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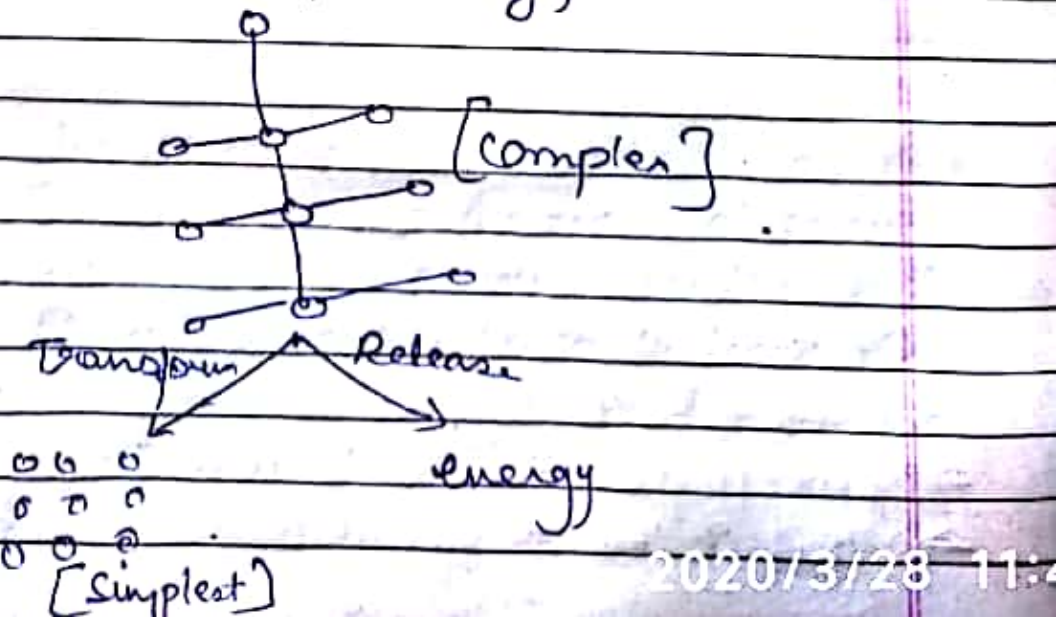
Bioenergetics

Bioenergetics is the part of biochemistry concerned with the energy involved in making and breaking of chemical bonds in the molecules found in the biological organisms. It can also be defined as the study of energy relationships and energy transformation and transduction in living organisms.

Metabolism → The chemical rxn taking place in the body is known as metabolic rxn. The chemical process in plants or animals that change food into energy and help them to grow is known as metabolism process. It is divided into two type :-

1) Catabolism → Catabolism process also known as [Destructive] exergonic process. In these catabolism complex molecule in living organisms convert into a simpler one together with the release of energy.



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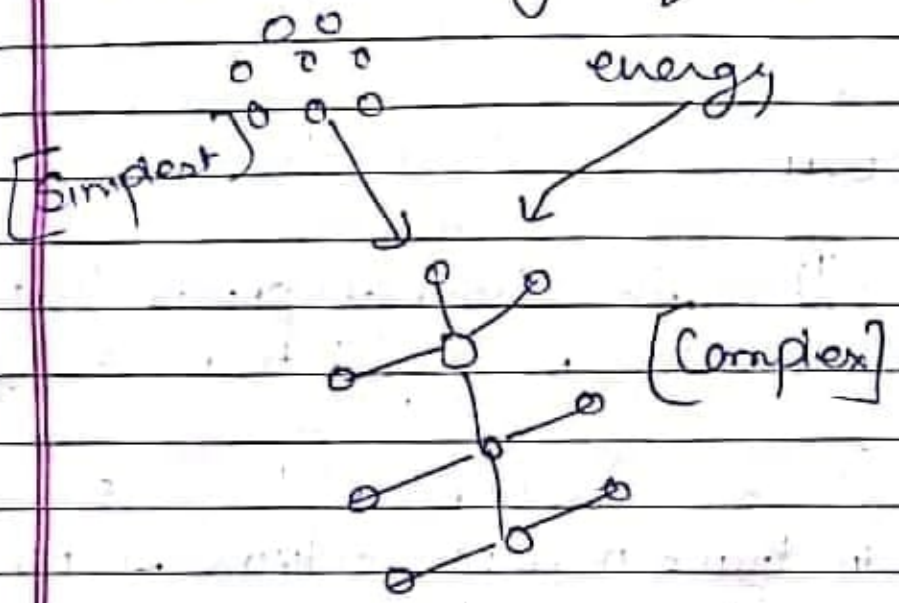
eg → The breakdown of complex fat molecules into fatty acid in the adipose tissue is an eg of catabolism process.

