⇒ Complexes are also called → coordination complex
or
Coordination Compounds.

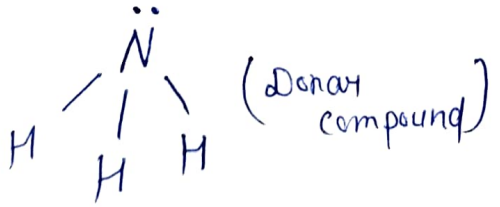
⇒ Complexation may be defined as ⇒ association of two or more species to form a complex

⇒ A coordination complex is the product of
↓
Lewis-acid-base reaction.
or
Dono-acceptor mechanism in which neutral molecules or ions → Ligands
↓
bond to a central metal atom or ions
↓
by coordinate covalent bonds.

Following intermolecular forces are involved in the formation of complexes-

→ Covalent bond
→ Hydrogen bond
→ Vander walls forces
→ Ion - dipole
→ dipole - dipole.
→ dipole - induced dipole

e.g. NH_3



(Donar compound)

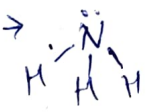
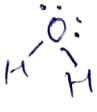
Classification :-

- Complexes
  - 1. Metal Ion Complexes
    - (i) Inorganic type
    - (ii) Chelates
    - (iii) Olefin type
    - (iv) Aromatic type
      - (a) Pi-complexes
      - (b) Sigma-complexes
      - (c) Sandwich compounds
  - 2. Organic Molecular Complexes
    - (i) Quinhydrone type
    - (ii) Picric acid type
    - (iii) Caffein and other drug complexes
    - (iv) Polymer type
  - Inclusion Compounds
    - (i) Channel lattice type
    - (ii) Layer type
    - (iii) Clathrates
    - (iv) Mono molecular type
    - (v) Macro molecular type.

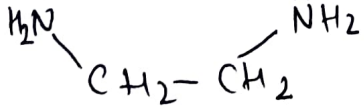
⇒ **Ligand** :- A ligand is an ion or molecule, which donates a pair of electrons to the central ~~atom~~ metal atom or ion to form a coordination complex.

Types-

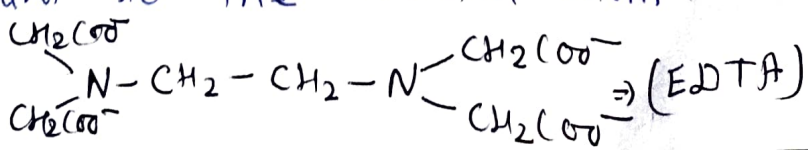
(1) **Monodentate** :- which provide only one centre for attachement to the central atom.

eg. $\ddot{N}H_3$ →  , H_2O_2 → 

(2) **Bidentate** :- which provide two centre for attachement to the central metal atom.

eg.  → Ethylenediamine

(3) **Polydentate** :- which provide ~~two~~ more than two centre for attachement to the central atom.

 ⇒ (EDTA)

Applications :-

① **Physical State** :- Physical state of substance can be changed. To convert liquid substances to solid complexes and improve its processing characteristics

② **Stability of drug** :- Stability of drugs can be enhanced by complexation.

③ **Solubility** :- Enhancement of solubility by using solid complexes.

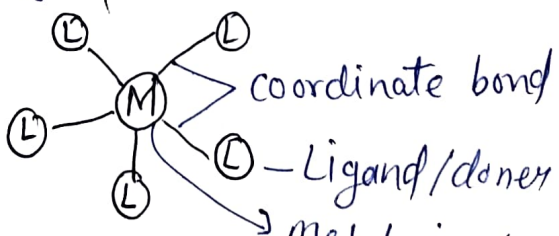
④ **Dissolution** :- Complexation enhances the solubility, thus, enhancing the dissolution of drugs.

⑤ **Absorption & Bioavailibility** :- Complexation helps in increasing the absorption and bioavailibility of drug in the body.

