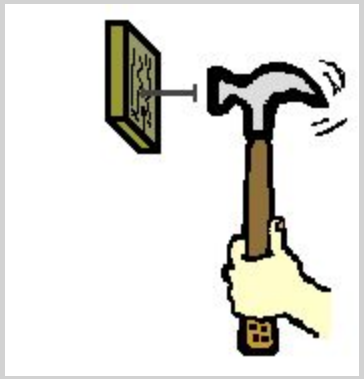
THERMODYNAMICS OF BIOLOGICAL SYSTEMS

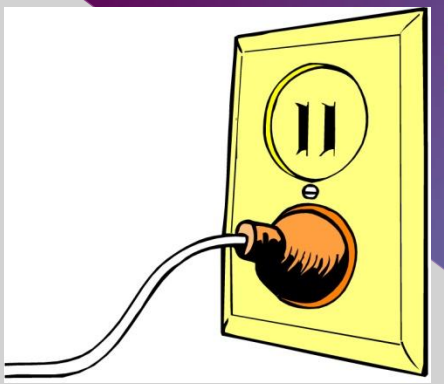
THERMODYNAMICS CONCEPT

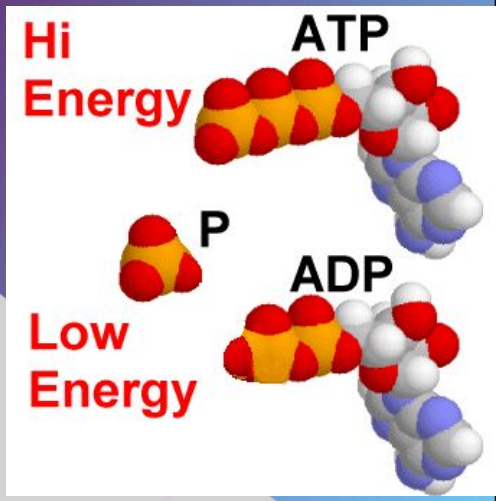
Thermodynamics – is a brunch of physics which studies energy, its transfer from one place to another and its transformation from one form to another

ENERGY

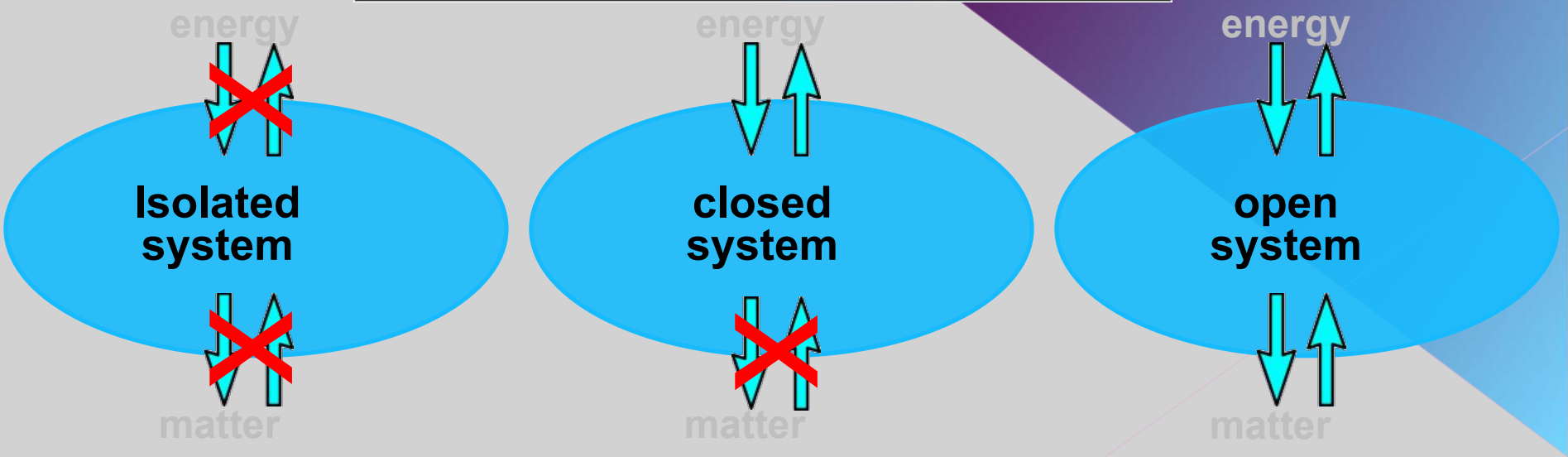
- **mechanical**
- **thermal**
- **electric**
- **chemical**





