**Table 1:** Hybridizations occurring in the *3d*- metal centres

| C.N. | Hybridization (orbitals used) | Geometry |
|---|---|---|
| 2 | ***sp*** ($4s$, $4p$) | Linear |
| 3 | ***sp²*** ($4s$, $4p^2$) | Trigonal-planar |
| 4 | ***sp³*** ($4s$, $4p^3$) | Tetrahedral |
| | ***dsp²*** ($3d_{x^2-y^2}$, $4s$, $4p_x$, $4p_y$) | Square- planar |
| 5 | ***dsp³*** ($d_{z^2}$, $4s$, $4p^3$) | Trigonal-bipyramidal |
| | ***sp³d*** ($4s$, $4p^3$, $4d_{x^2-y^2}$) | Square-pyramidal |
| 6 | ***d²sp³*** ($3d_{x^2-y^2}$, $3d_{z^2}$, $4s$, $4p^3$) | Octahedral (inner-orbital) |
| | ***sp³d²*** ($4s$, $4p^3$, $4d_{x^2-y^2}$, $4d_{z^2}$) | Octahedral (outer-orbital) |

Pauling made use of magnetic measurements to find out the number of unpaired electrons in a complex, which helped him to suggest the orbitals involved in the hybridization process.

The limitations of VBT are: it fails to explain the origin of color and magnetic properties of transition metal complexes. Thus, Crystal Field Theory (CFT) has become more powerful theory as it explains those two properties.

**Problems**

1. Using VBT, predict the hybridization of iron in $[Fe(H_2O)_6]^{2+}$ with $\mu_s$ = 4.9 BM.
2. Using VBT, predict the hybridization of Mn in $[MnBr_4]^{2-}$.
3. Using VBT, predict the hybridization of cobalt in $[Co(NH_3)_6]Cl_3$ if the magnetic moment is zero BM.
4. Show that all octahedral complexes of $Ni^{2+}$ are outer-orbital complexes.
5. Using VBT, predict the orbitals involved in the hybridization of the following.

   (a) $[FeF_6]^{3-}$ (b) $[Mn(CN)_6]^{3-}$ (c) $[Fe(CO)_5]$

Student Corner

# Opium Alkaloids

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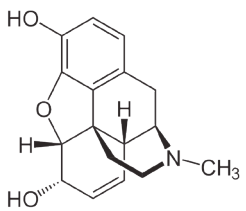
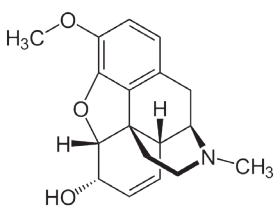
Alkaloids constitute a class of nitrogen containing organic compounds that possess significant pharmacological properties. They occur mainly in plants and to a lesser extent in microorganisms and animals. The name alkaloid or 'alkali-like' was first introduced by the German chemist Wilhemm Meissner in the early nineteenth century.

Opium poppy seed pod

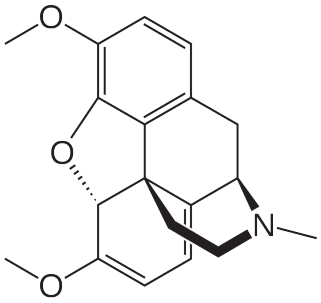
The study of alkaloids began in nineteenth century and the first alkaloid isolated in pure form was morphium by Friedrich Sertuner in 1805. This compound is commonly known as morphine and it is found in opium poppies. Opium is the dried milky exudate obtained from the unripe seed capsules of the opium poppy, Papaver somniferum. Opium has traditionally been smoked for pleasure, but it can also be used as an analgesic, sleep inducer and for treatment of coughs. However habitual users develop a craving for the drug as an addiction.




Morphine

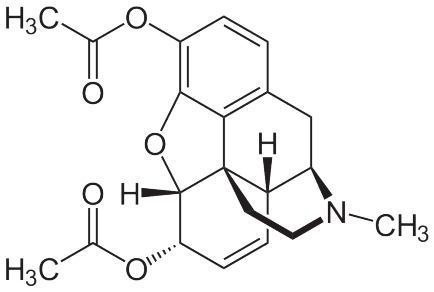



Codein



Thebaine

The principal opium alkaloids are morphine, codeine and thebaine. Morphine is a powerful analgesic and narcotic. Monoacetate ester of morphine is known as codeine and it produces morphine like analgesic effects. Thebaine differs structurally from morphine and codeine due to the presence of a conjugated diene ring system and it is used as a substrate in the semi-synthesis of other drugs. Diacetate of morphine is known as heroin and it is a highly addictive analgesic than morphine.



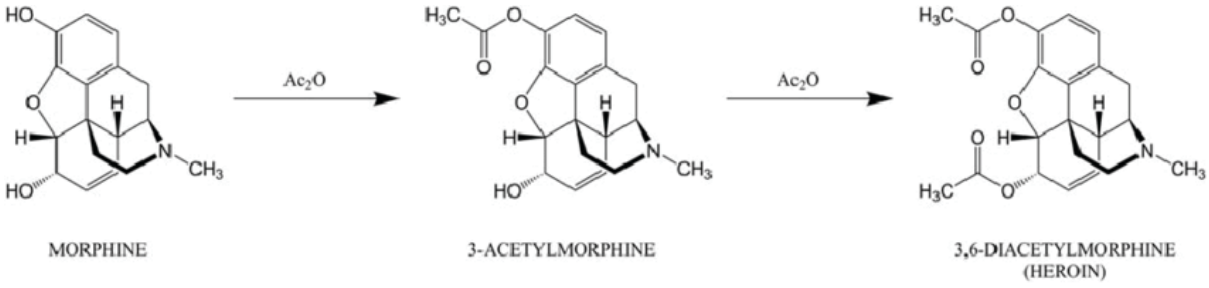
heroin

Is it possible to chemically synthesize heroin from morphine?

Yes. Heroin can be synthesized by treating morphine with acetyl chloride or acetyl anhydride. This is a simple reaction and yields are generally quantitative.

**References:**


1. Alkaloids: chemical and Biological Perspectives, S.W. Pelletier
2. Drugs of Natural Origin, Gunner Samuelson


MORPHINE 3-ACETYLMORPHINE 3,6-DIACETYLMORPHINE (HEROIN)