DEPARTMENT OF BIOTECHNOLOGY				*CLASS: II B.Sc. Biotechnology*				
Sem	**Course Type**	**Course Code**	**Course Title**	**Credits**	**Contact Hours/week**	**CIA**	**Ext**	**Total**
III	SBE-I	20U3LSM1	Biophysics and Bioenergetics	2	2	25	75	100

Nature of Course				
Knowledge and skill	✓		Employability oriented	
Skill oriented			Entrepreneurship oriented	

Course Objectives

1	To understand the concepts of energy in biological system.
2	To gain knowledge about biological oxidation.
3	To apprehend the biophysical property of proteins.

Unit	Description	Hours	K-level	CLO
I	**Thermodynamics of Biological system** First and second law of thermodynamics, activation energy. Biological systems as open, non-equilibrium systems,Concept of free energy, entropy, heat content of food, bomb calorimetry, Enthalpy, Standard free energy change, actual free energy depend on reactant and product concentration, standard free energy changes are additive	**6**	Up to K-2	**1**
II	**Redox potential** Oxidation and reduction, redox potential and its calculation by Nernst equation, examples of redox potential in biological system. Standard electrode potentials & its determination, its relationship with emf.	**6**	Up to K-3	**2**
III	**Bioenergetics** Concept of energy coupling in biological processes, Energy requirements in cell metabolism, structure and role of mitochondria, high energy phosphate bond, energy currency of cell, Biological oxidation, Electron-transport chain, Oxidative Phosphorylation including chemiosmotic hypothesis. Inhibitors of ETC, inhibitors of oxidative phosphorylation, uncouplers.	**6**	Up to K-4	**3**
IV	**Protein structure and Kinetics** Ramachandra plot, Structure of heme, Structure of Myoglobin and hemoglobin, Oxygen binding mechanism, Oxygen binding co-operativity, Hill equation, Hill coefficient, Allosteric protein, Allostery in hemoglobin, Bohr effect.	**6**	Up to K-3	**4**
V	**Dynamics of biomolecules** Diffusion, Laws of diffusion, Active transport, Facilitated diffusion, Osmosis, Osmotic pressure, Osmoregulation, Viscosity and its biological importance, Surface tension, Factors influencing surface tension.	**6**	Up to K-4	**5**

Books for Study

1. Jain JL. 2005. Fundamentals of Biochemistry. S.Chand &company Ltd.
2. Nelson DL and CoxMM. 2013. Lehninger'sPrinciples of Biochemistry. 6th edition. W.H. Freeman and Company. New York.

Books for Reference

1. Voet DJ, Voet JG and Pratt CW. Principles of Biochemistry. 2008. 3rd edition. John Wiley & Sons, Inc. New York.
2. StryerL. Biochemistry. 2000. Fourth edition. W.H. Freeman and Company. New York.

Web Resources

http://www.gwumc.edu

http://nptel.ac.in

http://swayam.gov.in

Rationale for Nature of the course

The skill based elective paper focuses on the ability to discern about the energy concepts in biological system. They would gain knowledge on various dynamics of macromolecules.

Activities having direct bearing on Skill development / Employability /Entrepreneurship

- Critical thinking and analysis on concepts related to energetics.
- Problem solving with thermodynamics in biological system.
- Model making to explain electron transport system in Mitochondria and chloroplast.
- Review about the 3D structure with kinetics and function.

Pedagogy

The teaching methods may include Chalk and talk, PowerPoint, demonstrations, assignments and group discussions and Problem solving

Course content designer:

Ms. R.Suguna
Dr. N.Krithiga

Course Learning Outcomes

On completion of this course the students will be able to

#	CLOs	K - Level
CLO-1	Discuss about the energy transfer as applicable to biological system.	Up to K-2
CLO-2	Interpret the concept of redox potential in living system.	Up to K-3
CLO-3	Explain the concept of energy coupling in biological processes.	Up to K-4
CLO-4	Apply the physical process of ligand binding to macromolecules.	Up to K-3
CLO-5	Distinguish the various dynamics of bio molecules.	Up to K-4

Mapping of Course outcomes with Program Outcomes

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5
CLO-1	3	2	2	1	2
CLO-2	3	1	3	2	1
CLO-3	3	2	2	2	2
CLO-4	3	2	3	2	3
CLO-5	3	1	2	2	1

Advance application-3; Intermediate level-2 & Basic level-1

Mapping of Course outcomes with Program specific Outcomes

CLO/PSO	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CLO-1	3	2	1	2	2
CLO-2	3	2	2	2	1
CLO-3	3	3	2	1	1
CLO-4	3	3	3	3	3
CLO-5	3	2	1	2	2

