksheets with colour & autoformats, graphically representing data: harts & Graphs, formatting worksheets, Analysing data: Data Menu, Subtotal, Filtering Data, Formatting worksheets.

Microsoft PowerPoint: Opening, viewing, creating, and printing slides, applying auto layouts, adding custom animation, using slide transitions, graphically representing data

R Language: Basic fundamentals, installation and use of software, data editing, use of R as a calculator, functions and assignments. Use of R as a calculator, functions and matrix operations, missing data and logical operators.

Recommended Textbooks and References:

1. Maths:- a self-study Guide (2003) Jenny Olive, Cambridge Low prices edition
2. Fundamentals of Biostatistics (1994) (Low price Third Revised edition); Khan and Khanum: Ukaaz Publication
3. Fundamental of Statistics, (2002) 1st Edition, S. P. Gupta, Sultan Chand & Sons Educational Publisher, New Delhi
4. Computer Fundamentals (2004) 6th Edition, Priti Sinha & Pradeep K., Sinha, BPB Publications
5. R software for Beginners (2018), 1st Edition, Mr. Akash J. Waghmare, Mr. Mahesh S. Wavare, Shaurya Publication, Latur.

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(Autonomous)
B.Sc. Biotechnology (Semester Pattern)
II Semester

Course Title: Lab Course VIII **Course Code: U-LAC-294**
Marks:50 **Credit: 02**

Learning Objectives:

- To introduce students to various statistical methods relevant to biologies like a measure of central tendency.
- To use mathematical tools, including calculus and mathematical statistics and in the description and development of statistical procedures.
- To understand Microsoft Office and its variety of business-based applications.
- To understand various aspects of the R language.

Course Outcomes:

On the successful completion of the course, students will be able to-

- recognize, describe and represent numbers and their relationships, and also they are able to count, estimate, calculate and check with competence and confidence in solving problems.
- apply statistical theory, methods and techniques to public health research data and the planning, implementation and evaluation of public health programs.
- find the middle, average of a data set and to determine the typical numerical point in a set of data. Create documents for printing and sharing and to create and share presentations.
- understand graphical representation by using statistical techniques with the help of the R language.

Practicals:

1. Exercise-based on Biomathematics
2. Exercise-based on Biostatistics
3. Exercise-based on statistical methods for biologists
4. Computer – Fundamental
5. Microsoft Office: Word, Excel, PowerPoint
6. File handling: copy, rename, delete, type, etc. Directory structure: make, rename, move the directory.
7. Use of the internet – Downloading & Installing software/plugins on Windows (Acrobat Reader, Post Scripts Viewer, etc.)
8. R Software: Basic fundamentals, installation on different operating systems
9. R is used Graphics function and plots
10. Statistical functions for central tendency, variation, skewness, and kurtosis
11. Handling of data through graphics, programming, and illustration with examples.

Summary of cross cutting issues:

Biotechnology is a collective term for a group of technologies that use biological matter or processes to generate new and useful products and processes. As such, it ranges in complexity and maturity from ancient brewing and bread-making techniques to genetic modification through hybridization and interbreeding of plants and animals, as well as the manipulation of individual genes in humans, animals, plants and micro-organisms. Biotechnology is a key technology for the new millennium. It has an immense range of applications in agriculture, medicine, food processing, environmental protection, mining, and even nanoelectronics.

It is expected to cover some critical issues in the designed curriculum for the development of Students. In our syllabus we tried to include following cross cutting issues.

