



Siderophores

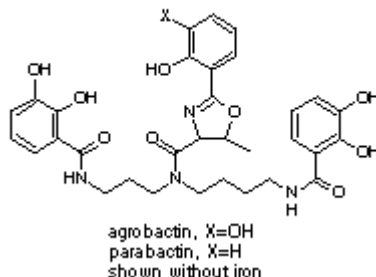
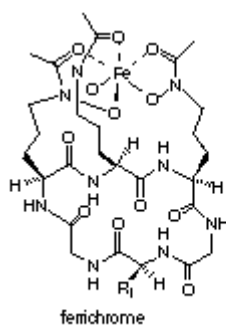
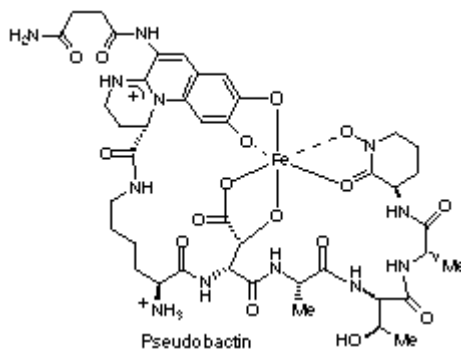
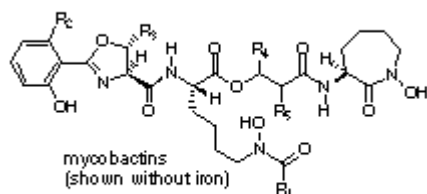
Siderophores (microbial iron chelators)

Although iron is one of the most abundant elements, its pivotal role in the evolution of life on earth depended on the development of effective methods for its assimilation. Ionic forms of iron, especially iron(III), its most common state, are very insoluble under physiological conditions. To circumvent the solubility problem, many microbes, plants and even higher organisms synthesize and utilize very specific low molecular weight iron chelators called siderophores grown under iron deficient conditions, many microbes will synthesize and excrete siderophores in excess of their own dry cell weight to sequester and solubilize iron.

A Siderophore (Greek for iron carrier) is an iron chelating compound secreted by microorganisms. Iron Fe^{3+} ions have a very low solubility at neutral pH and therefore cannot be utilized by organisms. Siderophores dissolve these ions by chelation as soluble Fe^{3+} complexes that can be taken up by active transport mechanisms. Many siderophores are nonribosomal peptides. To obtain iron from such minerals, cells produce iron-binding siderophores that bind iron and transport it into the cell. One major group of siderophores consists of derivatives of hydroxamic acid, which chelate ferric iron very strongly.

Examples of siderophores produced by various bacteria and fungi are ferrichrome (*Ustilago sphaerogena*), enterobactin (*Escherichia coli*), mycobactin (*Mycobacterium*), enterobactin and bacillibactin (*Bacillus subtilis*), ferrioxamine B (*Streptomyces pilosus*), fusarinine C (*Fusarium roseum*), yersiniabactin (*Yersinia pestis*), vibriobactin (*Vibrio cholerae*), azotobactin (*Azotobacter vinelandii*), pseudobactin (*Pseudomonas B 10*), erythroactin (*Saccharopolyspora erythroa*) or ornibactin (*Burkholderia cepacia*).

Representative Siderophores:





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Like all aerobic bacteria, pseudomonads need to take up iron via the secretion of siderophores which complex iron (III) with high affinity. Much progress has been made in the elucidation of siderophore-mediated high-affinity iron uptake by *Pseudomonas*, especially in the case of the opportunistic pathogen, *P. aeruginosa*. Fluorescent pseudomonads produce the high-affinity peptidic siderophore pyoverdine, but also, in many cases, a second siderophore of lesser affinity for iron. Some of the genes for the biosynthesis and uptake of these siderophores have been identified and the functions of the encoded proteins known. Iron uptake via siderophores is regulated at several levels, via the general iron-sensitive repressor Fur (Ferric Uptake Regulator), via extracytoplasmic sigma factors/anti-sigma factors or via other regulators. Since pseudomonads are ubiquitous microorganisms, it is not surprising to find in their genome a large number of genes encoding receptors for the uptake of heterologous ferrisiderophores or heme reflecting their great adaptability to diverse iron sources.