Savitribai Phule Pune University

Faculty of Science & Technology

Curriculum

For

Second Year (S.E.)

B.Tech. Biotechnology

(Choice Based Credit System)

(2019 Course)

(With Effect from Academic Year 2020-21)

Savitribai Phule Pune University, Pune
SE(Bio-Tech) 2019 Course
(With effect from Academic Year 2020-21)

Semester-III

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit			
		Theory	Practical	Tutorial	IN-Sem	End-Sem	TW	PR	OR	Total	TH	PR	TUT	Total
215461	Biochemistry I	3		-	30	70	-	-	-	100	3		-	3
207004	Engineering Mathematics III	3	-	01	30	70	25	-	-	125	3	-	1	4
215462	Fluid Flow & Unit Operations	3	-	-	30	70	-	-	-	100	3	-	-	3
215463	Heat transfer	3	-	-	30	70	-	-	-	100	3	-	-	3
215464	Microbiology	3	-	-	30	70	-	-	-	100	3	-	-	3
215465	Biochemistry I Lab	-	4	-	-	-	50	-		50	-	2	-	2
215466	Fluid Flow & Unit Operations Lab	-	2	-	-	-	25	-	-	25	-	1	-	1
215467	Heat transfer Lab	-	2	-	-	-	-	-	50	50	-	1	-	1
215468	Microbiology Lab	-	4	-	-	-	-	50	-	50	-	2	-	2
215469	Mandatory Audit Course 3	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	15	12	01	150	350	100	50	50	700	15	06	1	22

Abbreviations:

TH : Theory TW : Term Work PR : Practical
OR : Oral TUT : Tutorial

Note: Interested students of S.E. (Biotechnology) can opt any one of the audit course from the list of audit courses prescribed by BoS (Biotechnology Engineering)

Savitribai Phule Pune University, Pune
SE(Bio-Tech) 2019 Course
(With effect from Academic Year 2020-21)

Semester-IV

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit			
		Theory	Practical	Tutorial	IN-Sem	End-Sem	TW	PR	OR	Total	TH	PR	TUT	Total
215470	Biochemistry II	3	-	1	30	70	-		-	100	3	-	1	4
215471	Cell Biology & Tissue Culture	3	-	1	30	70	-	-	-	100	3	-	1	4
215472	Thermodynamics	3	-	1	30	70	25	-	-	125	3	-	1	4
215473	Genetics &Molecular Biology	3	-	1	30	70	-	-	-	100	3		1	4
215474	Biochemistry II Lab	-	2	-	-	-	25	50	-	75		1	-	1
215475	Cell Biology & Tissue Culture Lab	-	2	-	-	-	25	-	50	75		1	-	1
215476	Genetics &Molecular Biology Lab	-	4	-	-	-	25	-	50	75		2	-	2
215477	Project Based Leaning	-	4	-	-	-	50	-		50	-	2	-	2
215478	Mandatory Audit Course 4	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	12	12	04	120	280	150	50	100	700	12	06	04	22

Abbreviations:

TH : Theory TW : Term Work PR : Practical
OR : Oral TUT : Tutorial

Note: Interested students of S.E. (Biotechnology) can opt any one of the audit course from the list of audit courses prescribed by BoS (Biotechnology Engineering)

Semester I

Savitribai Phule Pune University, Pune

Second Year of B.Tech. Biotechnology (2019 Course)

215461:Biochemestry I

Credit	
TH: 03	
Teaching Scheme: **TH: 03hrs/week**	**ExaminationScheme:** **TH In Sem: 30** **TH End sem :70** **Total :100**

Prerequisites: - Basic knowledge of Biology and chemistry

Course Objectives:

1. To make students acquainted with the functioning of the bufferingsystem
2. To understand the working of basicbiomolecules
3. To recognize the clinical manifestations of vitamins and mineraldeficiency

Course Outcomes:

On completion of the course, the learner will be able to–

A. Understand the functioning of various buffering system existed in the humanbody

B. Recognize the structure and function of variousbiomolecules

C. Correlate various diseases associated with vitamin and mineraldeficiency

Course Contents

UnitI **(07Hrs)**

Water and buffer: Weak interactions in aqueous systems, Ionization of water, weak acid weak bases, Ion product of water, acids and bases, buffers, buffering against pH changes in biological systems, the fitness of the aqueous environment for living organisms, Problems using theHenderson-Hasselbalchequation, Blood, Lungs, and buffer: The bicarbonate buffer system, Water as a reactant

UnitII **(08Hrs)**

Carbohydrate:Monosaccharidesanddisaccharides,Polysaccharides,Homopolysaccharidesinthe role of fuel and structural, Heteropolysaccharides, Glycoconjugates- Proteoglycans, Glycoproteins, and glycolipids, Carbohydrate as informational molecules- Lectin

UnitIII **(07Hrs)**

Proteins:CommonStructuralfeaturesofaminoacids,classificationofaminoacids(onthebasisofR groups, functions of uncommon amino acids, acid base properties of amino acids and titration curve.Peptidesandproteins,Separation,Purificationandcharacterizationofproteinsby electrophoresis. Covalent structure of proteins, The Lambert-Beer law, Ramachandran plot.

UnitIV **(08Hrs)**

Nucleotides and Nucleic acids: Characteristic bases and pentoses, phosphodiester bond, propertiesof nucleotidebasesandthree-dimensionalstructureofnucleicacids,Nucleicacidstructure,Nucleicacid chemistry, Determination of sequences of DNA, Functions of nucleotides.

UnitV **(08Hrs)**

Lipids:Storagelipids,Fattyacidsashydrocarbonderivatives,Triacylglycerol,Waxesasenergystores and water repellents, Structural lipids in membranes, Glycerophospholipids, Galactolipids, Sulfolipids, Sphingolipids, Composition and architecture of membranes. Inherited human diseases resultingfromabnormalaccumulationsofmembranelipids,Lipidsassignals,cofactorsandpigments,

Lipid extraction, Adsorption chromatography and Gas-liquid chromatography in the separation of lipid,

Composition and architecture of membranes.

UnitVI **(07Hrs)**

Vitamins and Minerals: classification and functions of vitamins, (vit B1, B2 ,B6 , B12, vit C), fat soluble vitamins (vit A, D, E, K), Vitamins deficiencies (night blind ness, keratomalacia, rickets, osteomalacia prolonged clotting time etc.) clinical manifestations of mineral deficiency (termatitis, dementia, diarrhea, pernicious anemia, survey etc)

Books

Text:

1. DJVoet,JGVoet,CWPratt,"PrinciplesofBiochemistry",3rd ed.,JohnWiley&Sons,Inc.2008

2. D T. Plummer, "An Introduction to practical biochemistry", Tata McGraw Publishing Company Ltd,1988

Reference:

1. J H Weil, "General Biochemistry", New Ages International (P) Ltd.1997.

2. JMBerg,JLTymoczko,LStryer,"Biochemistry",6th ed.,FreemanWH&Company,NewYork, 2007

3. DLNelson,MMCox"PrinciplesofBiochemistry",4th ed.,W.H.Freemanandcompany,New York, 2007

Savitribai Phule Pune University, Pune

Second Year of B.Tech. Biotechnology (2019 Course)

207004:Engineering Mathematics III

Credit	
TH: 03	**TUT:01**
Teaching Scheme: **TH: 03 hrs/week** **TUT:01hr/week**	**ExaminationScheme:** **TH** **InSem:30TH** **End Sem :70** **TW :25** **Total :125**

Prerequisites: -

Differential & Integral calculus, Linear Differential equations of first order andfirst degree, Collection, classification & representation of data, Permutations & combinationsFourier series and Vector algebra.

Course Objectives: To make the students familiarize with concepts and techniques in Ordinary and Partialdifferential equations, Fourier transform, Laplace transform and Vector calculus. The aim is toequip them with the techniques to understand advanced level mathematics and its applicationsthat would enhance analytical thinking power, useful in their disciplines.

Course Outcomes:

At the end of this course, students will be able to

A. Solve higher order linear differential equations and its applications to engineering problems in their disciplines.

B. Apply Integral transform techniques such as Fourier transform & Laplace transform to solve differential equations involved in Vibration theory, Heat transfer, Liquid level systems and related engineering applications.

C. Apply Statistical methods like correlation & regression and probability theory as applicable to analyzing and interpreting experimental data in testing and quality control.

D. Perform vector differentiation & integration, analyze the vector fields and apply to fluid flow problems.

E. Solve Partial differential equations such as wave equation, one and two dimensional heat flow equations.

Course Contents

Unit I: Linear Differential Equations (LDE) and Applications (08 Hours)

LDE of n th order with constant coefficients, Complementary Function, Particular Integral, Method of Variation of parameters, Cauchy's and Legendre's DE, Simultaneous and Symmetricsimultaneous DE. Applications of LDE to engineering problems and Mass spring system.