Advance application-3; Intermediate level-2 & Basic level-1

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LESSON PLAN

Unit	Description	Hours	Mode
UNIT - I	First and second law of thermodynamics, activation energy. Biological systems as open, non-equilibrium systems	2	Chalk and talk Problem solving
	Concept of free energy, entropy, heat content of food, bomb calorimetry	2	Chalk and talk Problem solving
	Enthalpy, Standard free energy change, actual free energy depend on reactant and product concentration, standard free energy changes are additive.	2	Chalk and talk Problem solving
UNIT - II	Oxidation and reduction, redox potential and its calculation by Nernst equation	2	Chalk and talk Problem solving
	Examples of redox potential in biological system.	2	Chalk and talk
	standard electrode potentials & its determination , its relationship with emf	2	Chalk and talk
UNIT - III	Concept of energy coupling in biological processes, Energy requirements in cell metabolism	2	Chalk and talk
	structure and role of mitochondria, high energy phosphate bond, energy currency of cell, Biological oxidation	2	Chalk and talk
	Electron-transport chain, Oxidative Phosphorylation including chemiosmotic hypothesis. Inhibitors of ETC,inhibitors of oxidative phosphorylation,uncouplers	2	Chalk and talk PPT
UNIT-IV	Ramachandraplot,Structure of heme, Structure of Myoglobin and hemoglobin, Oxygen binding mechanism	3	Chalk and talk PPT
	Oxygen binding co-operativity, Hill equation, Hill coefficient, Allosteric protein, Allostery in hemoglobin, Bohr effect.	3	Chalk and talk
UNIT - V	Diffusion, Laws of diffusion, Active transport, Facilitated diffusion, Osmosis, Osmotic pressure	2	Chalk and talk
	Osmoregulation, Viscosity and biological importance	2	Chalk and talk Problem solving
	Surface tension, Factors influencing surface tension.	2	Chalk and talk Problem solving

Learning Outcome Based Education & Assessment (LOBE)
Blue Print – Biophysics and BioenergeticsCourse
Articulation Mapping – K Levels with Courses Learning Outcomes (CLOs)

BLUE PRINT FOR INTERNAL ASSESSMENT – I

S. No.	CLOs	K-Level	Section A		Section B		Section C (Either / or Choice)	Section D (Open Choice)
			MCQs		Short Answers			
			No. of Questions	K-Level	No. of Questions	K-Level		
1.	CLO 1	Up to K 2	2	K1 & K2	1	K1	2 (K1&K1)	1(K2)
2.	CLO 2	Up to K 3	2	K1 & K2	1	K2	2 (K2&K2)	1(K3)
No. of Questions to be asked			4		3		4	3
No. of Questions to be answered			4		3		2	2
Marks for each Question			1		2		5	10
Total Marks for each Section			4		6		10	30

BLUE PRINT FOR INTERNAL ASSESSMENT – II

S. No.	CLOs	K-Level	Section A		Section B		Section C (Either / or Choice)	Section D (Open Choice)
			MCQs		Short Answers			
			No. of Questions	K-Level	No. of Questions	K-Level		
3.	CLO 3	Up to K 4	2	K1 & K2	1	K1	2 (K3&K3)	1(K4)
4.	CLO 4	Up to K 3	2	K1 & K2	1	K2	2 (K3&K3)	1(K3)
No. of Questions to be asked			4		3		4	3
No. of Questions to be answered			4		3		2	2
Marks for each Question			1		2		5	10
Total Marks for each Section			4		6		10	30

Learning Outcome Based Education & Assessment (LOBE)
Blue Print – Biophysics and BioenergeticsCourse
Articulation Mapping – K Levels with Courses Learning Outcomes (CLOs)

S. No.	CLOs	K-Level	Section A		Section B		Section C (Either / or Choice)	Section D (Open Choice)
			MCQs		Short Answers			
			No. of Questions	K-Level	No. of Questions	K-Level		
1.	CLO 1	Up to K-2	2	K1 & K2	1	K1	2 (K1&K1)	1(K2)
2.	CLO 2	Up to K-3	2	K1 & K2	1	K2	2 (K2&K2)	1(K3)
3.	CLO 3	Up to K-4	2	K1 & K2	1	K1	2 (K3&K3)	1(K4)
4.	CLO 4	Up to K-3	2	K1 & K2	1	K2	2 (K3&K3)	1(K3)
5.	CLO 5	Up to K-4	2	K1 & K2	1	K2	2 (K4&K4)	1(K3)
No. of Questions to be asked			10		5		10	5
No. of Questions to be answered			10		5		5	3
Marks for each Question			1		2		5	10
Total Marks for each Section			10		10		25	30

Distribution of Section-wise Marks with K Levels

K Levels	Section A (No Choice)	Section B (No Choice)	Section C (Either/or)	Section D (Open Choice)	Total Marks	% of Marks without choice	Consolidated
K1	5	4	10	-	**19**	15.83	**42%**
K2	5	6	10	10	**31**	25.83	
K3	-	-	20	30	**50**	41.67	**42%**
K4	-	-	10	10	**20**	16.67	**16%**
Total Marks	10	10	50	50	**120**	100.00	**100%**

Distribution of Unit-wise questions with K Levels

Section A	Section B	Section C	Section D
2 Questions for each Unit (K1 & K2 Level)	1 Question from each Unit (K1 & K2 Level)	2 Questions from Unit-I (K1 Level)	1Question from Unit-I (K2 Level)
		2 Questions fromUnit-II (K2 Level)	1Question from Unit-II (K3 Level)
		2 Questions from Unit-III (K3 Level)	1Question from Unit-III (K4 Level)
		2 Questions from Unit-IV (K3 Level)	1Question from Unit-IV (K3 Level)
		2 Questions from Unit-V (K4 Level)	1Question from Unit-V (K3 Level)

K1 –Remembering and recalling facts with specific answers
K2 – Basic understanding of facts and stating main ideas with general answers
K3 – Application oriented – Solving Problems
K4 – Examining, analyzing, presentation and make interferences with evidences