

University of Mumbai



No. AAMS_UGS/ICC/2023-24/29


CIRCULAR:-

Attention of the Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology is invited to this office Circular No. UG/212 of 2017-18 dated 22nd August, 2017 relating to the revised syllabus as per the (CBCS) for the S.Y.B. Sc. Biotechnology (Sem -III & IV).

They are hereby informed that the recommendations made by the Board of Deans at its meeting held on 27th June, 2023 vide item No. 6.5 (R) have been accepted by the Academic Council at its meeting held on 27th June, 2023 vide item No. 6.5 (R) and that in accordance therewith, the **revised syllabus of S.Y.B. Sc. (Biotechnology) (CBCS) (Sem – III & IV)** has been brought into force with effect from the academic year 2023-24.

(The said circular is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
13th July, 2023


(Prof. Sunil Bhirud)
I/c. REGISTRAR

To

The Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology.

A.C/6.5 (R) /27/06/2023

Copy forwarded with Compliments for information to:-

- 1) The Dean, Faculty of Science & Technology,
- 2) The Chairman, Board of Studies **Biotechnology**,
- 3) The Director, Board of Examinations and Evaluation,
- 4) The Director, Board of Students Development,
- 5) The Director, Department of Information & Communication Technology,
- 6) The Co-ordinator, MKCL.

Copy for information and necessary action :-

1. **The Deputy Registrar, College Affiliations & Development Department (CAD),**
2. **College Teachers Approval Unit (CTA),**
3. **The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
4. **The Deputy Registrar, Academic Appointments & Quality Assurance (AAQA)**
5. **The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
6. **The Deputy Registrar, Executive Authorities Section (EA)**
He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to the above circular.
7. **The Deputy Registrar, PRO, Fort, (Publication Section),**
8. **The Deputy Registrar, Special Cell,**
9. **The Deputy Registrar, Fort Administration Department (FAD) Record Section,**
10. **The Deputy Registrar, Vidyanagari Administration Department (VAD),**

Copy for information :-

1. **The Director, Dept. of Information and Communication Technology (DICT), Vidyanagari,**
He is requested to upload the Circular University Website
2. **The Director of Department of Student Development (DSD),**
3. **The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**
4. **All Deputy Registrar, Examination House,**
5. **The Deputy Registrar, Finance & Accounts Section,**
6. **The Assistant Registrar, Administrative sub-Campus Thane,**
7. **The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
8. **The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
9. **P.A to Hon'ble Vice-Chancellor,**
10. **P.A to Pro-Vice-Chancellor,**
11. **P.A to Registrar,**
12. **P.A to All Deans of all Faculties,**
13. **P.A to Finance & Account Officers, (F & A.O),**
14. **P.A to Director, Board of Examinations and Evaluation,**
15. **P.A to Director, Innovation, Incubation and Linkages,**
16. **P.A to Director, Department of Lifelong Learning and Extension (DLLE),**
17. **The Receptionist,**
18. **The Telephone Operator,**

Copy with compliments for information to :-

19. **The Secretary, MUASA**
20. **The Secretary, BUCTU.**

UNIVERSITY OF MUMBAI



**Revised Syllabus for
S.Y.B.Sc. (Biotechnology)
(Sem. III & IV)
(CBCS)**

(With effect from the academic year 2023-24)

University of Mumbai



Syllabus for Approval

Sr. No.	Heading	Particulars
1	O: _____ Title of Course	S.Y.B.Sc. (Biotechnology)
2	O: _____ Eligibility	As per the University Ordinance O.5106
3	R: _____ Passing Marks	40 %
4	No. of years/Semesters:	3 Years/ 6 Semesters
5	Level:	P.G. / U.G. / Diploma / Certificate (Strike out which is not applicable)
6	Pattern:	Yearly / Semester (Strike out which is not applicable)
7	Status:	Revised / New (Strike out which is not applicable)
8	To be implemented from Academic Year :	From Academic Year: 2023-24

Prof. Shivram S. Garje,
Dean,
Faculty of Science and Technology

SEMESTER- III				
Course code	Course type	Course Title	Credits	Lectures/ Week
USBT301	Core Subject	Bioprocess technology	2	3
USBT302	Core Subject	Medical Microbiology	2	3
USBT303	Core Subject	Applied chemistry-1	2	3
USBT304	Core Subject	Fundamentals in Biophysics	2	3
USBT305	Core Subject	Immunology	2	3
USBT306	Core Subject	Molecular biology-III	2	3
USBT307	General Elective	Biosafety	2	3
USBTP301	Core Subject Practicals	Practicals of USBT_301 and USBT_302	2	6
USBTP302	Core Subject Practicals	Practicals of USBT_303 and USBT_304	2	6
USBTP303	Core Subject Practicals	Practicals of USBT_305 and USBT_306	2	6
SEMESTER-IV				
Course code	Course type	Course Title	Credits	Lectures/ Week
USBT401	Core Subject	Medical biotechnology	2	3
USBT402	Core Subject	Cell biology and cytogenetics	2	3
USBT403	Core Subject	Applied chemistry-2	2	3
USBT404	Core Subject	Biochemistry	2	3
USBT405	Core Subject	Molecular diagnostics	2	3
USBT406	Core Subject	Bioinformatics and Biostatistics	2	3
USBT407	General Elective	Research methodology	2	3
USBTP401	Core Subject	Practicals of USBT_401 and USBT_402	2	6

	Practicals			
USBTP402	Core Subject Practicals	Practicals of USBT_403 and USBT_404	2	6
USBTP403	Core Subject Practicals	Practicals of USBT_405 and USBT_406	2	6