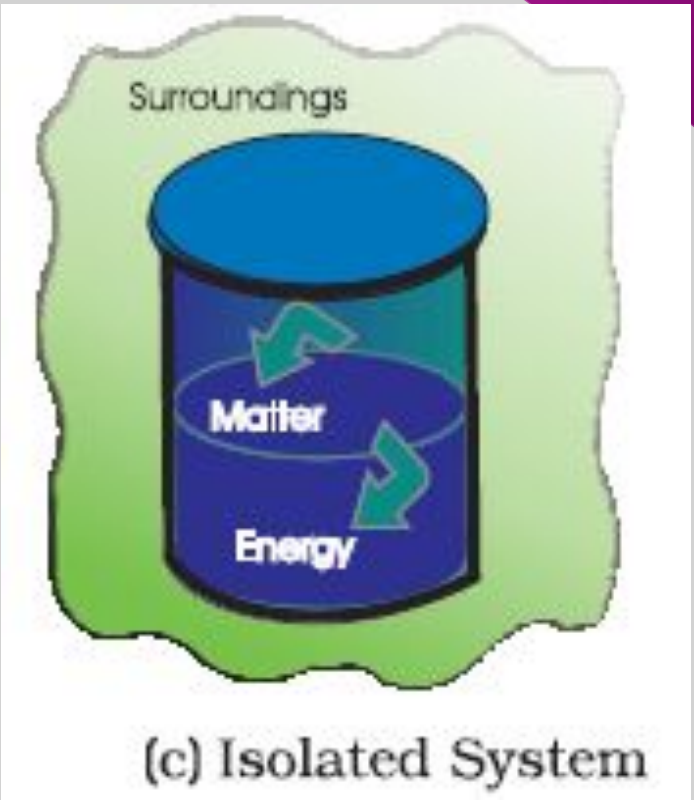


THERMODYNAMIC SYSTEM



ISOLATED SYSTEM

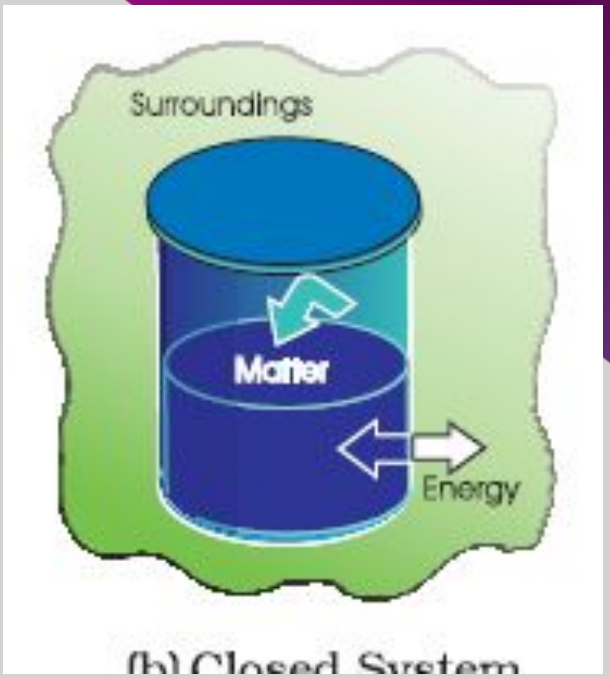
This system doesn't exchange energy or matter with the surroundings.



Universe is considered to be an isolated system

CLOSED SYSTEM

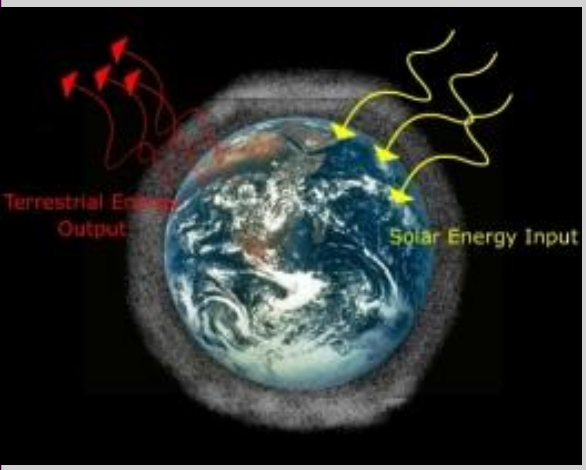
A system, that doesn't exchange matter but exchanges energy with the surroundings.