1) Anabolism → It is also known as endergonic process. Anabolism is the set of metabolic pathways that construct molecule from smaller units. These may requires energy



In our body or in living organisms first Catabolic pathways are needed to breakdown nutrients molecule from into small building block then these smaller molecule are then join together to make different bigger molecules called macromolecule.

Eg → Building of new cells in the living organism is an eg. of anabolic process. Another Eg is the growth of body parts such as bones and muscles.

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Bioenergetics

It is the study of energy flow within living system.

Energy → Capacity to perform work

Metabolism → Chemical Reaction in the body
Conversion of food to energy

Catabolism Anabolism

Metabolism → It is the chemical process that change food to energy and help them to grow.

Catabolism → (Exergonic) The breakdown of Complex molecules in living organism to form simpler ones together with the release of energy.
Eg → Break down of fat molecules into fatty acid.

Anabolism → (endergonic) → Anabolism is the set of metabolic pathways that Construct molecules from smaller units, these requires energy.

Thermodynamics →
⇒ Thermodynamics is a branch of science which deals with energy associated with different atoms, molecules and chemicals bonds.

Three Parts :-
① Systems

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(2) Surrounding
(3) enthalpy

1) System → Any solution / Solid part in which which molecules are there and some chemical reaction are happening.
Eg → Solution in a beaker
Air filled in a balloon

2) Surrounding → whatever is present in Surrounding a system.
Eg → Air present above the solution in beaker.

3) Enthalpy → (H) denoted
Heat Content of the System.
⇒ It is the energy stored in ~~er ere energy energy~~ every chemical bond in the molecules of the System.

There are 2 laws of Thermodynamics :-
(1) First law of Thermodynamics
(2) Second law of "

1) First law → Energy can neither be created nor be destroyed, but it can transform to another form.
It means that the amount of energy in the universe is constant.

2) Second law → The second law of thermodynamics states that the total entropy of an isolated system can ~~never~~ never decrease over time

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and is constant and only if all process are reversible. Isolated system spontaneously evolve towards thermodynamic equilibrium the state with maximum entropy.

→ The universe tends towards maximum disorder.

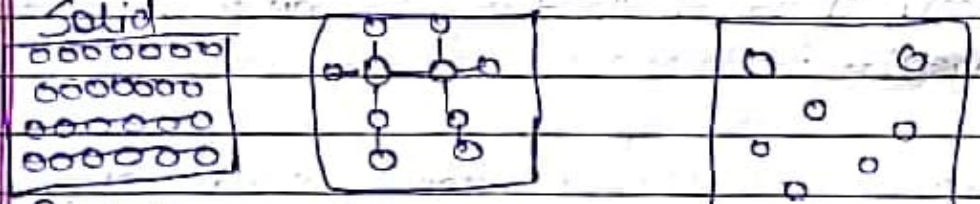
→ D is a spontaneous process.

Entropy → D is a thermodynamic property which provides a quantitative measure of the disorder of a given thermodynamic states.

→ ~~When entropy is more then disorder will be also more and vice versa.~~

→ "Where disorder is more Entropy is more"

→ "Where disorder is less Entropy is less"



Perfect lattice Structure less entropy

Higher entropy than Solid.

Higher entropy than Liquid.

* Where freeness is more entropy is more.

Gibbs free Energy

→ The gibbs free energy of a system is a measure of the amount of ~~was~~ the Usable energy that can do work.

Eg → example

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Relation between exothermic and endothermic reaction

→ Endothermic and exothermic are chemical reaction that absorb and release heat respectively

→ Many chemical reaction release energy in the form of heat light or sound, these are exothermic reactions. It occurs spontaneously

Eg of exothermic Process

① Condensation of rain from water vapour
② Mixing water and strong acids.

Eg of endothermic process

① Photosynthesis
② Melting ice.

Relationship between Gibbs free energy/enthalpy and entropy

→ 'G' is the Gibbs free energy which is equal to the total amount of energy capable of doing work during a process at constant temperature and pressure.

→ If ΔG is negative, then the process is spontaneous and termed as Exergonic.

→ If ΔG is positive, then the process is non-spontaneous and termed as Endergonic.

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→ If ΔG is equal to Zero, then the process has reached equilibrium.

→ 'H' the enthalpy which is the heat Content of the System.