Unit II: Laplace Transform (LT) and Applications (08 Hours)

Definition of LT, Inverse LT, Properties & theorems, LT of standard functions, LT of some special functions viz. Periodic, Unit Step, Unit Impulse, Error, Si(t) and Ei(t), first order Bessel's.

Applications of LT for solving ordinary differential equations, liquid level systems consisting of single tank and two tanks in series (interacting and non-interacting systems), Second order systems (Damped vibrator).

Unit III: Fourier Transform (FT) (07 Hours)

Fourier integral theorem. Fourier Sine & Cosine integrals. Fourier transform, Fourier Cosine transform, Fourier Sine transforms and their inverses. Finite FT, Application of FT to problems on one and two dimensional heat flow problems.

Unit IV: Statistics and Probability (07 Hours)

Measures of central tendency, Measures of dispersion, Coefficient of variation, Moments, Skewness and Kurtosis, Correlation and Regression, Reliability of Regression estimates. Probability, Probability density function, Probability distributions: Binomial, Poisson, Normal, Test of hypothesis: Chi-square test.

Unit V: Vector Calculus (08 Hours)

Vector differentiation, Gradient, Divergence and Curl, Directional derivative, Solenoidal and Irrotational fields, Vector identities. Line, Surface and Volume integrals, Green's Lemma, Gauss's Divergence theorem and Stoke's theorem.

Unit VI: Applications of Partial Differential Equations (PDE) (08Hours)

Basic concepts, modeling of Vibrating string, Wave equation, one and two dimensional Heat flow equations, method of Separation of variables, use of Fourier series, Applications of PDE to problems of Chemical and allied engineering.

Text Books:

1. Higher Engineering Mathematics by B.V. Ramana (Tata McGraw-Hill).
2. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication, Delhi).

Reference Books:

1. Advanced Engineering Mathematics, 10e, by Erwin Kreyszig (Wiley India).
2. Advanced Engineering Mathematics, 2e, by M. D. Greenberg (Pearson Education).
3. Advanced Engineering Mathematics, 7e, by Peter V. O'Neil (Cengage Learning).
4. Differential Equations, 3e by S. L. Ross (Wiley India).
5. Introduction to Probability and Statistics for Engineers and Scientists, 5e, by Sheldon M. Ross (Elsevier Academic Press)

6.Partial Differential Equations for Scientists and Engineers by S. J. Farlow (Dover Publications, 1993)

Guidelines for Tutorial and Term Work:

i) Tutorial shall be engaged in four batches (batch size of 20 students maximum) per division.

ii) Term work shall be based on continuous assessment of six assignments (one per each unit) and performance in internal tests.

Savitribai Phule Pune University, Pune

Second Year of B.Tech. Biotechnology (2019 Course)

215462: Fluid Flow and Unit Operations

Credit	
TH: 03	
Teaching Scheme: **TH: 03hrs/week**	**ExaminationScheme:** **TH** **InSem:30TH** **End Sem :70** **Total :100**

Prerequisites: -

Basic Knowledge of Physics and Mathematics.

Problem Solving ability, Information manipulation and Processing skills.

Course Objectives:

1. To provide familiarity with the nature and properties of fluids and to understand the basic equations of fluid flow along with their respectiveapplications
2. To provide concept of pressure drop and energy losses during fluidflow
3. To familiarize students with unit operations based on solid liquid systems and the related equipment's
4. To introduce students to particle technology – basic concepts, laws and unitoperations involved in pretreatment for different bioprocesses

Course Outcomes:

On completion of the course, learner will be able to–

A. Characterize fluids encountered in Biotechnology industries and predict their flowbehavior.
B. Select and operate equipment based on the properties of the material beinghandled.
C. Select, design and operate systems based onfluidization.
D. Select and operate equipment based on the properties of the material beinghandled.

UnitI **(07Hrs)**

System of units and conversions; Basics of Unit Operations & Fluid – Definition and important properties,viscosity,temperatureandpressuredependence,Newton'slaw,Classificationoffluids;

Fluid statics: hydrostatic forces on surface, Manometer & Inclined Manometer; Types of flow,

Laminar and turbulent flow – Concept of Reynold's number; Formation and separation of boundary layer.

UnitII **(08Hrs)**

Laws of incompressible potential flow: Mass balances - Continuity equation and its applications to fluid dynamics, Energy balances in fluid dynamics: Euler's equation, Bernoulli's equation and its applications, Flow measurement using venturimeter, orificemeter and pitot tube; Hagen Poiseuelle equation, turbulent flow in pipes, effect of roughness, friction in flowing fluid, Moody,sdiagram; Minor losses in pipe flow, effect of fittings and valves.

UnitIII **(07Hrs)**

Introduction to the dynamics of suspended particles: Lift and drag forces, drag coefficients; Flow of solids through fluids: Gravity settling of particles, Terminal velocity, Stoke's law and Newton'slaw, Freeandhinderedsettling,Sinkandfloatmethod,Differentialsettlingmethod;Sedimentation:Batch andcontinuous,equipmentsforsedimentation,Centrifugalsettling:Advantagesandequipments– cyclones and hydrocyclones.

UnitIV **(08Hrs)**

Flow of fluid through solids: Characteristics of flow through packed beds - Darcy's equation, Equations for laminar flow (Kozeny Carmen) and turbulent flow (Burke Plummer), Ergun equation; Introductionoffluidization,minimumfluidizationvelocity,characteristicsoffluidizedsystems,types of fluidization and their applications, Introduction to computational fluid dynamics (CFD)

UnitV **(07Hrs)**

Fluid moving machinery-pumps, Types of pumps: positive displacement pump and centrifugal pumps, Characteristics of Centrifugal Pumps, NPSH; Valves and their types; Mixing and Agitation - Necessityofmixingandagitation,TypesofImpellers–Radialandaxialflow,Differentflowpatterns in mixing, Agitator selection, Calculation of power requirement, Mixing equipment; Mixing equipment for pastes and viscous material

UnitVI **(08Hrs)**

Particle Technology: Properties of solids - Particle size and shape, Mixtures of particles, Determination of particle size; Screening - Standard screen series, screen analysis, Screen effectiveness and capacity, Industrial screening equipment; Size reduction: Crushing efficiency, energyrequirementscalculationsbyusingdifferentcrushinglaws,Sizereductionequipment:Primary crushers,secondarycrushers,Intermediateandfinegrinders,OpencircuitandClosedcircuitgrinding.

Books

Text:

1. R K Bansal, “A Textbook of Fluid Mechanics and Hydraulic Machines”, 9th ed., Laxmi Publications, New Delhi,2004

2. McCabe, Smith, Harriot, “Unit Operations in Chemical Engineering”, 7th ed., Tata McGraw Hill Publications

Reference:

1. R K Rajput, “A Textbook of Fluid Mechanics”, S. Chand Ltd.,2008

2. George Granger Brown, “Unit Operation”; Asia Publishing House’, FirstEdition

3. Bird R.B., Stewart W.E., Lightfoot E.N. “Transport phenomena” 2ed., Wiley Publications,2002.

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Second Year of B. Tech. Biotechnology (2019 Course)

215463: Heat Transfer

Credit	
TH: 03	
Teaching Scheme: **TH: 03hrs/week**	**ExaminationScheme:** **THInSem:** **30TH Endsem** **:70** **Total:100**

Prerequisites: -

Basic Knowledge of Physics, Mathematics and fluid mechanics.

Problem Solving ability with concept understanding and applications

Course Objectives:

1. To make students aware of basic principles and mechanism of heat transferprocess.
2. To develop understanding of heat transfer systems and heat balanceequations.
3. To study various heat transfer equipments and theirapplication.
4. To provide information about the scope and applications of heat transfer in the fieldof biotechnology

Course Outcomes:

On completion of the course, learner will be able to–

A. Understand and apply knowledge of heat transferprinciples
B. Understand and write heat balances of thesystem.
C. Choose suitable heat transfer equipment for the requiredprocess.
D. Design heat transferequipment.

Course Contents

UnitI **(07Hrs)**

Introduction:Modesofheattransfer,conduction,convection,andradiation,Applicationsofheat transfer in biotechnology;Conduction: Fourier's law of heat conduction, thermal conductivity of liquids, gases and solids, Concept of thermal resistance, thermal conductance and contact resistance,Introductiontosteadyandunsteadystateconduction,Steadystateconductionin infinitely long slab, hollow cylinder and hollow spheres.

UnitII **(08Hrs)**

Conduction: Heat transfer through Composite Materials, Thermal resistance in composite slab andcylinder,Heatlossesthroughpipe,thermalinsulationandoptimumthicknessofinsulation, properties of insulator, Heat transfer from extended surfaces with uniform crosssection, classification of extended surfaces, efficiency of longitudinal fin.

