



Titanium, Mineral & Chemicals

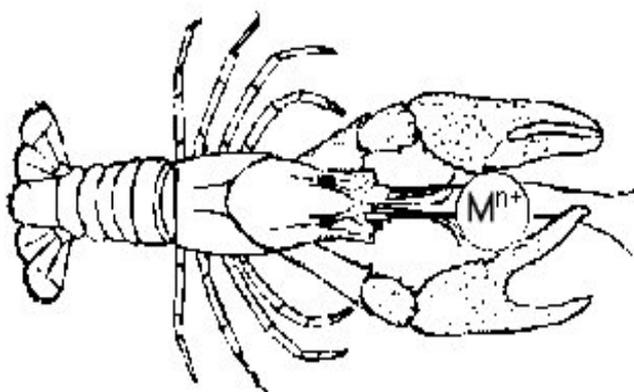
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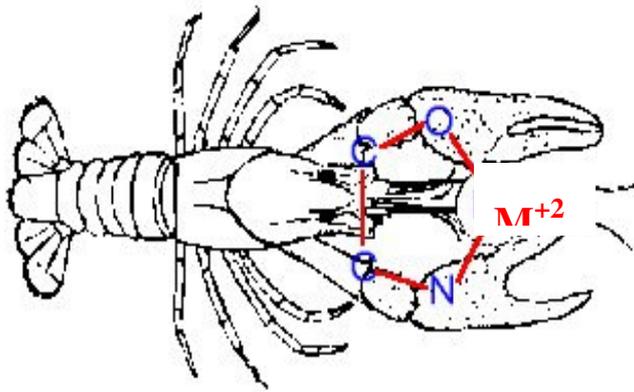
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Chelation

A simple amino acid anion is a potential bidentate ligand which may coordinate to a transition metal ion through the amino lone pair of electrons and the carboxylate oxygen lone pair of electrons. Amino acids which possess a side chain containing a potentially coordinating atom (N, O, or S) may act as tridentate ligands. Species which can coordinate to one metal ion with two or more atoms simultaneously are called *chelates*. The origin of this term is described below.

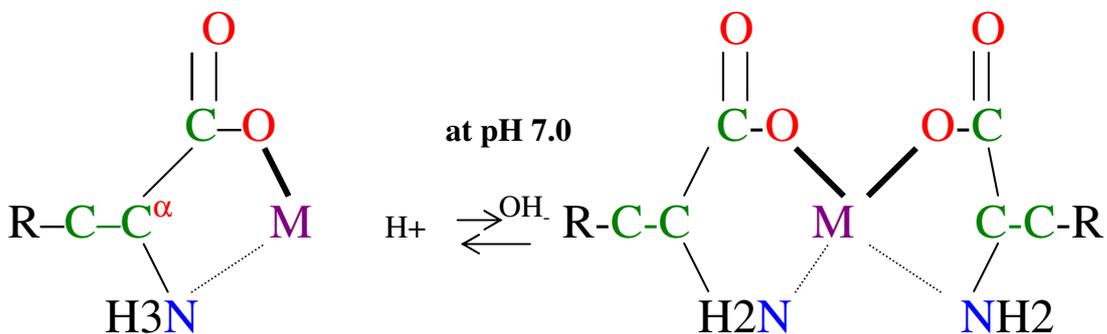


two or more nuclei that are good potential chelate ligands. The term was first applied in 1920 by Sir George N. Lewis and H.D.K. Drew [Morgan, 1920]. He stated: "The adjective chelate, from the great claw or chela (*Greek*: lobster or other crustaceans, is the caliper-like groups which act as associating units and fasten to the central atom so as to produce heterocyclic rings." This term is generic for all ligands which have at least two atoms coordinated to the central metal ion. The terms *bidentate*, *tridentate*, *etc.*, describe specifically ligands which have *two*, *three*, *etc.*, coordinating atoms. The angle described by the (chelate atom - metal cation - chelate atom) trio is called the *bite angle*. The lobster Figure was found on the [coordination chemistry](#) material prepared by Dr. R.J. Lancashire in the [Chemistry Department](#) of the [Mona Campus of the University of the West Indies](#).

M^{+2} 

o acid can act as a bidentate ligand, forming a five-membered heterocyclic chelate ring with metal cations. In this Figure, one oxygen atom is shown as one of the carboxylate oxygen atoms; and the nitrogen atom is the amino group. The carboxylic group coordinates *only* when it is in its ionized state, $-\text{COO}^-$. (I.e., it does not coordinate when it is in its neutral state, $-\text{COOH}$.) The amino nitrogen coordinates only when it has a lone pair of electrons, as it does in the $-\text{NH}_2$ state. (I.e., it cannot coordinate when the amino group of the amino acid is in its protonated state, $-\text{NH}_3^+$.) Note also that the carbon atom of the carboxylic acid group is part of the ring, as is the alpha-carbon atom of the amino acid. A beta-amino acid, such as beta-alanine, would form a six-membered heterocyclic ring with a metal cation.

The Figure above indicates that an *alpha*-amino acid forms a five-member chelate ring with a transition metal cation. A *beta*-amino acid would form a six-member chelate ring. As has been observed for organic compounds, five- and six-membered rings are especially stable. The coordination properties of transition metal cations allow for more than one amino acid anion to coordinate, as discussed in the next section.



Binding Sites

1. N-terminal NH_2^+ group

2. **C-terminal COO⁻ group**