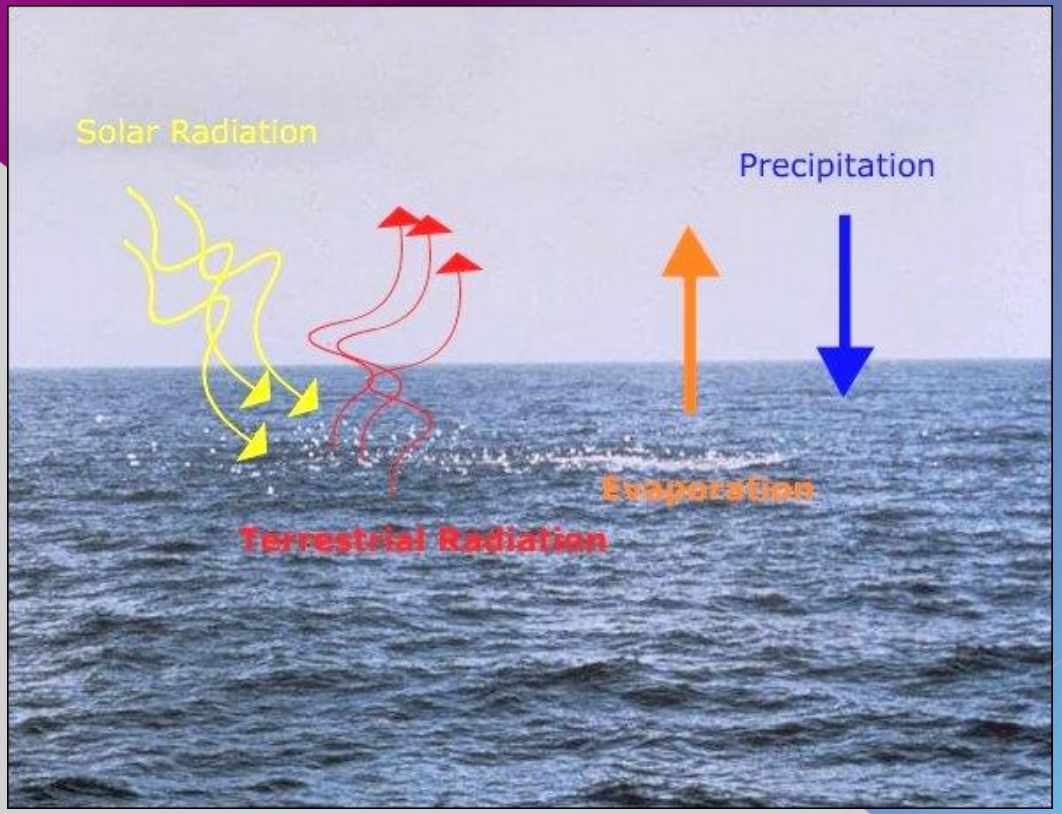


(b) Closed System

OPENED SYSTEM

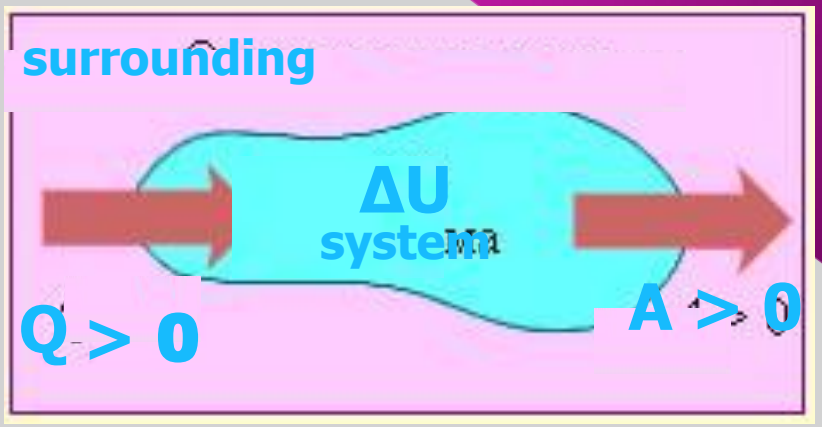
A system, that exchanges both matter and energy with surroundings.

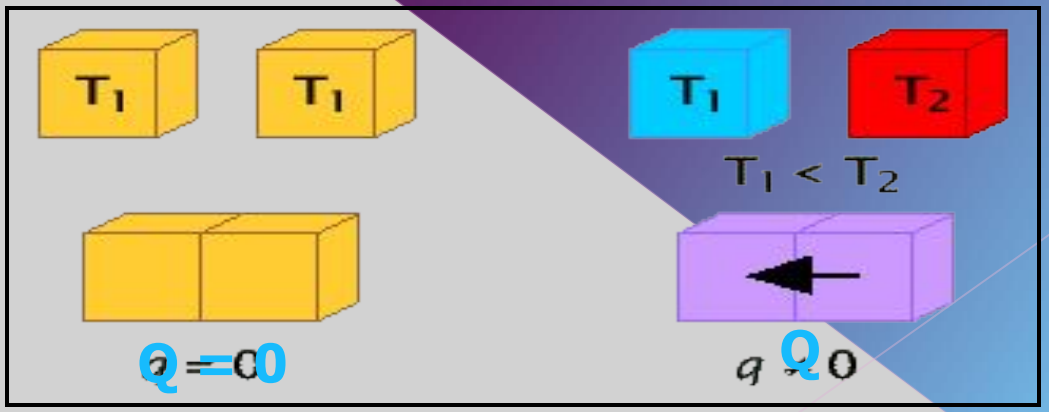




All living organisms are opened systems.