UnitIII **(07Hrs)**

Convection: Types, Newton's law of cooling, Individual and overall heat transfer coefficient, Natural and forced convection in laminar and turbulent flow, Heat transfer with phasechanges: Condensation and Boiling liquids Modes and features, Dimensional Analysis, units of various quantities used in heat transfer, Importance of dimensional analysis in experimental design and datareduction,laminarandforcedconvectiongoverningequationsbyAlgebraicRayleigh's method

UnitIV **(08Hrs)**

Convection: Analogy between heat, mass and momentum transfer. Principal and heat balance equation in laminar flow and empirical equations for turbulent flow through tube, through annulus, over the plate, Concept of thermal boundary layer and its significance

Radiation:Fundamentalfactsanddefinitionofterms:Emissivity,absorptivity,blackbody,gray body,opaquebody,StefanBoltzmanlaw,Kirchoffslaw,Plankslaw,Wien'slaw,Theshape factor

UnitV **(07Hrs)**

Heat exchange equipment: Types of heat exchangers including compact heat exchangers, parallelflowarrangement,foulingfactor,LMTDinparallelandcounterflow,Effectiveness NTU method, shell and tube heat exchanger.

UnitVI **(08Hrs)**

Evaporation: Types of evaporators, performance, capacity and economy, Boiling point elevation, heat transfer coefficients, Material balance calculations, Multiple effect evaporators: Feed Forward and Feed Backward evaporator, Methods of feeding, capacity and economy, effect of liquid head and boiling point elevation

Books

Text:

1. S. P. Sukhatme, "A Textbook on Heat Transfer", 4th ed, Universities Press (India),2005
2. K. A. Gavhane, "Heat Transfer" , 10 th edition, NiraliPrakashan,2010
3. R.C. Sachdeva "Fundamentals of Engineering *Heat* and Mass *Transfer"* 5th edition, New age international Publisher,2010

Reference:

1. Frank Kreith, Mark Bohn, "Principles of Heat Transfer" 5th edition, PWS Publishing company,Boston(1997)
2. D.Q.Kern,"ProcessHeatTransfer",11thed.,TataMcGrawHillPublication,NewDelhi
3. **Böckh**, Peter, **Wetzel**, Thomas, Heat Transfer, Basics and Practice, Springer,2012
4. Sinnout R.K. "Coulson Richardson's chemical engineering vol.6" Pergamon Press,1993

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Second Year of B.Tech. Biotechnology (2019 Course)

215464: Microbiology

Credits	
TH: 03	
Teaching Scheme:	**Examination Scheme:**
TH: 03 hrs/week	**TH Insem:30** **TH Endsem:70** **Total:100**

Prerequisites: Basic knowledge of Biology and Chemistry

Course Objectives:

1. To introduce the concept, development and significance of microbiology in day to day life.
2. Totrainthestudentstoaseptichandlingtechniquesalongwith,culturing,utilizationand elimination of microorganisms from differentenvironments.
3. To make the students aware of the ubiquitous nature, diversity and growth of different microorganisms and their significance inbiotechnology
4. To introduce the concept of diseases and role of microorganism in differentdiseases

Course Outcomes:

On completion of the course, learner will be able to–

A. Graduates are made aware of significance ofmicrobiology
B. Graduates would be trained to identify, handle, cultivate and eliminate microorganisms from different environments
C. Graduates are trained to understand growth requirements of differentmicroorganisms
D. Graduates are able to understand significance of clean and asepticteчniques.
E. Graduates are made aware of different microbiology related processes in the fields of agriculture, medicine andfood.

F. Graduates can identify general principles of microbiology, underlying cause,treatment and prevention of diseases.

CourseContents **(07 Hrs)**

Unit I: Introduction to Microbiology:

The History and scope of microbiology, Types of Microorganisms: Bacteria, fungi, algae, protozoa, Actinomycetes, viruses. Ultrastructure of Prokaryotic and Eukaryotic cell with functions. Microscopy and Staining methods, Bacterial classification

Unit II: Cultivation and Isolationofmicroorganisms: **(08 Hrs)**

Basic Nutritional and environmental Requirements- macro and micronutrient requirements, growth factors, Nutritional types of microorganisms: Photoautotrophs, Photo heterotrophs, Chemoautotrophs, Chemoheterotrophs, Environmental Effects on Bacterial Growth: Temperature, Oxygen, pH, Osmotic pressure classes,Extremophiles.

Design, types, composition and use of Media: Solid, liquid, semi-solid media, general purpose, selective media, differential media, enrichment media, enriched media. Microbial cultivation-Concept of pure culture, co-culture, mixed culture and colony characteristics. Isolation of microorganism & Pure culture techniques: Streak, Spread and Pour plate method. Culture Techniques for Anaerobes, Preservation and maintenance methods.

Unit III: Microbial Growth andEnumeration Techniques **(07 Hrs)**

Reproduction in microorganisms: Binary fission, asexual methods, Growth curve, Logarithmic representation of bacterial population, calculation of generation time and specific growth rate, Enumerationofbacteria-Directcount,StandardPlateCount,Microscopiccount,Turbidometry, Flow cytometer, Biomass determination, other microscopic and nucleic acid basedmethods. Batch, Continuous and Synchronous cultures.

Unit IV: Controlof Microorganisms: **(08 Hrs)**

Concept and definition-Sterilization and disinfection. Control of Microorganisms by Physical and Chemical Agents: Concept, Heat (Dry, Moist),Pasteurization, Radiation, filtration, Chemical agents-Alcohols, Quaternary ammonium compounds, phenoliccompounds, Disinfectants, Antimicrobial agents, Antibiotics, Concept of MIC and MBC, Drug resistance.

Unit V: Microbial interactionsinenvironment **(07Hrs)**

Microbial interactions in environment, commensalisms, antagonism, symbiosis.Microbiology of air, soil, food, milk, water and waste water, Potability of water.

Unit VI: Medicalmicrobiology **(08Hrs)**

The Epidemiology of Infectious Diseases, Human diseases caused by bacteria –Typhoid, Cholera, Tuberculosis. Viral diseases- Rabies, HIV, Influenza, fungal diseases – Candidiasis

Books:

Text:

1. Prescott Harley Klein, Microbiology, Fifth Edition, "Microbiology", 5th Edition, The McGraw Hill Companies,2002

2. Michael Pelczar, "Microbiology", 5th Edition, Tata McGraw-Hill Education,1993

3. Michael T., Madigan, John M. Martinko, Jack Parker, "Brock biology of microorganisms", Prentice Hall,2000.

Reference:

1. A. J. Salle, "Fundamental Principles of Bacteriology", 7th edition, Tata McGraw- Hill education.

2. Roger Y. Stainier et al. "General Microbiology" , 5th edition., PHIPublication.

3. Tortora, "Microbiology: An Introduction", 9th edition, Pearson Education India,2008.

4. Schlegel H.G. – "General Microbiology" , 8th edition, Cambridge University Press,1995.

5. Robert Cruikshank, "Medical Microbiology", Churchill Livingstone,1975.

6. Thomas Jones Mackie, et al, "Mackie & McCartney medical microbiology: a guide to the laboratory diagnosis and control of infection", Churchill Livingstone,1989

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Second Year of B.Tech. Biotechnology (2019 Course)

215465 : Biochemistry I Lab

Credit	
	PR : 02
Teaching Scheme: **PR: 04hrs/week**	**ExaminationScheme:** **TW :50** **Total :50**

Prerequisites: - Basic knowledge of Biology and chemistry

Course Objectives:

1. To develop basic lab skills
2. To learn methods for the isolation of biomolecules

Course Outcomes:

On completion of this course, students will be able to

A. Prepare laboratory reagents, learn to extract biomolecules, and interpretation of results.

B. Justify the use of buffers in studying biological systems

C. Identify biomolecules by suitable tests

Suggested List of Laboratory Assignments (Any 8)

Sr. No.	**Group A**
1.	Preparation of molar and normal solutions
2.	Calibration of pH meter
3.	Calibration of pipette
4.	Preparation of Buffer solution
Group B	
1.	Extraction of protein
2.	Qualitative analysis of protein
3.	Extraction of polysaccharide

4.	Iodine test for polysaccharide
Group C	
1.	The determination of pKa
2.	To check the resistance of buffer for pH change
3.	To check the reproducibility of the experiment
4.	Quantitative estimation ofprotein
5.	Qualitative Testing of Lipid

Guidelines for Instructor's Manual

1. Students should be briefed with Risk Assessment and Biosafety Levels
2. All the instruments to be validated before use
3. All the experiments should be standardized
4. The instructor is responsible for seeing that the consequences of student are rectified, including the correction of damages and violations and take-down of experiments.

Guidelines for Student's Lab Journal

1. Use a bound notebook.
2. Lab notebooks should be done in pen and no erasing or white-out is allowed
3. Number the pages
4. Title and underline each lab exercise at the top of the page and date it. Each lab writeup should be done separately even if more than one exercise is performed in a lab period. Leave enough room in the lab notebook to complete the entire lab including results and discussions.
5. Briefly explain the lab exercise objectives in a few sentences.
6. Record observations, diagrams, and results from the exercise.
7. Conclude the report with a brief discussion in the essay form.
8. Write neatly, be organized, and follow a standard format.