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SEMESTER-III

Course Code	Title	Credits	No. of Lectures
USBT301	BIOPROCESS TECHNOLOGY	2	
<p>Course objectives: The objective of this course is to understand the basics skills applied in fermentation technology and build a foundation for more advanced studies in bioprocess technology.</p> <p>Learning outcomes:- By the end of the course the student will be able to:</p> <ul style="list-style-type: none"> ● develop an understanding of the various aspects of bioprocess technology. ● develop skills associated with screening of industrially important strains. ● understand principles underlying design of fermenter and fermentation process. 			
<p align="center">UNIT I</p> <p>Fermentor design , media and sterilization</p>	<p>Fermentor designs: Air lift fermentor, Tower fermentor, Acetator and cavitator, deep jet, packed Tower</p> <p>Fermentation Media: Media components : Carbon source-factors affecting choice of Carbon source with examples, Nitrogen source factors affecting choice of Carbon source with examples, Growth factors, Minerals, buffers, minerals, Inducers, precursors Antifoam agents- Types , Properties of Antifoam agent</p> <p>Medium properties: Fast metabolism, Rheology Concept of Inoculum and Production Media Sterilization : Sterilization of Fermentor and Fermentation Media. Sterilization of Media -Batch and Continuous Concept of Del factor Sterilization of Fermentor, feeds, liquid wastes Sterilization of Air Supply, Exhaust gases Filter sterilization</p>		15

<p>UNIT II</p> <p>Inoculum development and process parameters</p>	<p>Introduction to Inoculum development; Bacterial and fungal inoculum development with two examples each, scale up, scale down.</p> <p>Detailed steps in Monitoring and Control of process variables</p>		15
<p>UNIT III</p> <p>Fermentation processes-1</p>	<p>Types of fermentations and fermentation process</p> <p>Significance and applications of</p> <p>Batch and continuous, surface and submerged, aerobic and anaerobic, Solid state fermentation.</p> <ul style="list-style-type: none"> • Industrial products from Microorganisms- Penicillin, semisynthetic penicillin, Streptomycin, Vaccines, hormones • Enzymes and Organic acids from Microorganisms: Ethanol, Citric acid, acetic acid, Lysine, Glutamic acid, Amylases, protease 		15

Course Code	Title	Credits	No. of Lectures
USBT302	MEDICAL MICROBIOLOGY	2	
<p>Course objectives:- The objective of this course is to gain insight into disease factors and processes and diseases caused by microorganisms.</p> <p>Learning outcomes:- By the end of the course the student will be able to:</p> <ul style="list-style-type: none"> ● list the factors playing a role in causing a disease gain. ● discuss the various aspects of systemic infections including causative agents, symptoms and prophylaxis. ● gain the technical capability of handling, isolating and identifying various bacteria. 			
UNIT I General Bacteriology and Bacteria as Human pathogen, Host parasite interactions	Host Parasite Relationship: Normal Flora; Factors Affecting the Course of Infection and Disease; Mechanisms of Infection and Virulence Factors. Infection: Patterns of Infection; Types of Infections; Signs and Symptoms; Epidemiology and Epidemiological Markers. Diseases: Origin of Pathogens; Vectors; Acquisition of Infection; Koch's Postulates.		15
UNIT II Causative organisms-1	Skin: <i>S. aureus, S. pyogenes.</i> Respiratory Tract Infections: <i>M. tuberculosis, S. pneumoniae</i> (Characteristics Transmission, Course of Infection, Lab Diagnosis, Management of TB, Prevention and Control, Immuno and Chemoprophylaxis, DOTS and MDR). Urinary Tract Infections: <i>E.coli</i> : Characteristics, Virulence, Clinical disease, and <i>E.coli</i> Infections.		15

<p>UNIT III</p> <p>Causative organisms-2</p>	<p>GI Tract Infections: <i>Salmonella and Shigella</i> spp. (Characteristics, Virulence- Pathogenesis and Immunity, Clinical Disease, Carriers Lab Diagnosis, Phage Typing Prophylaxis and Treatment).</p> <p>Sexually Transmitted Diseases : <i>Syphilis and Gonorrhoea.</i></p> <p>Nosocomial Infections : <i>Ps. aeruginosa</i></p>		<p>15</p>
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Course Code	Title	Credits	No. of lectures
USBT303	APPLIED CHEMISTRY-1	2	
<p>Course objectives:- The objective of this course is to have a firm foundation in the fundamentals and applications of organic and green chemistry.</p> <p>Learning outcomes:- By the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • develop an understanding of the different aspects of organic and green chemistry. • discuss the role of organic compounds in biology and synthesis of organic compounds. • discuss the role of green chemistry and its application in industry. <p>Understand the basic concept of electrophoresis</p>			
UNIT I Organic chemistry	<p>Introduction to Types of Organic Reactions : Addition, Elimination and Substitution Reactions.</p> <p>Essential and Non-essential Elements in Biological Systems.</p> <p>Role of Metal Ions in Biological Systems. Metal Coordination in Biological Systems : Enzymes, Apoenzymes and Coenzymes. Biological Role of Metalloenzymes wrt Myoglobins, Haemoglobin.</p> <p>Biological Role of Carboxypeptidases, Catalases and Peroxidases.</p>		15
UNIT II Chromatography and centrifugation	<p>Chromatography- Principle, working and applications of: Affinity chromatography, Ion-exchange chromatography, Molecular (size) exclusion chromatography.</p> <p>Centrifugation- Basic Principle of sedimentation, Types of Centrifugal Separation- Differential Centrifugation, Density Gradient Centrifugation, Rotor Categories, Applications of Centrifugation</p>		15
UNIT III Electrophoretic Techniques	<p>Electrophoresis: Migration of Ions in an applied electric field; Factors affecting Electrophoretic Mobility; Moving Boundary Electrophoresis; Principle of Electrophoresis; Supporting Matrix; Paper Electrophoresis; AGE; Native and SDS PAGE (reducing and non-reducing, continuous and discontinuous); IEF and 2D PAGE. Staining and Detection Methods; Gel-Documentation. Applications in Biology.</p>		15