⑥ **Antidote in poisoning** :- Also reduced toxicity of poisons by making complex with metal poison. So, work as antidote.

1. Metal Ion Complexes → called as → Coordinate complex.

In this type, metal ion constitutes as central atom an interacts with ligands

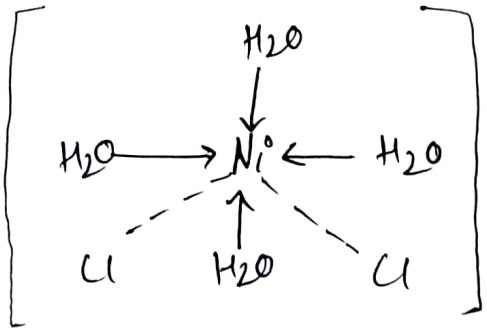


① **Inorganic type** :-

In this complex, ligand are inorganic in nature, which attached with metal atom.

eg. Ligand use → $\ddot{N}H_3$, $H_2\ddot{O}$:, & $C\equiv\ddot{N}$ (all are inorganic)

→ $[Ni(H_2O)_4]Cl_2 \longrightarrow 2Cl^- + [Ni(H_2O)_4]^{+2}$



1° Valency = Ionic bond = 2
2° Valency = Co-ordinate Bond = 4

→ Coordination number = maximum number of atom binding to the central atom.

C.N = 2+4 = 6

→ $[Co(NH_3)_6]^{3+}$, $(Fe(CN)_6)_4$ etc.

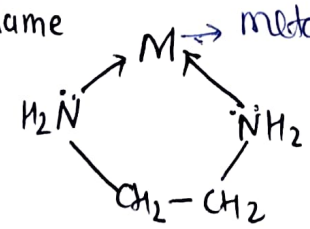
(ii) Chelates :- Substances having two or more donor groups form complex with the metal ion, that complex is known as chelate.

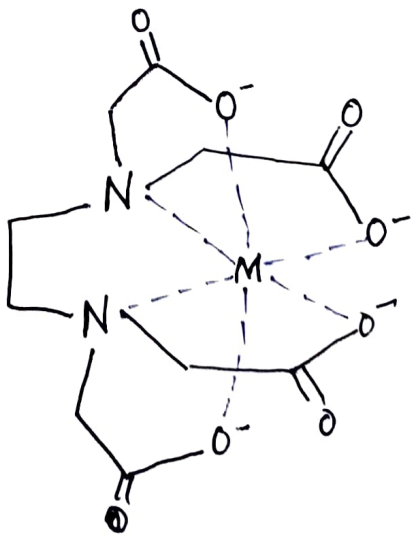
→ Bonds invalves may be → ionic, primary covalent or co-ordinate covalent bond

→ It is only perform in bidentate, tridentate and polydentate.

→ When metal ion attached with these ligands, it form cyclic structure.

→ Ethylenediame → metal ion ② EDTA.

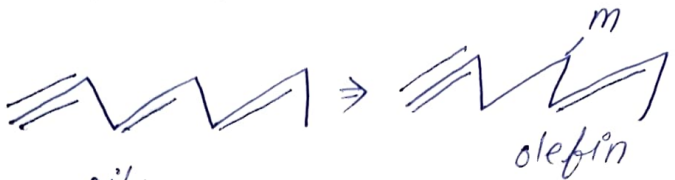




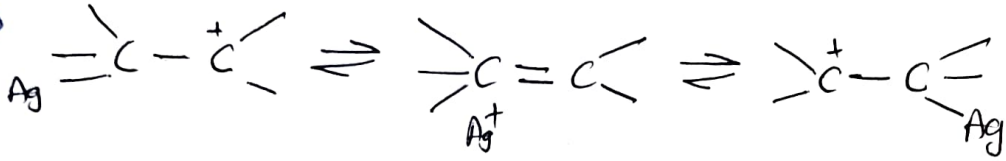
(iii) Olefin type :-

Aqueous solution of some metal ions like platinum, iron, palladium, mercury, silver absorb olefin such as ethylene to yield water soluble complexes.