Note: The purpose of the lab notebook is to encourage students to compile and organize their laboratory notes and to understand the purpose of the laboratory exercises and the meaning of their results.

Guidelines for Lab /TW Assessment
Lab Assessment will be based on the following points

1. Present/Absent
2. A completion date of the journal
3. Regularity
4. Understanding
5. Presentation

Guidelines for Laboratory Conduction
The following rules must be observed during laboratory conduction

1. Lab coat should be worn by students before entering the laboratory
2. Students shall keep their belongings on storage rack
3. Loose hair and flowing parts of apparel shall be properly tied before commencing of work
4. Enter the usage of chemicals and equipment's in a logbook
5. The instruction manual should be read before operating any instrument
6. Students should make aware of hazard warning symbols on reagent bottle
7. Protective devices must be worn when it is necessary to protect the eyes and face from splashes
8. All chemicals, glassware, reagents and plastic wares should be kept on their appropriate place after use
9. Reagents to be stored should be labeled with due discarding date
10. Instructions for proper disposal of waste material should be followed
10. Report accidental cuts or burns to the instructor immediately.
11. Perform the experiment. Collect data in a clear and organized fashion. Be sure to note the units for each measurement. Also, be sure to participate in the experiment rather than just recording data for your group

General Guidelines:
Before starting any experiment, clearly define the goals. What question are you answering or what principle are you trying to demonstrate? What data is needed to solve the problem?
Identify the methods of measurement and instrumentation to be used.

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Second Year of B.Tech. Biotechnology (2019 course)

215466 :Fluid Flow and Unit Operations Lab

Credit	
	PR : 01
Teaching Scheme **PR: 02hrs/week**	**Examination Scheme:** **TW : 25** **Total : 25**

Prerequisites: - Basic Knowledge of Physics and Mathematics.

Problem Solving ability, Information manipulation and Processing skills.

Course Objectives:

1. To learn the fluid properties and fundamentals of fluid flow.
2. To introduce the flow measuring devices.
3. To impart knowledge in measuring pressure, discharge and velocity of fluid flow.
4. To provide practical knowledge in verification of principles of fluid flow.

Course Outcomes:

On successful completion of the course students will be able to

A.Understand basic physics of fluid.

B. Calculate and design engineering applications involving fluid.

C.Analyse flow in terms of mass, momentum and energy balance.

D. Predict the coefficient of discharge for flow through Venturimeter and Orifice.

Guidelines for Instructor's Manual

The Fluid Flow Laboratory is a substantial part of the course “Fluid Flow and Unit Operations” and is constructed to complement the lecture portion of the course. The labs are designed to provide the student with a physical understanding of the fundamental principles and basic equations of fluid mechanics. This understanding is gained through the application of “text book” concepts and equations to real problems.

The student is to read the lab manual chapter assigned to each laboratory period BEFORE coming tothe lab. Some labs contain thought questions or require that you perform some derivations before proceeding.

Guidelines for Lab /TW Assessment

Attendance is required for all of the lab sessions. Each session, except one demonstration activity, requiresthecompletionofaformallabreport.Thesereportsarethebasisofyourfinallabgrade.Eachassignment represents a substantial fraction of your total score.

Guidelines for Laboratory Conduction

Safety Guidelines:

Beverycarefulandawareofthevariousexperimentcontrols(startbutton,stopbutton,speedcontrol) for each labsession.

Ask lab instructor, if you are not sure about what to do. Make sure all spilled liquids are wiped upimmediately. Do not leave experimentsunattended.

Any injuries should be reported immediately for proper care.

General Guidelines:

Before starting any experiment, clearly define the goals. What question are you answering or what principle are you trying to demonstrate? What data is needed to solve the problem?

Identify the methods of measurement and instrumentation to be used. At the research stations, "play around" with the equipment so that you understand how the instruments work, what you are measuring, and how what you are measuring connects with the physics of the problems at hand.

Perform the experiment. Collect data in a clear and organized fashion. Be sure to note the units for each measurement. Also, be sure to participate in the experiment rather than just recording data for your group.

Suggested List of Laboratory Assignments (Any 8)

Sr. No.	
1.	Determination of viscosity
2.	Flow through venturimeter
3.	Flow through orifice meter.
Group B	
1.	Friction during flow through pipe
2.	Verification of Bernoulli's theorem

3.	Verification of Stoke's law
Group C	
1.	Verification of Darcy's law
2.	Flow through pipe fittings
3.	Flow through packed bed

Savitribai Phule Pune University, Pune

Second Year of B.Tech. Biotechnology (2019 Course)

215467:Heat Transfer Lab

Credit	
	PR : 01
Teaching Scheme: **PR: 02hrs/week**	**Examination Scheme:** **OR :50** **Total :50**

Prerequisites: - Basics of mathematics and physics, Fundamental principles of heat transfer and theory content related to experiment

Course Objectives:

1. To make students aware of application of basic principles and mechanism of heat transfer process
2. To develop understanding of various heat transfer systems and heat balance equations.
3. To study various heat transfer equipments, designs and their application.
4. To study the industrial scope and applications of heat transfer in the field of biotechnology

Course Outcomes:

On completion of the course lab, learner will be able to–

A. Understand and apply knowledge of basic heat transfer principles
B. Understand and write heat balances around the system.
C. Understand design aspects and choose suitable heat transfer equipment for the required process/application
D. Calculate the rate and area of heat transfer, individual and overall co-efficient of heat transfer, efficiency etc.

Suggested List of Laboratory Assignments (Any 8)

Sr. No.	**Group A – Conduction, Convection and Radiation**
1	Heat transfer from fin in a natural convection
2	Heat transfer in forced convection
3	Composite wall apparatus
4	Emissivity Measurement

Group B - Heat Exchanger Equipments	
6	Co- current and countercurrent heat exchanger
7	Plate type heat exchanger
8	Shell and tube heat Exchanger
Group C –Study Experiments	
9	Double effect evaporator
10	Agitated Vessel

Guidelines for Instructor's Manual

1. Students should be briefed with risk assessment and safety levels.
2. All the instruments to be validated before use.
3. All the experiments should be standardized.
4. The instructor is responsible for seeing that the consequences of student are rectified, including correction of damages, violations and take down of experiments.

Guidelines for Student's Lab Journal

1. Use a bound notebook.
2. Lab notebooks should be done in pen and no erasing or white-out is allowed
3. Number the pages
4. Title and underline each lab exercise at the top of the page and date it. Each lab write-up should be done separately even if more than one exercise is performed in a lab period. Leave enough room in the lab notebook to complete the entire lab including observations, calculations, results and discussions.
5. Briefly explain the lab exercise objectives in a few sentences.
6. Record observations, diagrams and results from the exercise.
7. Conclude the report with a brief discussion in essay form.
8. Write neatly, be organized and follow a standard format.

Note: The purpose of the lab notebook is to encourage students to compile and organize their laboratory notes and to understand the purpose of the laboratory exercises and the meaning of theirresults.

Guidelines for Lab /TW Assessment

Term work marks distribution should be carried out based on following points:

1. Regularity and sincerity of students during lab practicals
2. Journal presentation
3. Understanding of the experiment
4. Performance in unit tests
5. Attendance during theory lectures

Guidelines for Laboratory Conduction

1. Please do not touch open wires.
2. Make the connection as per the circuit diagram.
3. Check permissible range heat input written on the setup before setting parameters current and voltage.
4. Ensure that the connections are properly tightened then Start the power supply.
5. After the experiment is over reduce the dimmerstat to zero.
6. Switch off the power supply and remove the connections.
7. Turn off all valves and water supply completely.

Savitribai Phule Pune University, Pune
Second Year of B.Tech. Biotechnology (2019 Course)
215468:Microbiology Lab

Credit

PR : 02

Teaching Scheme:	**Examination Scheme:**
PR: 04hrs/week	**PR :50**
	Total :50

Course Objectives:

1. To train the students to aseptic handling techniques and elimination of microorganisms from different environments.
2. To train the students different methods of isolation and culturing of microorganisms from different sources.
3. To make the students aware of the ubiquitous nature, diversity and growth of different microorganisms
4. To aware students for the significance of microorganism in Biotechnology

Course Outcomes:

On completion of the course, learner will be able to–

A. Graduates are able to understand significance of clean and aseptic techniques.
B. Graduates would be trained to identify, handle, cultivate and eliminate microorganisms from different environments
C. Graduates are trained to understand growth requirements of different microorganisms
D. Graduates are made aware of different microbiology related processes in the fields of agriculture, medicine and food.

Suggested List of Laboratory Assignments
Group A Study of laboratory equipment's.

1. Introduction and working of basic laboratory instruments.

Aseptic Handling Techniques-Laminar Flow System, Autoclaving,

Group B Culture media preparation and aseptic techniques

Cotton Plug preparation. Plate and pipettes wrapping & autoclaving

2. Nutrient Media preparation and sterilization for Bacteria and Fungi-- Broth, Plate and Slant Culture transfer and preservation techniques- subuturing, Glycerol stocks.