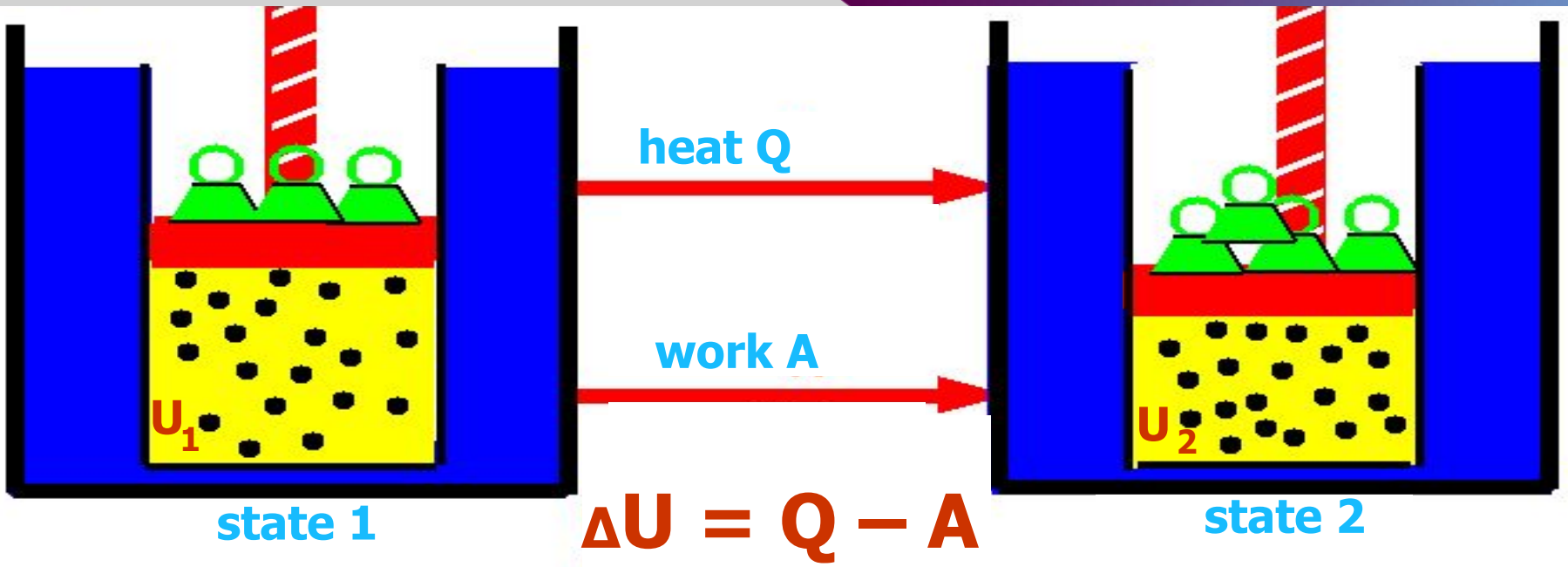
WORK & HEAT EXCHANGE



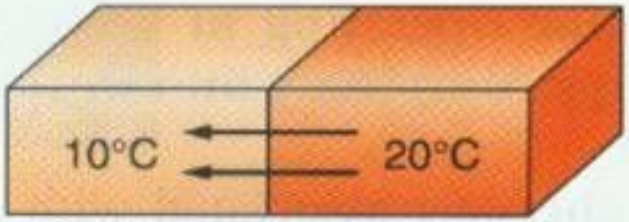


THE FIRST LAW OF THERMODYNAMICS

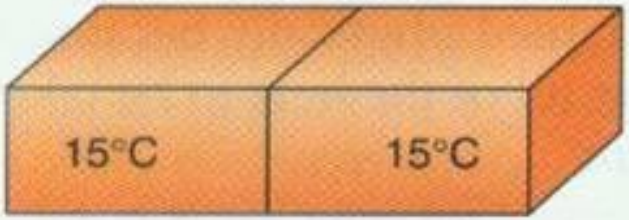
$\Delta U = Q - A.$



THE SECOND LAW OF THERMODYNAMICS