Cross-cutting issues relevant to Professional Ethics, Gender, Environment and Sustainability, and Human Values into the curriculum:

Sr. No.	Course Name	Code	Relevant to Professional Ethics	Description
1	Cell Biology	U-CEB-187	Professional Ethics	Expertise in cell culture techniques will create employability in Pathology labs and Research Institutes
2	Introductory Microbiology	U-INM-189	Professional Ethics	Expertise in Microbiological techniques will create employability in Pathology Labs, Research and Industries
3	Bioinstrumentation	U-BIO-287	Professional Ethics	Expertise in Handling of Instruments
4	Inheritance Biology	U-INB-288	Professional Ethics	Expertise in Genetics and create employability as Laboratory geneticist
5	Introduction to Biomolecules	U-ITB-289	Professional Ethics	Expertise in qualitative and Quantitative analysis

				of biomolecules will create employability in Pathology labs, QA and QC
6	Biomathematics, Biostatistics, & Computer	U-BBC-290	Professional Ethics	Expertise in data analysis

Sr. No.	Course Name	Code	Relevant to Human Values	Description
1	Moral Education	U-MOE-235	Human Values	Inculcate human values and ethics

Curricula developed and implemented have relevance to the local, national, regional and global developmental needs

Sr. No.	Course code	Course Name	Linkage with Local/National/Regional/Global development
1	U-CEB-187	Cell Biology	Basic Cellular Information and Techniques (Competitive Examination and Research)
2	U-INP-188	Introduction to Physiology	Plant and Animal Physiology (Competitive Examination and Research)
3	U-INM-189	Introductory Microbiology	Basic Microbial Techniques (Research)
4	U-BCP-190	Basics of Chemistry and Physics	Basic Chemical and Physical Concepts ((Competitive Examination)
5	U-BIO-287	Bioinstrumentation	Basic Techniques (Competitive Examination, Research, Industry etc)
6	U-INB-288	Inheritance Biology	Genetics (Competitive Examination and Research)
7	U-ITB-289	Introduction to Biomolecules	Qualitative and Quantitative Analysis of Biomolecules (Industry, Research etc.))
8	U-BBC-290	Biomathematics, Biostatistics, & Computer	Concepts applicable to Scientific Research

Courses having focus on employability/ entrepreneurship/ skill development

Sr. No	Name of the Course	Course Code	Activities/Content with a direct bearing on Employability/ Entrepreneurship/ Skill development			Year of introduction
			Employability	**Entrepreneurship**	**Skill development**	
1	Cell Biology	U-CEB-187			student will understand basics of cell structure and function which will help them to develop research aptitude and encourage them to enrol in research field	2017-18
2	Introduction to Physiology	U-INP-188	Basics of Physiology helps in consolidating ideas about employability in application in biology	Knowledge of Basic bioscience boosts the ideas about applicability of biology in plant and animal-based industry.	Skills in taxonomy and basic physiology of plants and animals developed	2022-23
3	Introductory Microbiology	U-INM-189	This course will produce Employability to students in different sectors like Pharmaceutical Industries. Universities. Laboratories. Private Hospitals.	This course knowledge will help students to open the Pathology lab, Healthcare & medicine industry	This course produce student with expertise in Microbial Techniques which help them for fetching	2017-18

			Research Organizations.4EnvironmentalAgencies. Food Industry. Beverage Industry.		job in Industries.	
4	Basics of Chemistry and Physics	U-BCP-190	Students can get the job as Lab. Technician.		Students will skill in Chemical preparation dealing with chemicals.	2022-23
5	Bioinstrumentation	U-BIO-287	Students can get the job for handling the instruments.	This course knowledge will help students for operating Medical Instrumentation and Devices.	This course helps the student to understand the principle and working of every instrument.	2022-23
6	Inheritance Biology	U-INB-288	Student can work as genetic counsellor	Research and development of new varieties of agricultural and industrial importance.	Genetics improves the logical thinking of students in biology.	2022-23
7	Introduction to Biomolecules	U-ITB-289	Student can work as Biochemist		Student gains proficiency in basic laboratory techniques in both Chemistry and Biology	2022-23
8	Biomathematics, Biostatistics, and Computer	U-BBC-290			The main focus is given to types of data, measurement of central variations,	2017-18

					and basic tests, which are useful for analysis of different types of observations. Few parameters like a normal distribution, calculation of sample size, level of significance, null hypothesis, indices of variability, and different test	