Group C Bacterial Morphology and Staining

3. Smear Preparation and Simple Staining
4. Differential Gram's staining.

Group D Isolation ofmicroorganisms:

5. Serial dilution
6. Spread plate method
7. Pour plate method
8. Streak plate method
9. Colony characteristics- Size, Shape, color, margin, Consistency. Opacity, Gram's Character

Group E Microbial Growth Characteristics

10. Determination of generation time of *E.coli*
11. Effect of temperature/pH/atmospheric oxygen on growth of *E.coli*

Group F Study of Molds and yeast (any one)

12. Standard plate count/Total Viable Count from food/milk
13. Morphology of fungi on direct microscopic count/media.
14. Antibiotic sensitivity test

Guidelines for Instructor's Manual

1. Discuss the syllabus for the course
2. Go through the general procedures for lab safety
3. Review the guidelines for laboratory reports
4. Practice some of the scientific calculations that will be used throughout the semester
5. Practice some basic laboratory methods such as the use of balances, pipets, and Micropipettes
6. Students should be briefed with Risk Assessment and Biosafety Levels
7. All the instruments to be validated before use
8. All the experiments should be standardized

The instructor is responsible for seeing that the consequences of student are rectified, including correction of damages and violations and take-down of experiments

Guidelines for Student's Lab Journal

Please read these instructions now and refer to them regularly!
These instructions must be followed carefully.

1. Use a bound notebook for notes and lab observations.
2. Lab notebooks should be done in pen and no erasing or white-out is allowed
3. For the Journal use Journal Pages and ensure you draw neat diagrams wherever necessary
4. Number the pages
5. Title and underline each lab exercise at the top of the page and date it.
6. Each lab write-up should be done separately even if more than one exercise is performed in a lab period.
7. Briefly explain the lab exercise objectives in a few sentences.
8. Record observations, diagrams and results from the exercise.
9. Conclude the report with a brief discussion in essay form.
10. Write neatly, be organized and follow a standard format.

Note: The purpose of the lab notebook is to encourage students to compile and organize their laboratory notes and to understand the purpose of the laboratory exercises and the meaning of their results.

Guidelines for Lab /TW Assessment

Lab assessment will be based on following points

1. Present / Absent
2. Completion date of journal
3. Regularity
4. Understanding
5. Presentation

Guidelines for Laboratory Conduction

Basic Principles for Students Working in Cell Biology Laboratories :
The following rules must be observed at all times to prevent accidental injury to and infection of yourself and others and to minimize contamination of the lab environment:

1. Never place books, backpacks, purses, etc., on bench tops. Always place these in the assigned cubicles. Keep manuals and pens on pull-out desks.
2. Clean your work area with dilute bleach solution at the beginning AND end of each

lab.

3. Wash your hands with soap and dry with paper towels when entering and leaving the lab.
4. Wear a lab coat at all times while working in the lab to prevent contamination or accidental staining of your clothing.
5. Closed-toe shoes (no sandals) are to be worn in the lab.
6. Long hair must be tied back to prevent exposure to flame and contamination of cultures.
7. Do not place anything in your mouth or eyes while in the lab. This includes pencils, food, and fingers. Keep your hands away from your mouth and eyes.
8. Eating and drinking are prohibited in the lab at all times. This includes gum, cough drops, and candy.
9. Never pipet by mouth. Use a mechanical pipetting device.
10. Do not remove media, equipment, or bacterial cultures from the laboratory. This is absolutely prohibited and unnecessary.
11. Do not place contaminated instruments such as inoculating loops, needles, and pipettes on bench tops. Loops and needles should be sterilized by incineration, and pipettes should be disposed of in designated receptacles of bleach solution.
12. Carry cultures in a test tube rack when moving around the lab or when keeping cultures on bench tops for use. This prevents accidents and contamination of your person or belongings.
13. Immediately covers spilled cultures or broken culture tubes with paper towels and then saturate them with disinfectant solution. Notify your instructor that there has been a spill. After 15 minutes, dispose of the towels and broken items as indicated by your instructor.
14. Report accidental cuts or burns to the instructor immediately.
15. At the end of each lab session, place all cultures and materials in the proper disposal area.
16. Electronic devices should not be brought into the lab. This includes, but is not limited to iPods, MP3 players, radios, cell phones, and calculators.

General Guidelines:

Before starting any experiment, clearly define the goals. What question are you answering or what principle are you trying to demonstrate? What data is needed to solve the problem?Identify the methods of measurement and instrumentation to be used.

Reference Books:

Laboratory Exercises in Microbiology-Harley Prescott 5th Edition

215469:Mandatory Audit Course 3

In addition to credits courses, it is recommended that there should be audit course (non-credit course). Audit course is for the purpose of self-enrichment and academic exploration. Audit course carry no academic credit. Selection of audit courses helps the learner to explore the subject of interest in greater details resulting in achieving objective of audit course's inclusion. Evaluation of audit course will be done at institute level. Method of conduction and method of assessment for audit courses is suggested.

Criteria:

The student registered for audit course shall be awarded the grade PP and shall be included such grade inthesemestergradereportforthatcourse,providedstudentshastheminimumattendanceasprescribed by the Savitribai Phule Pune university and satisfactory in-semester performance and secured a passing grade in that audit course. No grade point is associated with this "PP" grade and performance in these courses is not accounted in the calculation of the performance indices SGPA andCGPA.

Guidelines for Conduction and Assessment (Any one or more of following but not limited to)

1. Lecture/Guestlecture
2. Visit (Social/field) andreports
3. Demonstrations
4. Surveys
5. Mini project
6. Hands on experience on specific focusedtopic.
7. Seminar/Workshop

Guidelines for Assessment (Any one or more of following but not limited to)

1. Writtentest
2. Quiz
3. Demonstrations/practicaltest
4. Presentations
5. IPR/publication
6. Report

Audit course 2 Options (Anyone)

1. Bio safety inBiotechnology
2. Leadership and PersonalityDevelopment

Semester II

Savitribai Phule Pune University, Pune

Second Year of B. Tech. Biotechnology (2019 Course)

215470:Biochemistry II

Credits

TH: 03	**TUT:01**
Teaching Scheme: **TH: 03 hrs/week** **TUT: 01 hrs/week**	**ExaminationScheme:** **TH Insem : 30** **TH Ensem :70** **Total:100**

Prerequisites: - Basic Knowledge of structure and function of biomolecules

Course Objectives:

1. To examine the main pathways of metabolism and how they are integrated withother Pathways within thecell.
2. To provide an understanding about disorders occur due to defects inmetabolism
3. To understand the basic functioning ofenzymes

Course Outcomes:

On completion of the course, the learner will be able to–

A. Understand the metabolism of major classes of biomolecules like carbohydrates, lipidsand proteins in living systems and their relation inbetween

B. Apply knowledge of biochemistry to understand genetic diseases involving disordersof metabolism

C. Understand the functioning ofenzymes

Course Contents

UnitI **(07Hrs)**

Principles of Bioenergetics: Bioenergetics and thermodynamics, Phosphoryl group transfer and ATP, The free energy of hydrolysis of ATP within cells, Energy required to the assembly of informational macromolecules, Transphosphorylations between nucleotides, Potential phosphoryl group donor

UnitII **(08Hrs)**

Primary, secondary (alpha helix, beta sheets, turns, and loops), tertiary (myoglobin) and quaternary structure(hemoglobin)ofprotein,Namingandclassificationofenzymes,enzymecofactors,the kinetics ofenzyme-catalyzedreactions,MichaelisMentenequation,the effectofpH,temperatureonenzymeactivity.

UnitIII **(07Hrs)**

Glycolysis,PreparatoryphaseandPayoffphase,Canceroustissuesandglucosemetabolism,feeder pathwaysforGlycolysis,Fatesofpyruvateunderanaerobiccondition,gluconeogenesisPentose phosphate pathway of glucose oxidation, Glucose 6-Phosphate dehydrogenase deficiency

UnitIV **(08Hrs)**

Glycogens break down, Synthesis of glycogen and Starch and the role of nucleoside diphosphate sugars,TCAcycle,discoveryofTCAcycle,intracellularlocationoftheenzymesoftheTCAcycle, reactionsoftheTCAcycle,regulationoftheTCAcycle,electrontransportchain,oxidative phosphorylation, Cori cycle, Disorders of carbohydrate metabolism E.g., glycogen storage disease

UnitV **(07Hrs)**

Protein purification (molecular size, solubility difference, electric charge, selective adsorption, affinity chromatography), digestion and absorption of proteins, removal of nitrogen in amino acid degradation,ammoniatoxicity,pathwaysofaminoaciddegradation,inheriteddefectsoftheurea cycle

UnitVI **(08Hrs)**

Digestionandabsorptionoflipidsbeta-oxidationoffattyacid,ketonebodies,ketoacidosis,oxidation of fatty acid in peroxisomes, degradation of odd chain fatty acid, oxidation of PUFA. Synthesis of fattyacid:FormationofmalonylCoA,the roleoffattyacidsynthaseinthe synthesisoffattyacids,transferof acetyl CoA to the cytoplasm, sources of NADPH for fatty acid synthesis.