⇒ A long chain of unsaturated hydrocarbon called oil on the basis of structure.



⇒

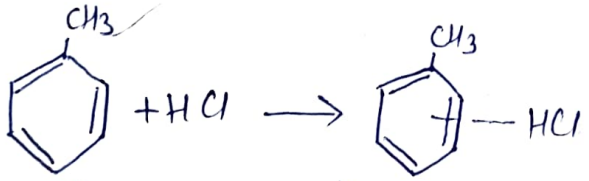


(iv) Aromatic type :-

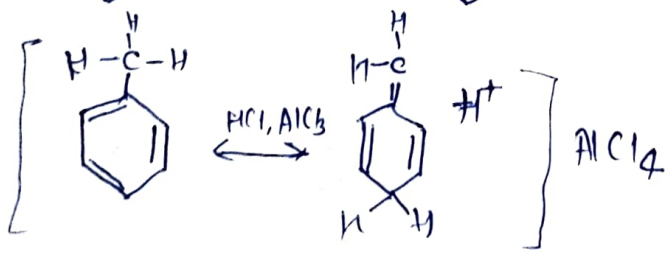
They are formed by intraction of metal ion as acceptors with aromatic molecules such as benzene, toluene & xylene.

- π bond
- σ bond
- Sandwich compounds

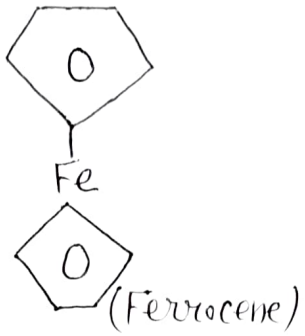
• π bond ⇒



• σ bond ⇒



• Sandwich Compound :- Sandwich compound are relatively stable complexes involving a delocalized covalent bond between the d-orbital of a transition metal and a molecular orbital of cromatic ring.



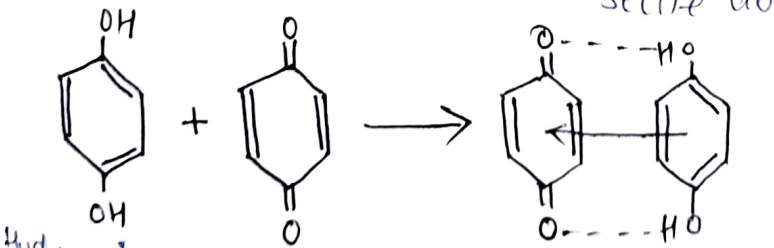
(Ferrocene)

2. Organic Molecular Complexes

Organic molecular complexes, also known as addition complexes are formed by union of two organic molecules held together by electrostatic forces, ionic, covalent and also by hydrogen bonded complexes.
also known as charge transfer complexes.

Quinhydrone Complexes :-

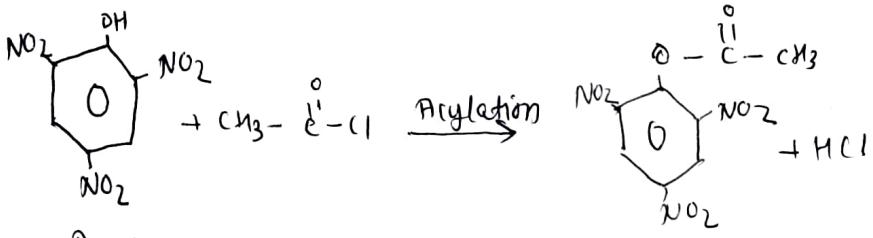
Formed by mixing → equimolar quantity of benzoquinone
→ Hydroquinone
↓
green crystals of quinhydrone complex settle down.