Course Code	Title	Credits	No. of Lectures
USBT304	FUNDAMENTALS IN BIOPHYSICS	2	
<p>Course objectives:- The objective of this course is to have a firm foundation in the fundamentals and applications of current biophysical theories.</p> <p>Learning outcomes:- By the end of the course the student will:</p> <ul style="list-style-type: none"> • develop an understanding of the different aspects of classical physics. • be able to relate principles of physics to applications and techniques in the field of biology such as microscopy, spectroscopy and electrophoresis 			
UNIT I Optics and Microscopy	Introduction to Optics and Lasers: Optics : Properties of Light - Reflection, Refraction, Dispersion, Interference. Lasers : Properties of Lasers, Stimulated Emissions, Laser Action; Applications of Laser. Microscopy: Types of Microscopy; Electron Optics; Electron Microscopy- Preparation of Specimen, Construction, Principles and Working: SEM, TEM and Immuno-Electron Microscopy. Fluorescence Microscopy.		15

<p>UNIT II Heat, Sound, Magnetism and Fluid Dynamics</p>	<p>Heat: Concept of Temperature; Modes of Heat Transfer; Measuring Temperature; Platinum Resistance Thermometer; Thermocouple and Thermistors.</p> <p>Sound: Types of Sound Waves - Audible, Ultrasonic and Infrasonic Waves; Doppler Effect; Applications of Ultrasonic Waves.</p> <p>Magnetism: Magnetic Field; Magnetism of Earth; Paramagnetism, Diamagnetism, Ferromagnetism. Nuclear Magnetism and Biomagnetism.</p> <p>Fluid Dynamics :</p> <p>Viscosity: Definition Flow of Liquids through Capillaries; Stokes' Law; Terminal Velocity. Determination of 'η' by Falling Sphere Method; Viscosity Estimation by Oswald's Viscometer.</p> <p>Surface Tension: Definition - Surface Tension and Surface Energy; Capillary Action; Angle of Contact; Wettability; Temperature Dependence of Surface Tension. Applications in Biology.</p>		15
<p>UNIT III Spectroscopy</p>	<p>Spectroscopy Types and Properties of Spectra; Basic Laws of Light Absorption. Principle, instrumentation, working and applications of: UV Spectroscopy Fluorescence Spectroscopy Luminometry Light scattering spectroscopy Infrared Spectroscopy</p>		15

Course Code	Title	Credits	No. of Lectures
USBT305	IMMUNOLOGY	2	
<p>Course objectives:- The objective of this course is to familiarize students with the immune effector mechanisms and various immunotechniques.</p> <p>Learning outcomes:- By the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • understand the role of different types of cells, effector molecules and effector mechanisms in immunology. • understand the principles underlying various immunotechniques. 			
UNIT I Cell and organs of immune system, Complement system	Haematopoiesis; Cells of the Immune System; Primary and Secondary Lymphoid Organs. Complement System- Classical, Alternate and Lectin; Regulation and Biological Effects of Complement System; Deficiencies of Complement System		15
UNIT II MHC and Antigen presentation pathways, TCR/BCR, T cell and B cell Activation	T-cell Receptor Complex : Structure and Activation. MHC Classes - General Organization and Inheritance; Structures and Peptide Interactions; Class I and II Diversity and Polymorphism; Antigen Presentation - Endocytic and Exocytic Pathways; MHC Restriction. B-cell Receptor : Structure, Maturation and Activation B-T Cell Interaction (B-T cell Cooperation)		15
UNIT III Immunotechniques	Precipitation Reactions : Immunoprecipitation, Immunoelectrophoresis, CIEP, Rocket Electrophoresis and 2-D Immunoelectrophoresis. Agglutination Reactions : Passive, Reverse Passive, Agglutination Inhibition. Coomb's Test; Complement Fixation Tests, RIA, ELISA, ELISPOT, Chemiluminescence, Western Blot, Immunofluorescence, Flow Cytometry. Alternatives to Antigen-Antibody Reactions		15

Course Code	Title	Credits	No. of Lectures
USBT306	MOLECULAR BIOLOGY-III	2	
<p>Course objectives:- The objective of this course is to have an insight into the mechanism of gene expression and regulation.</p> <p>Learning outcomes:- By the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • discuss the mechanisms associated with gene expression at the level of transcription and translation. • discuss the mechanisms associated with regulation of gene expression in prokaryotes 			
UNIT I Transcription	<p>Transcription Process in Prokaryotes : RNA Synthesis; Promoters and Enhancers; Initiation of Transcription at Promoters; Elongation and Termination of an RNA Chain.</p> <p>Transcription in Eukaryotes : Eukaryotic RNA Polymerases; Eukaryotic Promoters; Transcription of Protein Coding Genes by RNA Polymerase; Eukaryotic mRNA's; Transcription of other genes; Spliceosomes; RNA editing.</p>		15
UNIT II Translation	<p>Nature of Genetic Code. Wobble Hypothesis. Translation in Prokaryotes and Eukaryotes: Process of Protein Synthesis (Initiation, Elongation, Translocation, Termination); Post Translational Modifications. Protein sorting.</p>		15
UNIT III Regulation of gene expression in Prokaryotes and Viruses	<p>In Prokaryotes: lac Operon of <i>E.coli</i>; trp Operon of <i>E.coli</i>, Arabinose operon.</p> <p>In Viruses : Lytic and Lysogenic Regulation</p>		15