Text Book:

1. D J Voet, J G Voet, C W Pratt, “Principles of Biochemistry”, 3rd ed., John Wiley & Sons, Inc. 2008 2. D T. Plummer, “An Introduction to practical biochemistry”, Tata McGraw Publishing Company Ltd, 1988

Reference Book:

1. J H Weil, “General Biochemistry”, New Ages International (P) Ltd.1997.

2.JMBerg,JLTymoczko,LStryer,”Biochemistry”,6thed.,FreemanWH&Company,New York,2007

3. D L Nelson, M M Cox “Principles of Biochemistry”, 4th ed., W.H. Freeman and company, New York, 2007

Savitribai Phule Pune University, Pune

Second Year of B. Tech. Biotechnology (2019 Course)

215471: Cell Biology & Tissue Culture

Credits

TH :03 **TUT:01**

Teaching Scheme:	**ExaminationScheme:**
TH: 03 hrs/week	**TH Insem : 30**
TUT: 01 hrs/week	**TH Endsem :70**
	Total :100

Prerequisites: - Basic knowledge of Biology and Chemistry

Course Objectives:

1. To study cell structure and functions of organellefunctions
2. Exposure on transportations through cellmembrane
3. To focus on different receptors and model ofsignaling
4. To introduce the concept of cellsignaling
5. Different cell types offer differentfunctionality
6. Application of cell biology inbiotechnology

Course Outcomes:

On completion of the course, learner will be able to–

A. To understand the structure and function of eukaryoticcells.
B. To introduce basic techniques in cellbiology.
C. Understand the application of cell biology in disease and development oftherapy.
D. Give hands-on experience in cell biology techniques such as in-vitro cellculture

Course Contents

UnitI **(07Hrs)**

Structure and function of Cell –I

Structure of eukaryotic cell, chemical constituents of the cell, sub-cellular compartmentalization and organelles such as nucleus, peroxisomes, endoplasmic reticulum, Golgi apparatus, lysosomes, Bioenergetics and Metabolism – Mitochondria, chloroplasts,

UnitII **(08Hrs)**

Structure and function of Cell -II

Biomembranes, cytoskeleton structure and function, cell movement, ion channels transportof small molecules, Membrane proteins: Carrier proteins and active membrane transport, Endocytosis/Exocytosis/Pinocytosis, extracellular vesicles, cell–cell interactions, Junctions– Adhesion, Tight, Gap, Plasmodesmata.

UnitIII **(07Hrs)**

Intracellular signaling and Cell Cycle

Signaling molecules - receptors, functions, Pathways of intracellular signal transduction. General principles of communication, morphogen. Types of receptors GPCR, etc. Cell cycle, Cell cycle control system, Karyokinesis, Cytokinesis, Control of cell division and growth, Mitosis, Meiosis, Cell death and cell renewal - Programmed cell death Apoptosis.

UnitIV **(08Hrs)**

Tissues and Cancer

Epithelial tissue, connective tissue, muscle tissue, nervous tissue, blood. Stem cells: Hematopoietic stem cells & embryonic stem cells. Cancer: Development of Cancer and properties of Cancer.

UnitV **(07Hrs)**

Animal Cell and Tissue culture

Animal tissue culture: tissue culture media, Media types, Types of culture- adherent cell lines and suspension cell cultures, Passaging, Cell separation, characterization, cryopreservation of animal cells, contamination and cytotoxicity.

UnitVI **(08Hrs)**

Plant Tissue culture

Plant tissue culture: Totipotency, Requirements, Plant growth hormones. Types of culture:Callus culture, Pollen culture, Anther culture, Protoplast fusion. Application: Production of secondary metabolites, transgenic plants.

Books:

Text Book:

1. Karp, “Cell and Molecular Biology” John Wiley and Sons Pvt.Ltd
2. Sudha Gangal, ‘Animal tissue culture’, Orient Longman,2006
3. The Cell: A molecular approach by Geoffrey M.Cooper. ASM Press,Pages:673

Reference Book:

1. Cooper G.M. &Hausman, “The Cell”, fifth edition, ASMPress.
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. “MolecularBiologyoftheCell”,4thedition,GarlandPublishing,NewYork,London,(2002)
3. Harvey Lodishetal “ Molecular Cell Biology”, 4th edition, NewYork
4. M.K. Razdan , “Introduction to Plant Tissueculture”.
5. Freshney Ian ,”Animal tissueculture”
6. Tortora and Grabowasky “Human anatomy and physiology”, Wileypublication

Savitribai Phule Pune University, Pune

Second Year of B.Tech. Biotechnology (2019 Course)

215472: Thermodynamics

Credit	
TH :03	**TUT:01**
Teaching Scheme: **TH: 03hrs/week** **TUT: 01hr/week**	**ExaminationScheme:** **TH** **Insem:30TH** **Endsem :70** **TW:25** **Total :125**

Prerequisites: -

- Basic concepts of fundamental and derived properties like mass, acceleration,kinetic and potential energy,velocity.
- Basic biochemical pathways and general cellmetabolism.

Course Objectives:

1. To introduce students to basic concepts and first law ofthermodynamics
2. To develop an understanding of heat energy and its application to industrial and biochemicalprocesses
3. Tomakestudentsawareaboutfunctioningofindustrialsystemsbyintroducingthemwith second law ofThermodynamics
4. Provideanunderstandingoftheconceptofequilibriumanditsrelevanceto solution thermodynamics
5. To introduce students to concepts related to thermodynamics of chemically reacting systems
6. To demonstrate the applications of thermodynamic principles in context of biological systems

Course Outcomes:

On completion of the course, learner will be able to–

A. Analyze simple systems from thermodynamic aspect as also to apply this knowledge to evaluate the efficiency and feasibility of a physical or biochemicalprocess
B. Characterize systems comprising of solutions andmixtures
C. Predict equilibrium, conversion and efficiency of achemicalor biochemicalprocesses
D. Examine biological systems and biochemical reactions from a thermodynamic view and understand the various applications in thiscontext

Course Contents

UnitI **(07Hrs)**

Introduction to engineering thermodynamics: Scope and importance, fundamental and derived quantities, Joule's experiment, Internal Energy, The First law of Thermodynamics, Energy Balance for Closed Systems, Thermodynamic State and State Functions, equilibrium, The Phase Rule, The Reversible Process, Constant-V and Constant-P Processes, Enthalpy,Heat Capacity, Mass and Energy Balances for open systems, Processes Involving Ideal Gases

UnitII **(08Hrs)**

HeatEffects: Sensibleandlatentheateffects,temperaturedependenceofheatcapacity,standard heat of reaction, standard heat of formation, standard heat of combustion, Hess's law; Temperature dependence of standard heat of reaction, heat effects of industrialreactions

UnitIII **(07Hrs)**

Second law of Thermodynamics: Limitations of First Law, Heat Engines, Heat Pump and Refrigerator, Statement of second law, Criterion for irreversibility, Carnot cycle and theorems, Clausius inequality, Concept of entropy and its calculation, mathematical statement of 2ndlaw, Principle of entropy increase

UnitIV **(08Hrs)**

SolutionThermodynamics: Fundamentalpropertyrelations,TheChemicalPotentialandPhase Equilibria, Partial Properties, Ideal-Gas Mixtures, Fugacity and Fugacity Coefficient: Pure species,FugacityandFugacityCoefficient:SpeciesinSolution,GeneralizedCorrelationsforthe Fugacity Coefficient, The Ideal Solution, Excess Properties

UnitV **(07Hrs)**

Chemical Reaction Equilibria: Application of the criteria for equilibrium to chemical reactions, the standard Gibbs free energy change and the equilibrium constant; effect of temperature on equilibrium constant, evaluation of the equilibrium constant, relation of equilibrium constant to composition, calculation of equilibrium conversion for single reaction; The phase rule and Duhem's theorem for reacting systems

UnitVI **(08Hrs)**

Application of thermodynamics to biological systems: Energy transformations in biological systems, Examples of applications of laws of thermodynamics to bio-systems, Gibb's free energy concept for bio-changes and its applications; Thermodynamics of biochemicalchanges - Energy Yielding and Energy Requiring Reactions, feasibility of individual steps andoverall reactions

Books:

Reference:

1. J M Smith, H C Van Ness, "Introduction to Chemical Engineering Thermodynamics", 7th ed., McGraw-Hill Education, 2005
1. T E Daubert, "Chemical Engineering Thermodynamics", McGraw-Hill Inc., 1985

Text:

1. K V Narayanan, "A Textbook of Chemical Engineering Thermodynamics", PHI Learning Pvt. Ltd.,2004
2. Y V C Rao, "Chemical Engineering Thermodynamics", University Press,1997
3. D T Hayne, "Biological Thermodynamics", Cambridge UniversityPress

Savitribai Phule Pune University, Pune

Second Year of B.Tech. Biotechnology (2019 Course)

215473:Genetics and Molecular Biology

Credits	
TH: 03	**TUT:01**
Teaching Scheme:	**Examination Scheme:**
TH: 03 hrs/week **TUT: 01 hrs/week**	**THInsem-30THEndsem-70** **Total:100**

Prerequisites: Basic knowledge of Biology

Course Objectives:

1. To understand the classical Mendelian genetics & topological features ofDNA.
2. To understand the process of DNAreplication.
3. To understand the process oftranscription.
4. To understand the process oftranslation.