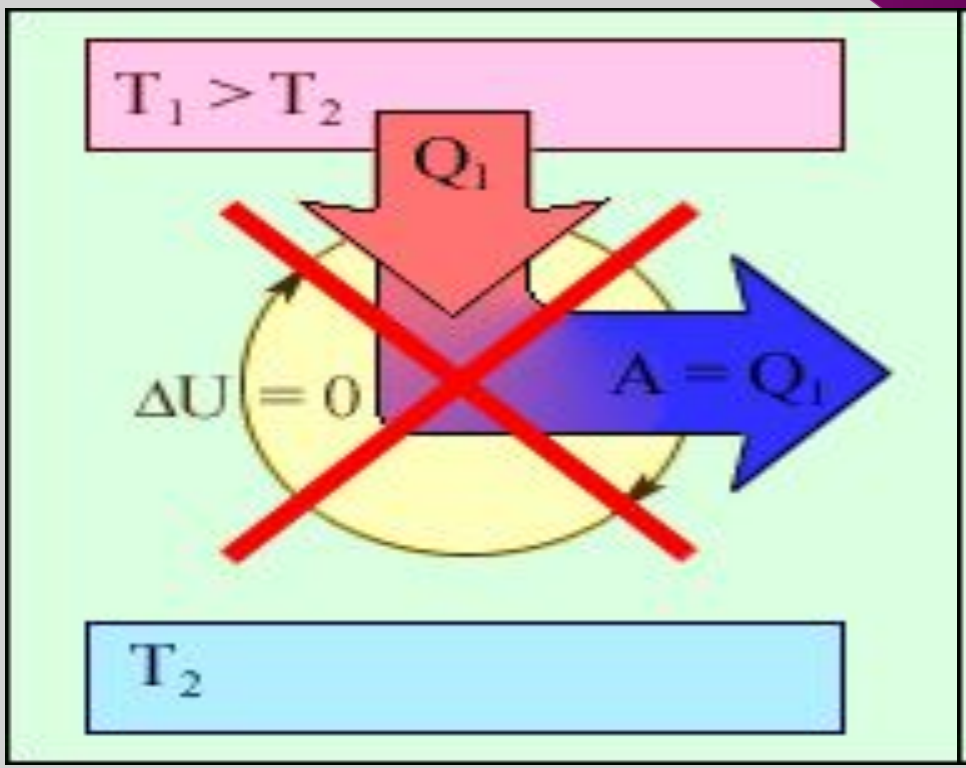
Heat flow direction

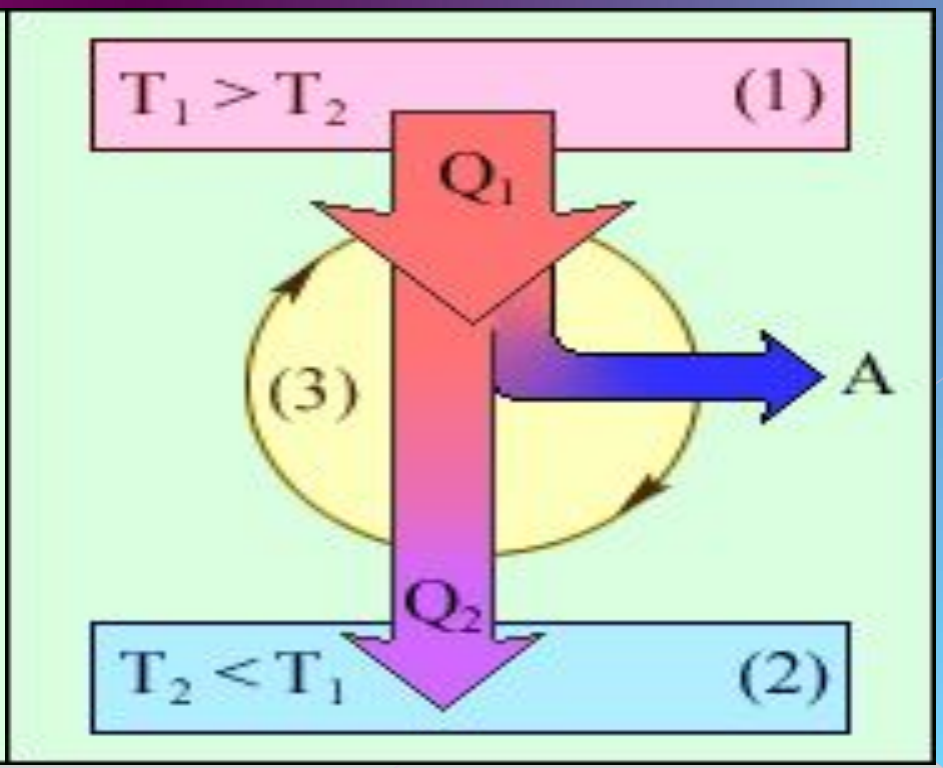


Heat equilibrium

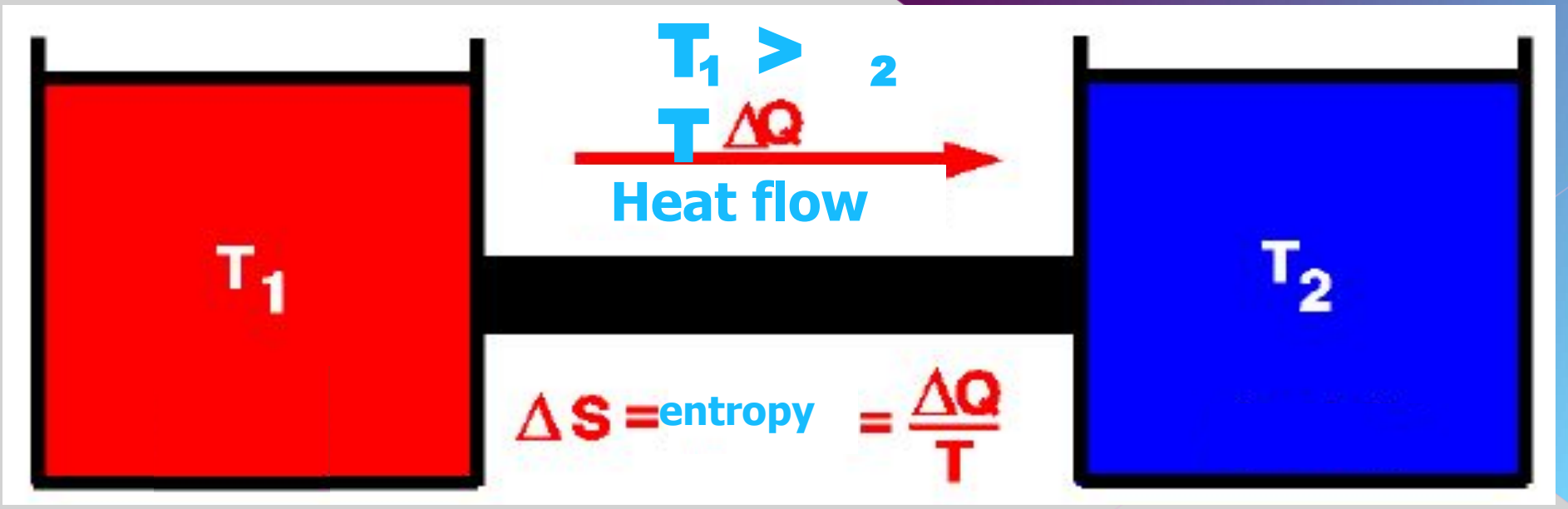
Impossible heat flow direction

IRREVERSIBILITY OF THERMAL PROCESSES