Course Code	Title	Credits	No. of Lectures
USBT307	BIOSAFETY	2	
<p>Objective: Learner should</p> <ul style="list-style-type: none"> • Understand the concept of GLPs. • Learn about routes of microbial contaminants and assays to detect contamination. <p>Learning Outcome: Learner will be able</p> <ul style="list-style-type: none"> • to document laboratory work, calibration records and prepare SOPs. • to identify the role of the Biosafety Professional in Biomedical Research Laboratories 			
<p>UNIT I Introduction to biosafety, GLP</p>	<p>Introduction: Biological Risk Assessment, Hazardous Characteristics of an Agent; Genetically modified agent hazards; Cell cultures; Hazardous Characteristics of Laboratory Procedures; Potential Hazards Associated with Work Practice. Concept of GLP; Practicing GLP; Guidelines to GLP; Documentation of Laboratory work; Preparation of SOPs; Calibration records; Validation of methods; Documentation of results; Audits & Audit reports.</p>		15
<p>UNIT II Biosafety in diagnostics labs</p>	<p>Biosafety Good diagnostic lab practice and procedures Personnel competence and training Facility design Specimen and material receipt and storage Decontamination and waste management Personal protective equipment Laboratory equipment Safe techniques Emergency/incident response Occupational health Transport Maintenance of records Reporting of accidents Training</p>		15
<p>UNIT III Detection and testing of contaminants</p>	<p>Microbial Contamination in food and pharma products; Some common microbial contaminants; Microbiological Assays for pharmaceutical products; Regulatory Microbiological testing in pharmaceuticals.</p>		15

SEMESTER IV

Course Code	Title	Credits	No. of Lectures
USBT401	MEDICAL BIOTECHNOLOGY	2	
<p>Course objectives:- Learner should</p> <ul style="list-style-type: none"> ● Comprehend pathogenesis and diagnosis process ● Understand mechanism of drug action and mode of drug resistance. <p>Learning outcomes:- Learner will be able to</p> <ul style="list-style-type: none"> ● Demonstrate knowledge for infectious agents and drug action mechanisms ● to identify drug resistance problems in disease treatment. 			
<p>UNIT I</p> <p>Viral and fungal diseases</p>	<p>Pathogenesis, clinical symptoms, laboratory diagnosis, epidemiology, prophylaxis and treatment of Viral diseases</p> <p>Air borne viral diseases:</p> <p>Influenza ,measles, COVID</p> <p>Vector Borne viral diseases:</p> <p>(Dengue, AIDS, Rabies).</p> <p>Fungal diseases- transmission, symptoms and prevention of cutaneous mycoses (Athlete's foot), systemic mycoses (Histoplasmosis) and opportunistic mycoses (Candidiasis)</p>		15
<p>UNIT II</p> <p>Chemotherapeutic agents I</p>	<p>Discovery and Design of antimicrobial agents; Classification of Antibacterial agents, Selective toxicity, MIC, MLC</p> <p>Inhibition of cell wall synthesis (Mode of action for): Beta lactam antibiotics: Penicillin, Cephalosporins; Glycopeptides: Vancomycin; Polypeptides: Bacitracin</p> <p>Injury to Plasma membrane: Polymyxin;</p> <p>Inhibition of protein synthesis Aminoglycosides, Tetracyclines Chloramphenicol, Macrolides Erythromycin;</p> <p>Inhibition of Nucleic acid synthesis:</p> <p>Quinolones, Rifampicin, Metronidazole ; Antimetabolites: Sulphonamides, Trimethoprim;</p>		15

<p>UNIT III</p> <p>Chemotherapeutic agents II</p>	<p>Antimicrobial susceptibility tests</p> <p>Drug Resistance: Mechanism, Origin and transmission of drug resistance;</p> <p>Use and misuse of antimicrobial agents;</p> <p>Antifungal drugs, Azoles, Polyenes, Echinocandins, Silylamines, Pyrimidine Analogues</p> <p>Antiviral drugs :</p> <p>Drugs that target the viral DNA polymerase (Acyclovir, Gancyclovir)</p> <p>Nucleoside and nucleotide reverse transcriptase inhibitors (Zidovudine)</p> <p>Non-nucleoside reverse transcriptase inhibitors (Nevirapine)</p> <p>Protease inhibitors</p> <p>Fusion inhibitors (Enfuvirtide)</p>		<p>15</p>
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Course Code	Title	Credits	No. of Lectures
USBT402	CELL BIOLOGY AND CYTOGENETICS	2	
<p>Course objectives:- The objective of this course is to have a firm foundation in the fundamentals of cell biology and cytogenetics.</p> <p>Learning outcomes:- By the end of the course the student will be able to:</p> <ul style="list-style-type: none"> ● develop an understanding of the cytoskeleton and cell membrane. ● discuss the structure of chromosomes and types of chromosomal aberrations. ● discuss the principles underlying sex determination, linkage and mapping. 			
UNIT I Cytoskeleton	Cytoskeleton : Overview of the Major Functions of Cytoskeleton. Microtubules: Structure and Composition. MAPs: Functions- Role in Mitosis, Structural Support and Cytoskeleton Intracellular Motility. Motor Proteins: Kinesins, Dynein; MTOCs. Dynamic Properties of Microtubules. Microtubules in Cilia and Flagella. Microfilaments: Structure, Composition, Assembly and Disassembly. Motor Protein: Myosin. Muscle Contractility: Sliding Filament Model. Actin Binding Proteins : Examples of Non Muscle Motility. Intermediate Filaments :Structure and Composition; Assembly and Disassembly; Types and Functions.		15
UNIT II Cell membrane	Cell Membrane : Uptake of Nutrients by Prokaryotic Cells; Cell Permeability. Principles of Membrane Transport Transporters and Channels; Active Transport, Passive Transport; Types of Transporters; Types of ATP Driven Pumps - Na ⁺ K ⁺ Pump. Cell Junctions; Cell Adhesion and Extracellular Material Microvilli; Tight Junctions, Gap Junctions; Cell Coat and Cell Recognition. Cellular Interactions.		15