Course Outcomes:

On completion of the course, learner will be able to–

A. Understand the concept of Mendelian genetics & nucleic acidstructure.
B. Comprehend the replicationmechanism.
C. Emphasize on role of different types of RNA & transcriptionprocess
D. Deduce the process oftranslation.

Course Contents

Unit I:MendelianGenetics **(07Hrs)**

Introduction,Mendelianinheritancepatternstudyandlawsofheredity,Co-dominance,linkage, linkage maps, Hardy-Weinberg Equation, Model systems like *Drosophila, C. Elegans, Zebra fish, Arabidopsis*

Unit II:DNATopology **(08Hrs)**

Watson-Crick'sdiscoveryofstructureofDNA,MacLeodandMcCarty'sexperiment,Hershey and Chase's experiment, Structure of DNA: A, B (Watson-crick model), and Zstructure,

Chargaff's rule, Physicochemical properties of DNA, DNA supercoiling, DNA packaging: Chromosome, Chromatin, Chromatid, Euchromatin and Heterochromatin.

Unit III:DNAReplication (07Hrs)

Introduction to replication of DNA, Chemistry of DNA synthesis, Mechanism of DNA polymerase, Replication Fork, DNA synthesis at the replication fork, Initiation of DNA replication, Elongation of DNA replication, Finishing replication, Telomere replication. Mutation and Repair

UnitIV:RNA (08Hrs)

TypesofRNA,Codingandnon-codingRNAs,tRNA,mRNA,rRNA,andsmallRNAs,introns and exons, chemistry of RNA splicing, splicing pathways, alternative splicing, ribozyme, importance of RNA, RNA world theory.

UnitV:Transcription (07Hrs)

Transcription, RNA polymerase, Transcription cycle in bacteria, concept of Operon, Transcription cycle in eukaryotes, Reverse Transcriptase, .Regulation.

UnitVI:Translation (08Hrs)

Genetic code, Protein biosynthesis, Initiation of translation, Translation elongation, Termination of Translation, regulation, posttranslational modifications, protein synthesis in prokaryotes and eukaryotes, chaperones, heat shock proteins.

Books:

Text:

1. JamesD.Watson,TaniaA.Baker,StephenP.Bell,"MolecularBiologyoftheGene" 5th edition, Dorling Kindersley (India) Pvt.Ltd.
2. Freifelder D. , "Molecular Biology", Jones and Bartlett Publishers,(1987)

Reference:

1. Benjamin Lewin, "Gene IX", Oxford University Press, Oxford, New York,(2000)
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, PeterWalter. "Molecular Biology of the Cell", 4th edition, Garland Publishing, New York, London, (2002)
3. T.A. Brown, "Genomes" John Wiley and Sons Pvt.Ltd
4. Ansumbel F.M, Brent R, Kingston R.E, Moore D.D., 'Curernt protocols in Molecular Biology' Green Publishing Associates,(1988)
5. Old R W and Primrose SB, "Principles of Gene manipulations: An introduction toGenetic Engineering" Blackwell Science publications, (1993)

Savitribai Phule Pune University, Pune

Second Year of B.Tech. Biotechnology (2019 Course)

215474: Biochemistry II Lab

Credit	
	PR : 01
Teaching Scheme: **PR: 02hrs/week**	**ExaminationScheme:** **TW :25** **PR:50** **Total :75**

Prerequisites: - Basic knowledge of Biochemistry I

Course Objectives:

1. To learn fundamental approaches for conduction of the experiment
2. To give hands-on experience to the students on the isolation of biomolecules
3. To make students acquainted with the kinetics of biocatalyst

Course Outcomes:

On completion of this course, students will be able to

A. Conduct experiments with satisfactory analysis of data and interpretation of results

B. To apply methods for extraction of biomolecules

C. Understand the functioning of enzymes (biocatalysts)

Suggested List of Laboratory Assignments (Any 8)

Sr. No.	**Group A**
1.	Determination of λmax
2.	Quantitative estimation of reducingsugar
3.	Protein estimations by Lowry/ Biuret/ Bradfordmethod
Group B	
1.	Estimation of protein by spectrophotometer at 280nm.
2.	Extraction ofcholesterol/lipids
3.	Estimation of cholesterolconcentration

Group C	
1.	Isolation ofEnzyme
2.	Varying enzymeassay
3.	To determine Km forenzyme

Guidelines for Instructor's Manual

1. Students should be briefed with Risk Assessment and Biosafety Levels
2. All the instruments to be validated before use
3. All the experiments should be standardized
4. The instructor is responsible for seeing that the consequences of student are rectified, including the correction of damages and violations and take-down of experiments.

Guidelines for Student's Lab Journal

1. Use a bound notebook.
2. Lab notebooks should be done in pen and no erasing or white-out is allowed
3. Number the pages
4. Title and underline each lab exercise at the top of the page and date it. Each lab writeup should be done separately even if more than one exercise is performed in a lab period. Leave enough room in the lab notebook to complete the entire lab including results and discussions.
5. Briefly explain the lab exercise objectives in a few sentences.
6. Record observations, diagrams, and results from the exercise.
7. Conclude the report with a brief discussion in the essay form.
8. Write neatly, be organized, and follow a standard format.

Note: The purpose of the lab notebook is to encourage students to compile and organize their laboratory notes and to understand the purpose of the laboratory exercises and the meaning of their results.

Guidelines for Lab /TW Assessment
Lab Assessment will be based on the following points

1. Present/Absent
2. A completion date of the journal
3. Regularity
4. Understanding
5. Presentation

Guidelines for Laboratory Conduction
The following rules must be observed during laboratory conduction

1. Lab coat should be worn by students before entering the laboratory
2. Students shall keep their belongings on storage rack
3. Loose hair and flowing parts of apparel shall be properly tied before commencing of work
4. Enter the usage of chemicals and equipment's in a logbook
5. The instruction manual should be read before operating any instrument
6. Students should make aware of hazard warning symbols on reagent bottle
7. Protective devices must be worn when it is necessary to protect the eyes and face from splashes
8. All chemicals, glassware, reagents and plastic wares should be kept on their appropriate place after use 8. Reagents to be stored should be labeled with due discarding date
9. Instructions for proper disposal of waste material should be followed
10. Report accidental cuts or burns to the instructor immediately.
11. Perform the experiment. Collect data in a clear and organized fashion. Be sure to note the units for each measurement. Also, be sure to participate in the experiment rather than just recording data for your group

General Guidelines:

Before starting any experiment, clearly define the goals. What question are you answering or what principle are you trying to demonstrate? What data is needed to solve the problem?
Identify the methods of measurement and instrumentation to be used.

Savitribai Phule Pune University, Pune

Second Year of B.Tech. Biotechnology (2019 Course)

215475:Cell Biology and Tissue CultureLab

Credit	
	PR : 01
Teaching Scheme: **PR: 02hrs/week**	**ExaminationScheme:** **TW :25** **OR:50** **Total :75**

Prerequisites: Basic Understanding of the Cell and its components.

Course Objectives:

1. To offer basic understanding of how eukaryotic cell functions
2. Role of lab and its equipments in helping understand the functioning and growth of the cells
3. To help understand the process of isolation and characterization of different types of cells
4. To give hands on experience to the students on isolation, characterization, culturing, sub-culturing and preservation of animal cells.

Course Outcomes:

A. The students will understand the difference between various types of cells.

B. The students will be able to use different types of microscopy techniques to observe the physiological characteristics of the cells.