Hydroquinone Benzoquinone Quinhydrone

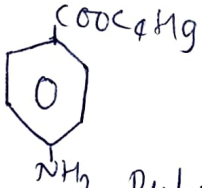
(ii) Picric Acid type :-

Picric acid (2,4,6-trinitrophenol), being a strong acid, forms organic molecular complexes with weak bases.



Picric acid

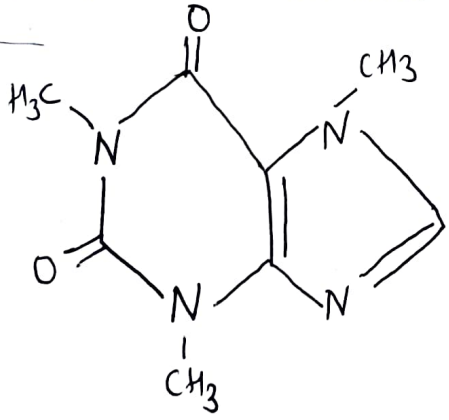
Ex



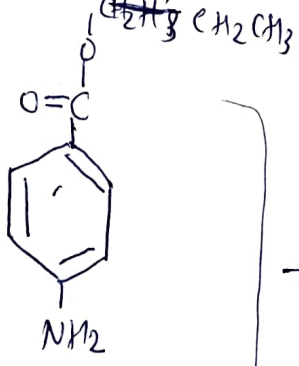
Butesin picrate → Used as local anaesthetic.

(iii) Caffein and other drug molecules :-

Caffein forms complexes with a number of drug such as benzocaine, tetracaine or procaine and this enhances the stability and appearance of pharmaceutical preparation of these drugs.



Caffein



Benzocaine

→ Caffein Complexes

(iv) Polymer type :-

Many pharmaceutical additives such as polyethylene glycols (PEGs), Polystyrene, Carboxymethyl cellulose (CMC). etc. -- can form complexes with a large number of drugs.

ex- $n(CH_2=CH_2) \xrightarrow[\text{polymerisation}]{h\nu} +(CH_2-CH_2-CH_2-CH_2-CH_2+$

ethene → Polythene

3. Inclusion Complexes

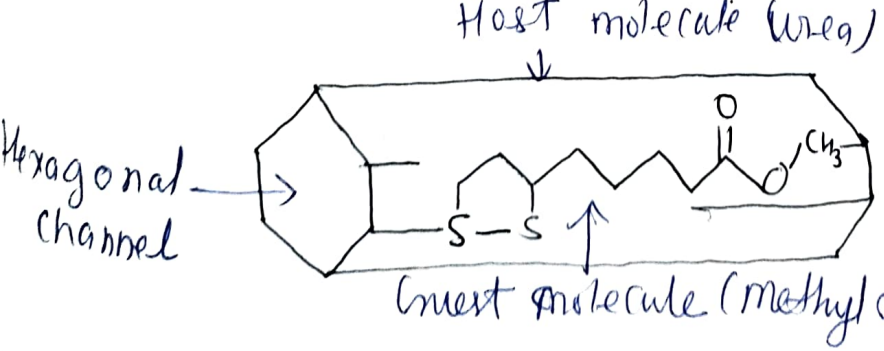
↳ Occulsion compound.

It can be considered as a host guest combination in which one compound (host) forms cavity in which other molecule of another compound (guest) fits.

* No involvement of any type of bond, so called no-bond complexes.

(i) Channel Lattice type :-

Channels are formed by crystallization of the host molecules in which the guest molecules can fit, the guest component is usually limited to long, unbranched straight chain compound.