→ When ΔH is negative the process produces heat and is termed as Exothermic.

→ When ΔH is positive the process absorbs heat is termed as Endothermic

→ S, the entropy is a quantitative expression of the degree of randomness of disorder of the System.

→ When ΔS is positive then the disorder of the system has increased.

→ When ΔS is negative then the disorder of the System has decreased.

→ The Conditions of biological System are Constant temperature and pressure. Under such conditions the relationship between the chem change in gibbs free energy, enthalpy and entropy can be described by the expression where T is the temperature of the System in kelvin.

$$\Delta G = \Delta H - T\Delta S$$

(Entropy)

Gibbs free energy (J/kJ) — Entropy — Temperature.

J → Joule

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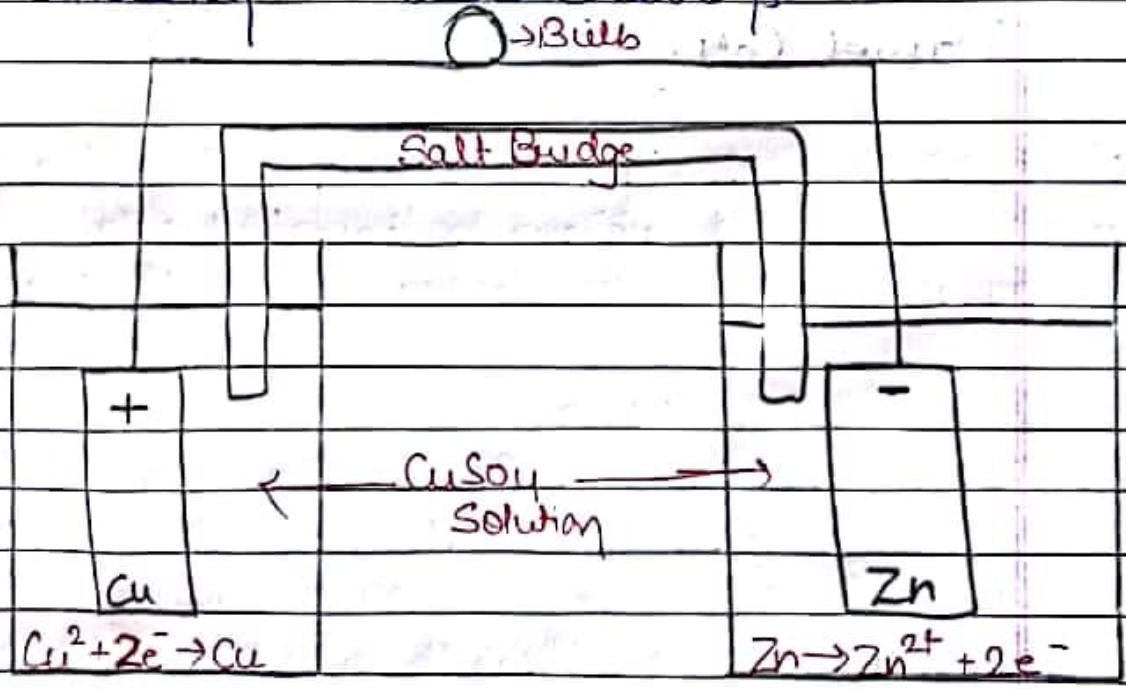
* Redox Potential →
Redox Potential also known as reduction/oxidation potential is a measure of the tendency of a chemical species to acquire electrons from a lose electrons to an electrode and thereby be reduced or oxidised respectively.

→ Redox Potential is measured in Volts (V) or millivolts.

→ Redox Potential is a Oxidation reduction reaction in which one compound is oxidised and the other compound is reduced.

→ The redox potential is used to describe a System overall reducing or oxidising capacity.

Reduction = Gain Electrons
Oxidation = losse Electrons



Daniel Cell

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⇒ For example, the redox reaction in which zinc displaces copper in an aqueous solution of copper sulphate.

$CuSO_4 + Zn \rightarrow ZnSO_4 + Cu$

In terms of electrons,

Reduction.

$Cu^{2+} + 2e^- \rightarrow Cu$

Oxidation.

$Zn \rightarrow Zn^{2+} + 2e^-$

→ These spontaneous reactions $\Delta G = -212.6\ kJ\ mol^{-1}$ would take place directly between the species if zinc metal were added to a vessel containing copper sulphate solution releasing heat. In electrochemical however these transfers takes places at separate electrodes releasing electrical energy such as the Daniel Cell.