<p>UNIT III</p> <p>Cytogenetics</p>	<p>Cytogenetics :</p> <p>Structure of Chromosome - Heterochromatin, Euchromatin, Polytene Chromosomes. Variation in Chromosomal Structure and Number :</p> <p>Deletion, Duplication, Inversion, Translocation, Aneuploidy, Euploidy and Polyploidy and Syndromes- Klinefelter, Turner, Cri-du-Chat, Trisomy -21, Trisomy 18 and Trisomy 13.</p> <p>Sex Determination and Sex Linkage : Mechanisms of Sex Determination (XX-XY, ZZ-ZW, XX-XO)</p> <p>Dosage Compensation and Barr Body. Genetic Linkage, Crossing Over and Chromosomal Mapping : Tetrad Analysis; Two-point Cross; Three point Cross; Pedigree Analysis.</p>		<p>15</p>
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Course Code	Title	Credits	No. of lectures
USBT403	APPLIED CHEMISTRY-2	2	
<p>Course objectives:- The objective of this course is to have a firm foundation in the fundamentals and applications of current chemical theories for the physical world.</p> <p>Learning outcomes:- By the end of the course the student will:</p> <ul style="list-style-type: none"> ● develop an understanding of the different aspects of analytical chemistry. ● gain knowledge of natural product chemistry and related acquired skills. ● gain an understanding of basic concepts in polymer chemistry and nanomaterials. 			
UNIT I Synthesis of organic compounds	Synthesis of Organic Compounds : Criteria for Ideal Synthesis; Selectivity and Yield. Linear and Convergent Synthesis and Multicomponent Reactions. Microwave Assisted Organic Synthesis, Ultrasound in Synthesis and Polymer supported Synthesis. Retrosynthesis.		15
UNIT II Natural product chemistry and green chemistry	Natural Product Chemistry : Primary and Secondary Metabolites. Classification of Natural Products based on Bio Synthesis. Classification of Natural Products based on Structure- Alkaloids, Phenolics, Essential Oils and Steroids. Structure Determination of Natural Products. Commercial Synthesis of Natural Products. Green Chemistry and Synthesis: Introduction to Green Chemistry; Need and Relevance of Green Chemistry; Principles of Green Chemistry. Green Synthesis in Industry: Green Materials, Green Reagents, Green Solvents and Green Catalysts.		15

UNIT III Nanotechnology	Nanomaterials : Introduction to Nanomaterials. Forms of Nanomaterials : Nanoparticles, Nanofilms and Nanotubes Synthesis and Characterization of Nanomaterials. Applications of Nanomaterials.		
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Course Code	Title	Credits	No. of lectures
USBT404	BIOCHEMISTRY	2	
<p>Course objectives:-</p> <ul style="list-style-type: none"> • Understand the order of reactions involved in carbohydrate, amino acid and lipids metabolism. • Learn how the metabolism pathways are regulated at molecular level. <p>Learning outcomes:- Learner should:</p> <ul style="list-style-type: none"> • Be able to illustrate the metabolism of carbohydrates, amino acids and lipids through various metabolic pathways. • Be able to undertake investigations and perform analysis that provide information about metabolic disorder. 			
UNIT I Carbohydrate Metabolism, ETS and Energy Rich Compounds	Carbohydrate Metabolism : Glycolytic Pathway and its Regulation, Homolactic Fermentation; Alcoholic Fermentation; Energetics of Fermentation; Citric Acid Cycle and its Regulation; Gluconeogenesis; Pentose Phosphate Pathway; Glyoxalate Pathway; Reductive TCA . (Sequence of Reactions, Regulation, Energy Yield and Metabolic Disorders of the above Pathways) Electron Transport System : Electron Transport and Oxidative Phosphorylation. Inhibitors of ETS. Energy Rich Compounds : ATP as Energy Currency, Structure of ATP, Hydrolysis, Other Energy Rich Compounds other than ATP like PEP, Creatine Phosphate, etc.		15

<p>UNIT II Amino acid metabolism</p>	<p>Amino Acid Breakdown : Deamination, Transamination, Urea Cycle, Breakdown of Glucogenic and Ketogenic Amino Acids. Amino Acids as Biosynthetic Precursors : Biosynthesis of Epinephrine, Dopamine, Serotonin, GABA, Histamine, Glutathione. (Sequence of Reactions, Regulation and Metabolic Disorders of the above Pathways)</p>		<p>15</p>
<p>UNIT III Lipid metabolism</p>	<p>Lipid Metabolism : Mobilization, Transport of Fatty Acids. Beta, Alpha and Omega Oxidation of Saturated Fatty Acids; Oxidation of Unsaturated Fatty Acids; Oxidation of Odd Chain Fatty Acids. Energy Yield, Ketone Body Breakdown to Yield Energy. (Sequence of Reactions, Regulation, Energy Yield and Metabolic Disorders of the above Pathways)</p>		<p>15</p>