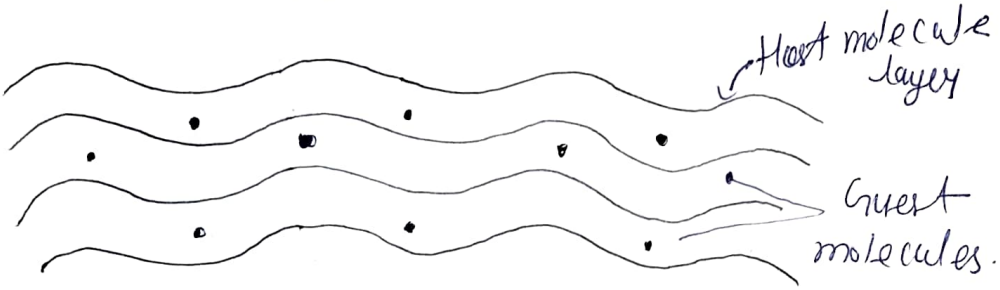
Host cell –
⇒ Iodine Soln.
Guest ⇒ Starch.

(i) Layer Type :-

In this type, Guest molecules is diffused between the layers of carbon atom, hexagonally oriented to form alternate layer of guest and host molecules.

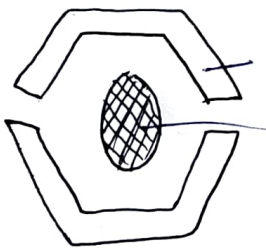
⇒ Bentonite intrapped in clay

eg Clays, Montmorillonite



(iii) Clathrates :-

Clathrates are inclusion compounds in which molecules of guest compound get entrapped within the cage like structure formed by the association of several molecules of host compounds.



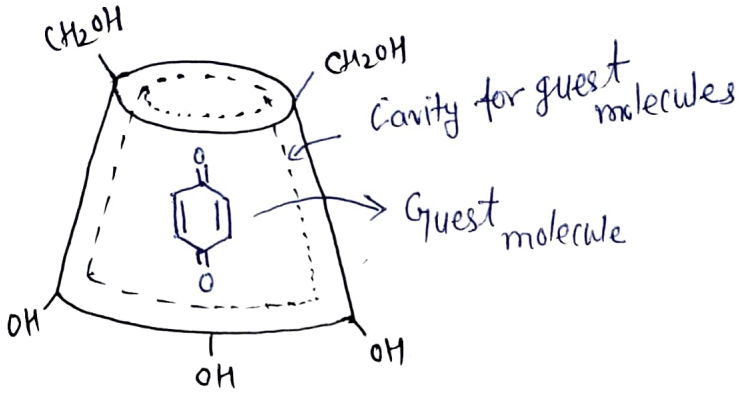
⇒ Iso propyl alcohol (guest)
⇒ Warfarmin Na (host)

. Hydroquinone in Benzoquinone

(iv) Monomolecular Compound :-

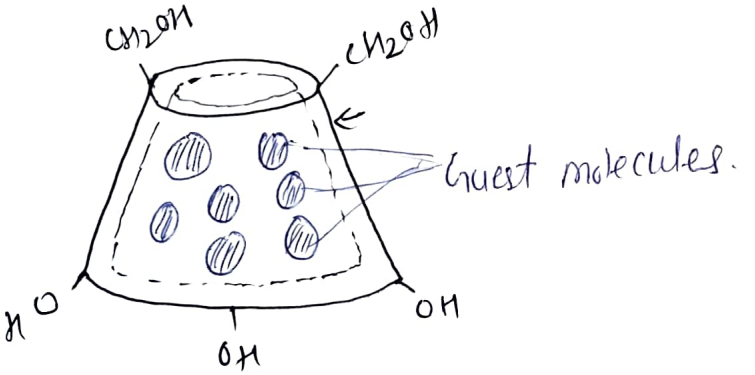
In this complexes, a single guest molecules is entrapped in the cavity of host molecules.

& Cyclodextrins → containing 6 D gluco-pyranose attached by α-1,4-linkages



⑤ Macromolecular Complexes:

In this complexes, more than one guest molecules is entrapped in the cavity of host molecules. eg. cyclodextrin as a host molecules.



Methods of Analysis of Complexation

After the complexation method, we find out have to know whether the complex is made or not?

for this, we use following method:-

① Continuous Variation Method
② pH titration method.
③ Distribution method
④ Solubility method
⑤ By spectroscopy.