C. The students will be able to prepare the lab for the growth of cells and will be able to characterize and understand the phenomena of growth

D. The students will be able to understand the media sterilization and cryopreservation techniques

Suggested List of Laboratory Assignments (Any 8)

Sr. No.	**Title of the Practical**
1.	Introduction to Cell biology and tissue culture facility.
2.	Microscope observation of adherent and suspension culture and confluence using inverted microscope
3.	Cell counting using hemocytometer: Animal cell count for passaging/WBC count.
4.	WBC Different cell types stain and visualize

5.	Onion Root Tip nuclear staining and observation of stages of Mitosis
6.	Filter sterilization of media for animal cell culture
7.	Passaging of adherent animal cell cultures.
8.	Cryopreservation of animal cells.
9.	Revival of animal cells
10.	Viability staining

Guidelines for Instructor's Manual

1. Discuss the syllabus for the course
2. Go through the general procedures for lab safety
3. Review the guidelines for laboratory reports
4. Practice some of the scientific calculations that will be used throughout the semester
5. Practice some basic laboratory methods such as the use of balances, pipets, and Micropipettes
6. Students should be briefed with Risk Assessment and Biosafety Levels
7. All the instruments to be validated before use
8. All the experiments should be standardized
9. The instructor is responsible for seeing that the consequences of student are rectified, including correction of damages and violations and take-down of experiments

Guidelines for Student's Lab Journal

Please read these instructions now and refer to them regularly!

These instructions must be followed carefully.

1. Use a bound notebook for notes and lab observations.
2. Lab notebooks should be done in pen and no erasing or white-out is allowed
3. For the Journal use Journal Pages and ensure you draw neat diagrams wherever necessary
4. Number the pages
5. Title and underline each lab exercise at the top of the page and date it.
6. Each lab write-up should be done separately even if more than one exercise is performed in a lab period.
7. Briefly explain the lab exercise objectives in a few sentences.
8. Record observations, diagrams and results from the exercise.
9. Conclude the report with a brief discussion in essay form.

10. Write neatly, be organized and follow a standard format.

Note: The purpose of the lab notebook is to encourage students to compile and organize their laboratory notes and to understand the purpose of the laboratory exercises and the meaning of their results.

Guidelines for Lab /TW Assessment

Lab assessment will be based on following points

1. Present / Absent
2. Completion date of journal
3. Regularity
4. Understanding
5. Presentation

Guidelines for Laboratory Conduction

Basic Principles for Students Working in Cell Biology Laboratories :
The following rules must be observed at all times to prevent accidental injury to and infection of yourself and others and to minimize contamination of the lab environment:

1. Never place books, backpacks, purses, etc., on bench tops. Always place these in the assigned cubicles. Keep manuals and pens on pull-out desks.
2. Clean your work area with dilute bleach solution at the beginning AND end of each lab.
3. Wash your hands with soap and dry with paper towels when entering and leaving the lab.
4. Wear a lab coat at all times while working in the lab to prevent contamination or accidental staining of your clothing.
5. Closed-toe shoes (no sandals) are to be worn in the lab.
6. Long hair must be tied back to prevent exposure to flame and contamination of cultures.
7. Do not place anything in your mouth or eyes while in the lab. This includes pencils, food, and fingers. Keep your hands away from your mouth and eyes.
8. Eating and drinking are prohibited in the lab at all times. This includes gum, cough drops, and candy.
9. Never pipet by mouth. Use a mechanical pipetting device.
10. Do not remove media, equipment, or bacterial cultures from the laboratory. This is absolutely prohibited and unnecessary.
11. Do not place contaminated instruments such as inoculating loops, needles, and pipettes on bench tops. Loops and needles should be sterilized by incineration, and pipettes should be

disposed of in designated receptacles of bleach solution.

12. Carry cultures in a test tube rack when moving around the lab or when keeping cultures on bench tops for use. This prevents accidents and contamination of your person or belongings.
13. Immediately covers spilled cultures or broken culture tubes with paper towels and then saturate them with disinfectant solution. Notify your instructor that there has been a spill. After 15 minutes, dispose of the towels and broken items as indicated by your instructor.
14. Report accidental cuts or burns to the instructor immediately.
15. At the end of each lab session, place all cultures and materials in the proper disposal area.
16. Electronic devices should not be brought into the lab. This includes, but is not limited to iPods, MP3 players, radios, cell phones, and calculators.

General Guidelines:

Before starting any experiment, clearly define the goals. What question are you answering or what principle are you trying to demonstrate? What data is needed to solve the problem?

Identify the methods of measurement and instrumentation to be used.

Savitribai Phule Pune University, Pune
Second Year of B.Tech. Biotechnology (2019 Course)
215476:Genetics and Molecular Biology Lab

Credits

	PR:02
Teaching Scheme: **PR:04hrs/week**	**Examination Scheme:** **TW:25** **OR:50** **Total: 75**

Course Objectives:

1. To understand the significance of different stocks and reagents used in molecular biology
2. To isolate and purify the DNA from prokaryotic and eukaryotic cells.
3. To estimate the quantitative purity of isolated DNA.
4. To understand the process of gel electrophoresis for qualitative analysis of nucleic acid.

Course Outcomes:

On completion of the course, learner will be able to–

A. Graduates are learn the principle of various buffer system and reagents required in molecular biology
B. Graduates are skilled to isolate the nucleic acids from prokaryotic and eukaryotic organisms.
C. Graduates are trained to use agarose gel electrophoresis system for estimation of nucleic acids
D. Graduates are trained to examine the DNA by qualitative and quantitative methods

Suggested List of Laboratory Assignments

1. Preparation of Stock & Working solutions-Tris-Cl, EDTA, Extraction Buffers, TE
2. Isolation of plant genomic DNA
3. Isolation of E.coli genomic DNA
4. Quantification and purity check of extracted DNA from Plant & E. coli by at 260/280,260/230 nm Spectrophotometer
5. Agarose Gel Electrophoresis
6. Study of effect of agarose concentration on electrophoretic mobility of DNA

7. Visualization of plant genomic DNA by agarose gel electrophoresis
8. Visualization of E. coli genomic DNA by agarose gel electrophoresis

Guidelines for Instructor's Manual

Students should be briefed with risk assessment and Biosafety levels

• All the instruments to be validated before use

• All the experiments should be standardized

• The instructor is responsible for seeing that consequences of student are rectified, including correction of damages and violations and take-down of experiments

Guidelines for Student's Lab Journal

• Use provided templates of experiment write ups

• Follow the sequence of experiments as per the index, while arranging journal file

• Draw necessary diagrams with pencil and fill other fields like observations, calculations, conclusion etc. with Pen

• Paste Images e.g. of specialized equipment, Gel pictures, isolated DNA wherever necessary

• Avoid overwriting and copying of results, conclusions etc.

Guidelines for Lab /TW Assessment

• Each experiment will be assessed based on following terms.

• Student should attend each practical in scheduled batch to gain full marks for that practical

• Regularity will be assessed throughout the semester for practical.

• Presentation of students in laboratory during practical will be assessed.

• Understanding and application of steps involved in practical to achieve good results will contribute in term work/lab assessment.

• For final term work assessment along with above all points, unit test marks, theory lecture attendance will also be considered

Savitribai Phule Pune University, Pune

Second Year of B.Tech. Biotechnology (2019 Course)

215477:Project based Learning

Credits	
	PR: 02
Teaching Scheme:	**Examination Scheme:**
PR : 04 hrs/week	**TW:50** **Total:50**

Projectbasedlearning(PBL)requirescontinuousmentoringbyfacultythroughoutthesemester for successful completion of the tasks selected by the students per batch. While assigning the teaching workload a load of 2 Hrs/week/batch needs to be considered for the faculty involved. The Batch needs to be divided into sub-groups of 5 to 6 students. Assignments / activities / models/projectsetc.underprojectbasedlearningiscarriedthroughoutsemesterandCreditfor PBLhastobeawardedonthebasisofinternalcontinuousassessmentandevaluationattheend ofsemester.

Few examples of problem based learning are as follows

1. Evaluation of Protein Content among Sprouted and Un-SproutedSeeds
2. To check pH of different watersamples
3. To estimate carbohydrate content in different foodsamples
4. Diversity of microorganisms of varioussamples.

215478:Mandatory Audit Course 4

In addition to credits courses, it is recommended that there should be audit course (non-credit course). Audit course is for the purpose of self-enrichment and academic exploration. Audit course carry no academic credit. Selection of audit courses helps the learner to explore the subject of interest in greater details resulting in achieving objective of audit course's inclusion. Evaluation of audit course will be done at institute level. Method of conduction and method of assessment for audit courses is suggested.

Criteria:

The student registered for audit course shall be awarded the grade PP and shall be included such grade in the semester grade report for that course, provided students has the minimum attendance as prescribed by the Savitribai Phule Pune university and satisfactory in-semester performance and secured a passing grade in that audit course. No grade point is associated with this "PP" grade and performance in these courses is not accounted in the calculation of the performance indices SGPA and CGPA.

Guidelines for Conduction and Assessment (Any one or more of following but not limited to)

1. Lecture/Guestlecture
2. Visit (Social/field) andreports
3. Demonstrations
4. Surveys
5. Mini project
6. Hands-on experience on a specific focusedtopic.
7. Seminar/Workshop

Guidelines for Assessment (Any one or more of following but not limited to)

1. Writtentest
2. Quiz
3. Demonstrations/practicaltest
4. Presentations
5. IPR/publication
6. Report

Audit course 2 Options (Anyone)

1. Professional Ethics andEtiquettes
2. Entrepreneurship Development inBiotechnology