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Course Code	Title	Credits	No. of Lectures
USBT405	MOLECULAR DIAGNOSTICS	2	
<p>Course objectives:- The objective of this course is learning and understanding molecular techniques and utilizing these techniques in diagnosis.</p> <p>Learning outcomes:- By the end of the course the student will be able to:</p> <ul style="list-style-type: none"> ● gain an understanding of the basic principles used in molecular diagnosis. ● gain critical thinking and analytical skills to understand new diagnostic methods. ● apply the knowledge and skills gained in the course should be useful in developing new diagnostic kits. 			
UNIT I Basics of molecular diagnostics	<p>Introduction to Molecular Diagnostics : Overview of Molecular Diagnostics; History of Molecular Diagnostics; Molecular Diagnostics in Post Genomic Era; Areas used in Molecular Diagnostics; Future Prospects - Commercialising Molecular Diagnostics, Personalized Medicine, Theranostics.</p> <p>Characterisation and analysis of Nucleic – Acids and Proteins :</p> <p>Extraction, Isolation and Detection of DNA, RNA and Proteins; Restriction Endonucleases and Restriction Enzyme Mapping.</p> <p>Hybridisation Techniques :</p> <p>Southern, Northern, Western and FISH; Markers, Probes and its Clinical Applications.</p>		15
UNIT II Nucleic acid amplification methods	<p>Target amplification : PCR - General Principle; Components of a Typical PCR Reaction; Experimental Design; Primer Designing; Control of PCR Contamination and Mispriming; PCR Product Clean-up and Detection.</p> <p>PCR Types : Reverse Transcriptase and Real Time PCR.</p> <p>Probe amplification : Ligase Chain Reaction</p>		15

<p>UNIT III Molecular biology based diagnostics</p>	<p>DNA Polymorphism and Identification: RFLP and Parentage Testing; RFLP and Sickle-Cell Anaemia. Genetic Counseling and Molecular Diagnosis Genetic Testing- Need and Uses; genetic Counseling. Case Studies- Diagnostic Testing for Cystic Fibrosis; Fragile X Diagnostic and Carrier Testing. Ethical, Social and Legal Issues to Molecular - Genetic Testing</p>		<p>15</p>
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Course Code	Title	Credits	No. of Lectures
USBT406	BIOINFORMATICS AND BIOSTATISTICS	2	
<p>Course objectives:- The objective of this course is learning and understanding basic concepts of Bioinformatics and Biostatistics.</p> <p>Learning outcomes:- By the end of the course the student will be able to:</p> <ul style="list-style-type: none"> ● gain an understanding of the basic concepts of Bioinformatics and Biostatistics. ● understand the tools used in bioinformatics. ● apply the various statistical tools for analysis of biological data. 			
UNIT I Introduction to Computers and Biological Databases	<p>Computer Basics : Basic Computer Operations: I/O Units; Computer Memory; Processor; Binary Arithmetic; Logic Circuit; Architecture; Operating Systems and application softwares.</p> <p>Biological Databases : Classification of Databases - Raw and Processed Databases; Primary (NCBI), Secondary (PIR) and Tertiary or Composite (KEGG) Databases; Structure and Sequence Databases.</p> <p>Specialized Databases - Protein Pattern Databases; Protein Structure and Classification Databases (CATH/SCOP). Genome Information Resources: DNA Sequence Databases Specialized Genomic Resources. Protein Databases based on Composition, Motifs and Patterns. Protein Structure Visualization Software.</p>		15
UNIT II BLAST and sequence alignment	<p>BLAST and Sequence Alignment : BLAST and its Types; Retrieving Sequence using BLAST.</p> <p>Pairwise Alignment : Identity and Similarity; Global and Local Alignment; Pairwise Database Searching. Multiple Sequence Alignment: Goal of Multiple Sequence Alignment; Computational Complexity; Manual Methods; Simultaneous Methods; Progressive Methods; Databases of Multiple Alignment; Secondary Database Searching; Analysis Packages; MSA.</p>		15

UNIT III Biostatistics	Theory and Problems based on- Coefficient of Correlation and Regression Analysis; Steps in Testing Statistical Hypothesis; Parametric Tests:- z Test – Single Mean and Two Means, t-Test – Single Man, Paired and Unpaired; Chi Square Test.		
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Course Code	Title	Credits	No. of Lectures
USBT407	RESEARCH METHODOLOGY	2	
<p>Course objectives:- The objective of this course is to develop research aptitude, logical thinking and reasoning.</p> <p>Learning outcomes:- By the end of the course the student will be able to:</p> <ul style="list-style-type: none"> ● understand basic principles of research methodology and identify a research problem. ● understand a general definition of research design. ● identify the overall process of designing a research study from its inception to its report. 			
UNIT I Introduction to Research Methodology and Research Problem	Meaning of Research; Objectives of Research; Motivation in Research; Types of Research; Research Approaches; Significance of Research; Research Methods versus Methodology; Research Process; Criteria of Good Research; Problems Encountered by Researchers in India; What is a Research Problem? Selecting the Problem; Necessity of Defining the Problem; Technique Involved in Defining a Problem		15
UNIT II Research Design, Data Collection and processing	Meaning of Research Design; Need for Research Design; Features of a Good Design; Important Concepts Relating to Research Design; Different Research Designs; Basic Principles of Experimental Designs; Developing a Research Plan Collection of Primary Data; Observation Method; Interview Method; Collection of Data through Questionnaires; Collection of Data through Schedules; Other Methods of Data Collection, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method		15
UNIT III Interpretation and Report Writing	Meaning of Interpretation, Why Interpretation?, Technique of Interpretation, Precautions in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.		15