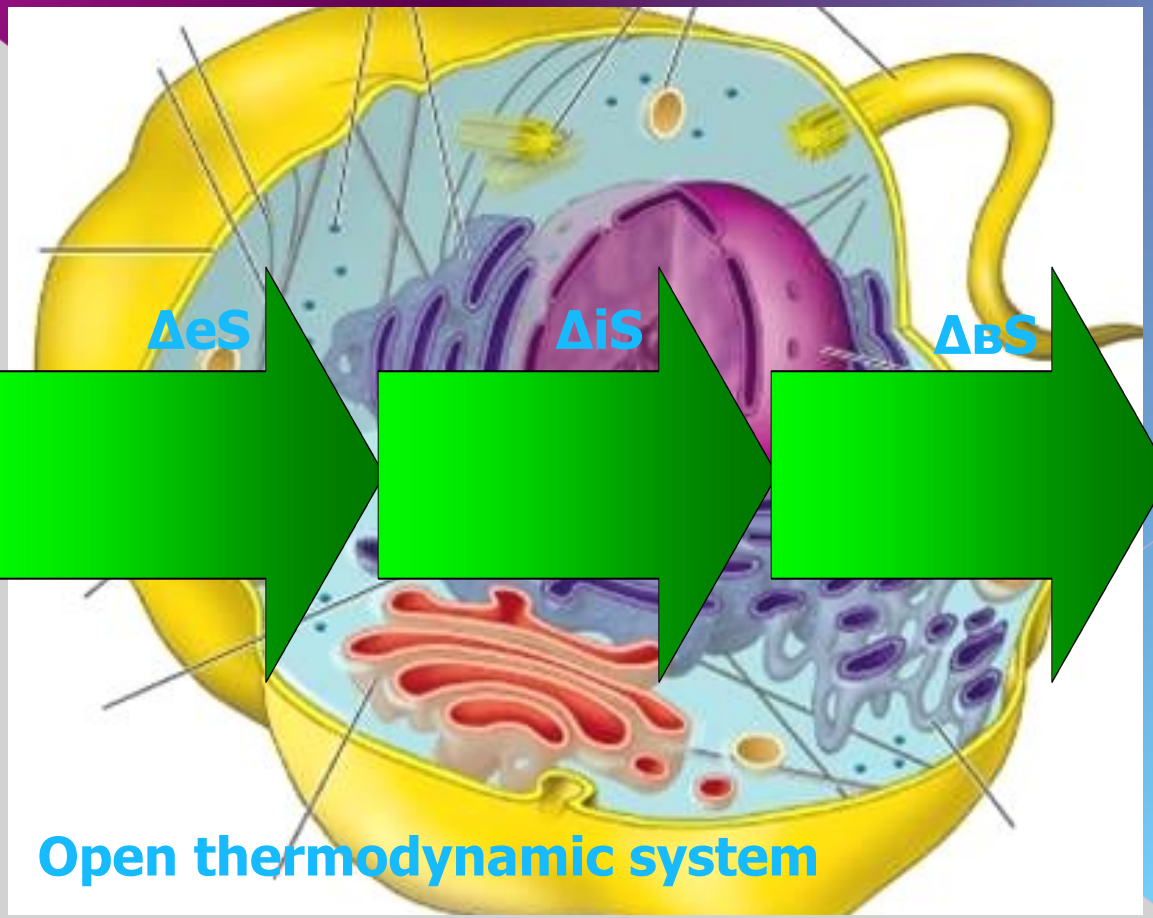




ENTROPY



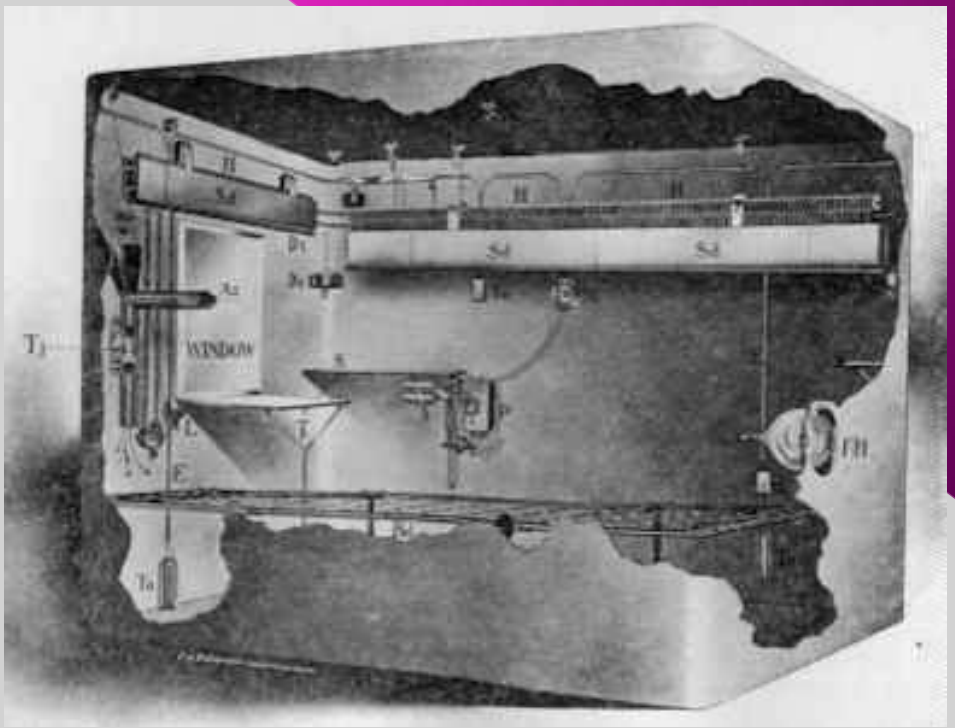
Prigogine state



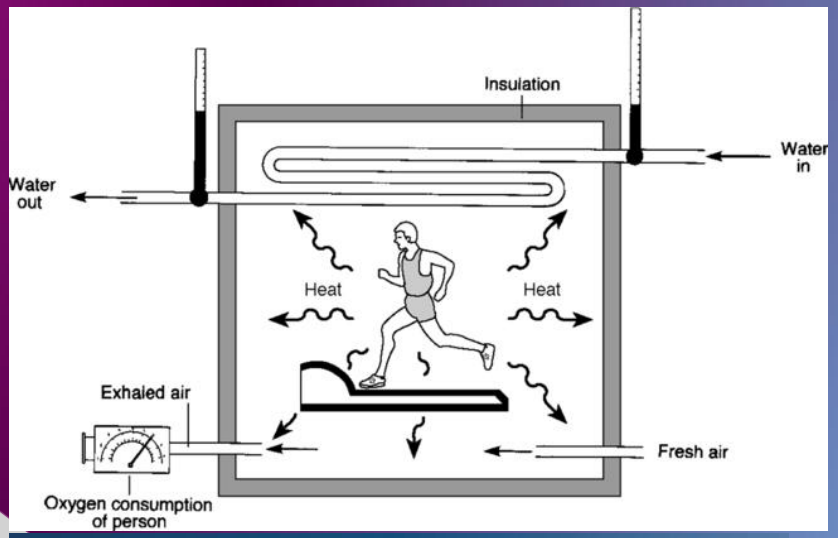
BIOCALORYMETRY

Biocalorymetry – is a measurement of the energetics of biological processes such as biochemical reactions, association of ligands to biological macromolecules, folding of proteins into their native conformations, phase transitions in biomembranes, and enzymatic reactions, among others.

