		Hours
1	**Introduction to Thermodynamic Systems:** Energetic process in the biosphere: The Ecosystem; Equilibrium, activity coefficients and phase equilibrium functions of state, cyclic processes, work, energy and metabolic heat; Mechanical equivalent of heat, energy as a function of state. Carnot cycle; Reverse Carnot cycle; use of heat transfer in biological processes	**9**
2	**The Laws of Thermodynamics:** Free energy; Entropy: Ideality and Molecular Cohesion, Probabilistic nature of Entropy, Order and Disorder	**8**
3	**Chemical Potential:** Visualization of the potential; Steady velocity and steady flow; Fick's law and diffusion; Local Equilibria and Steady State: Energy vs. Power; Transducers in biological states; Prigogine's principle; Spontaneous coupling and entropy production	**9**
4	**Non-equilibrium Thermodynamics:** Reversible work; Exact differentials and function of state; First and second law; The electrochemical potential; External forces and steady state; Fick's Law; Chemical reactions in the steady state; internal entropy production; Cells as non-equilibrium stationary states; Diffusion and membrane transport	**8**
5	**Thermodynamics of Biological Systems:** Biological Systems as open, non-equilibrium systems; Thermodynamic analysis of oxidative photophosphorylation; Stability of non-equilibrium stationary states; Ordering in time and space far from equilibrium; Glycolytic oscillations; Biological clocks	**8**
	Total	**42**

Books: -

S. No.	Name of Authors /Books / Publishers
1.	Bioenergetics by A.L. Lehninger. W.A. Benjamin Inc.
2.	Biological Thermodynamics by D.T. Haynie. Cambridge University Press
3.	Biophysical Chemistry by CR. Cantor and P.R. Schimmel. W.H. Freeman
4.	Thermodynamics and Kinetics for the Biological Sciences by G.G. Hammes. John Wiley and Sons Inc.
5.	Bioenergetics by Alexander Lowen. Penguin Books
6.	Bioenergetics by David G. Nicholls and Stuart Ferguson. Elsevier Ltd.
7.	**Principles of Bioenergetics by V. Skulachev, A.V. Bogachev, F.O. Kasparinsky. Springer-Verlag Berlin Heidelberg**
8.	**Thermal Biophysics of Membranes by T. Heimburg. Wiley-VCH**

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