PRACTICALS

SEMESTER III		
Course code	Title	Credits
USBTP301 (PRACTICALS based on USBT301 and USBT302)	<ol style="list-style-type: none"> 1. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS 2. Isolation of <i>S.aureus</i> using selective and differential media 3. Identification of <i>S.aureus</i>- Catalase, Coagulase Test. 4. Isolation of <i>E.coli</i> using selective and differential media 5. Identification of <i>E.coli</i>- Sugar Fermentations, IMViC. 6. Isolation of <i>Salmonella</i> using selective and differential media 7. Identification of <i>Salmonella</i>- Sugar Fermentations, TSI Slant. 8. Isolation of <i>Shigella</i> using selective and differential media 9. Identification of <i>Shigella</i>-, Sugar Fermentations, TSI Slant. 10. Isolation of <i>Pseudomonas</i> using selective and differential media 11. Identification of <i>Pseudomonas</i> - Urease test, Oxidase Test, TSI Slant. 12. Lab Scale Production of Penicillin (Static and Shaker). 13. Purification of <i>Penicillin</i> from Broth Culture of <i>Penicillium spp.</i> by Solvent Extraction. 14. Estimation of <i>Penicillin</i> from Recovered Broth by Chemical (Iodometric) Method. 15. Estimation of <i>Penicillin</i> from Recovered Broth by Biological (Bioassay) Method. 16. RPR Test (Kit Based). 17. Permanent Slide- Mycobacterium. 	2
Course code	Title	Credits
USBTP302 (PRACTICALS based on USBT303 and USBT304)	<ol style="list-style-type: none"> 1. SOP writing for Spectrophotometer 2. Estimation of hemoglobin by Cyanmethemoglobin Method. (Drabkin's reagent based kit can be used)- DEMONSTRATION ONLY 3. Qualitative analysis of DNA using Agarose Gel Electrophoresis. 4. Determination of Purity of DNA using UV Spectrophotometry. 5. Electrophoresis of Proteins by Native PAGE. 	2

	<p>6. Electrophoresis of Proteins by SDS PAGE.</p> <p>7. Separation of components from a mixture using Size exclusion chromatography (Kit may be used for demonstration)</p> <p>8. Separation of components from a mixture using ion exchange chromatography (Kit may be used for demonstration)</p> <p>9. Separation of components from a mixture using Affinity chromatography (Kit may be used for demonstration)</p> <p>10. Study of the Structure and Function of an Electron Microscope (Visit / Video Demonstration).</p> <p>11. Demonstration of sample preparation and staining for analysis using Electron Microscope.</p> <p>12. Study of the Structure and Working of a Fluorescence Microscope</p> <p>13. Demonstration of sample preparation and staining of sample for analysis using Fluorescence Microscope.</p> <p>14. Quantitative test- Catalase activity</p> <p>15. Quantitative test- Peroxidase activity</p> <p>16. Quantitative analysis of amylase extracted from a plant or bacterial source.</p>	
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Course code	Title	Credits
<p>USBTP303 (PRACTICALS based on USBT305 and USBT306)</p>	<ol style="list-style-type: none"> 1. Complement Fixation Test (CFT). 2. Passive Agglutination- RA Factor Test. 3. Immunoelectrophoresis. 4. Immunodiffusion technique - Single Radial Immunodiffusion by Mancini Method 5. Immunodiffusion- double immunodiffusion by Ouchterlony Method 6. ELISA (Kit-based) - HEP-ELISA. 7. DOT-ELISA. 8. Western Blotting - Demonstration. 9. Flow Cytometry - Lab Visit. 10. Qualitative detection of <i>Salmonella spp</i>- Rapid Slide agglutination test 11. Quantitative detection of <i>Salmonella spp</i>- Tube Agglutination test 12. Coomb's test (Demonstration) 13. Study of <i>E.coli</i> Diauxic Growth Curve- (Lactose and Glucose). 14. Study of <i>lac</i> Gene Expression using Blue-White Selection. 15. Chloroplast isolation using density gradient centrifugation. 16. Expression of β-galactosidase and Measurement of Activity. 	<p>2</p>