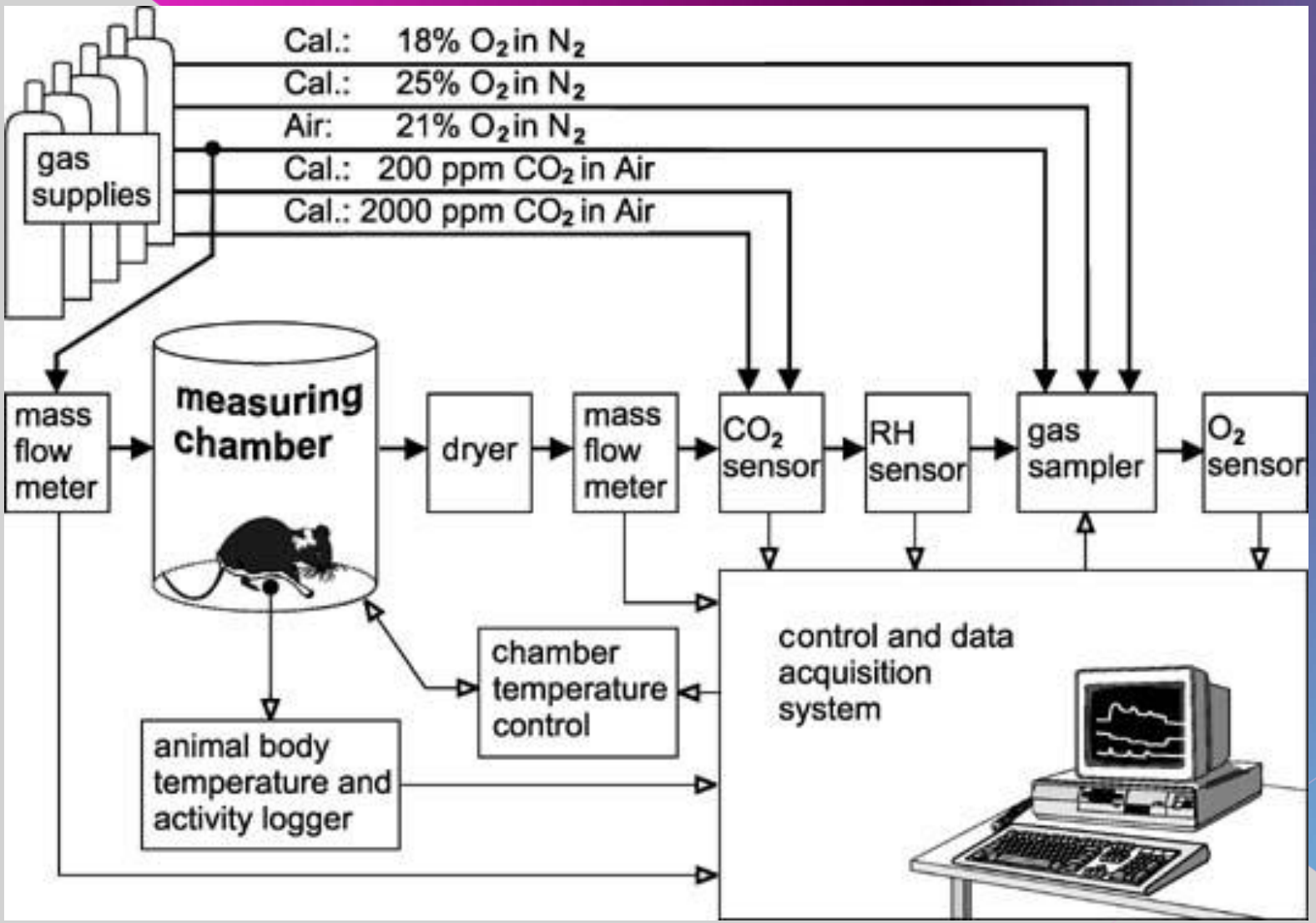
DIRECT BIOCALORYMETRY



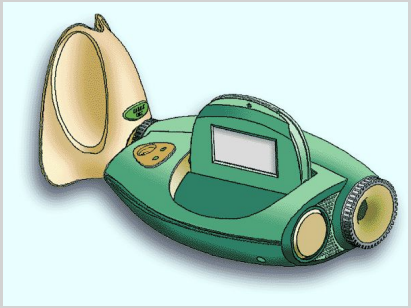
Inside the Atwater-Benedict human calorimeter.



DIRECT BIOCALORYMETRY



INDIRECT BIOCALORYMETRY



CALORIMETER

CRYOMEDICINE

CRYOSAUNA