SEMESTER IV		
Course code	Title	Credits
USBTP401 (PRACTICALS based on USBT401 and USBT402)	<ol style="list-style-type: none"> 1. Screening for an Antibiotic Producing Strain of Microorganism by Crowded plate Technique. 2. Screening for an Antibiotic Producing Strain of Microorganism by Wilkin Overlay plate Technique 3. MIC of any one antibiotic 4. MLC of any one antibiotic 5. Antibiotic sensitivity test using agar cup method 6. Antibiotic sensitivity test using paper disc method 7. Antibiotic sensitivity test using ditch method. 8. To study synergistic action of drugs 9. Study of Chromosomal Aberrations- Deletion, Duplication, Inversion, Translocation and Syndromes- Trisomy 21 Trisomy 13 Trisomy 18, Klinefelter, Turner and Cri-du-Chat. 10. Induction of Polyploidy by PDB Treatment using Suitable Plant Material. 11. Study of Polytene Chromosomes. 12. Mapping based on Tetrad Analysis and Three Point Cross. 13. Pedigree Analysis- Autosomal and Sex-Linked. 14. Material/Microscopic observation/display of photographs of human pathogens as per theory syllabus Paramyxovirus virus, Rhabdovirus, HIV. 15. Material/Microscopic observation/display of photographs of human pathogens as per theory syllabus- fungi-Candida albicans, Tinea, Trichomonas vaginalis. 	2
USBTP402 (PRACTICALS based on USBT403 and USBT404)	<ol style="list-style-type: none"> 1. Purification of any TWO Organic Compounds by Recrystallization Selecting Suitable Solvent. 2. Estimation of Acetone 3. Estimation of Amide 4. Estimation of Benzoic Acid. 5. Organic Preparations (Any ONE salt) : <ol style="list-style-type: none"> a) Acetylation of Primary Amine (Preparation of Acetanilide). b) Base Catalysed Aldol Condensation (Synthesis of Dibenzalpropanone). 6. Separation of Binary (Solid-Solid) Mixture (Min TWO). 7. Identification of Organic Compounds of Known Chemical Type (Min TWO). <ol style="list-style-type: none"> a. Preliminary examination b. Solubility profile c. Detection of elements C, H, (O), N, S and X. d. Detection of functional groups 	2

	<p>e. Determination of physical constants (M.P/B.P)</p> <p>f. Confirmatory tests to be performed.</p> <p>8. Determination of Lactate Dehydrogenase (LDH) Activity in Blood Serum.</p> <p>9. Determination of Total, LDL and HDL Cholesterol in Serum.</p> <p>10. Organ Function Tests: Liver (SGPT, SGOT); Kidney (Urea from serum).</p> <p>11. Estimation of Uric Acid and Creatinine in Urine.</p> <p>12. Qualitative Detection of Ketone Body in Urine.</p> <p>13. HPLC analysis and Interpretation of any one Secondary Metabolite from Plants</p> <p>14. HPTLC fingerprint analysis of any one Medicinally Important Plant.</p> <p>15. Chemical and Biological Synthesis of Silver Nanoparticles and its Characterisation by UV- VIS Spectrophotometer.</p>	
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Course code	Title	Credits
USBTP403 (PRACTICALS based on USBT405 and USBT406)	<p>1. Familiarization with NCBI, EMBL, DDBJ, PIR, KEGG databases.</p> <p>2. Use of NCBI BLAST Tool.</p> <p>3. Pairwise and Multiple Sequence Alignment.</p> <p>4. Classification of Proteins using CATH and SCOP.</p> <p>5. Visualization PDB Molecules using PyMOL and Swiss-PDB Viewer.</p> <p>6. Isolation and Detection of RNA from Bacteria OR Yeast.</p> <p>7. Restriction site analysis of lambda phage DNA.</p> <p>8. Primer Designing through Open Online Source NCBI- BLAST.</p> <p>9. DNA Amplification – PCR.</p> <p>10. Genetic Counseling and Molecular Diagnosis Genetic Testing</p> <p>11. Case Studies- for Cystic Fibrosis; Fragile X Diagnostic and Carrier.</p> <p>12. Problems based on correlation,</p> <p>13. Problems based on t test,</p> <p>14. Problems based on z-test</p> <p>15. Problems based on Chi Square Test</p> <p>16. Problems based on Regression</p>	2

Teaching pattern:

One (01) Credit would be of thirty to forty (30-40) learning hours; of this, more than fifty per cent of the time will be spent on classroom instructions including practical as prescribed by the University. Rest of the time spent invested for assignments, projects, journal writing, case studies, library work, industrial visits, attending seminars/workshops, preparations for examinations etc. would be considered as notional hours. The present syllabus considers (45 Lectures as classroom teaching and 15 lectures as Notional hours/ paper). Each lecture duration would be for 48 min. The names of the reference books provided in the syllabus are for guidance purposes only. Students and faculty are encouraged to explore additional reference books, online lectures, videos, science journals for latest/ additional information.

EVALUATION SCHEME

The performance of the learners shall be evaluated into TWO Parts.

1. Internal Assessment with 25 marks
2. Semester End Examinations with 75 marks.

Practical Training will have Practical Examination for 100 marks per practical paper at the end of Semester. The allocation of marks for the Internal Assessment and Semester End Examinations are as follows: -

For Core subjects:

- A. Internal Exam-25 Marks
 - i. Test/Assignment/Project/Presentation– 20 Marks
 - ii. Activities and Attendance - 5 Marks
- B. Semester End Examination - 75 Marks
- C. Practical Examination – Each practical paper **Sem -3 (USBTP301, USBTP302, USBTP303) and Sem- 4 (USBTP401, USBTP402, USBTP403)** of 100 marks = 3 core practical papers

For Ability Enhancement Course:

- A. Internal Exam-25 Marks
 - i. Assignment/Project/Presentation – 20 Marks
 - ii. Activities and Attendance - 5 Marks
- B. Semester End Examination- 75 Marks

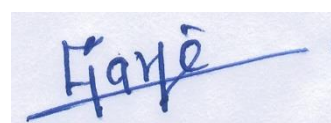
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13. Biosafety in Microbiological and Biomedical Laboratories-CDC
14. LABORATORY BIOSAFETY MANUAL FOURTH EDITION-WHO
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SEMESTER IV

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Prof. Shivram S. Garje,
Dean,
Faculty of Science and Technology