Nucleobases.
Their Acid-Base and Metal Ion-Binding Properties

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The biological importance of interactions between metal ions and nucleosides, nucleotides or nucleic acids is now generally accepted and the predominant tautomeric structures of the common nucleobase residues are established. However, by measuring the acidity constant of 7-methylguanosine and the application of micro acidity constants, it can be shown that the zwitterionic species of the guanosine residue, which carries a proton at N7 and a negative charge at N1, occurs with a ratio of 1:80000 compared with the dominating, neutral, uncharged guanosine moiety (1). Similarly, the imino form of adenosine is present in aqueous solution in a ratio of 1:100000 (1,2). These minority tautomeric forms are expected to be crucial in mutations.

Different metal ions coordinated to a given site, e.g., N7 of a guanine residue (which is exposed in the major groove of DNA), lead to different acidifications at the (N1)H unit; the effect decreases in the series Cu(II) > Ni(II) > Pt(II) ~ Pd(II) (2,3). By micro-acidity-constant considerations one may prove that the acidifications in purines are reciprocal and identical; e.g., Pt(II) coordinated to $(N1)^-$ of a guanine residue acidifies the $(N7)H^+$ unit to the same extent as (N7)-coordinated Pt(II) acidifies the (N1)H site (3). Regarding pyrimidines one obtains evidence based on stability-constant comparisons that in aqueous solution N3 of cytidine binds innersphere and (C2)O outersphere to Cu^{2+}, Zn^{2+} and Cd^{2+}, whereas the reverse appears to be true for Mg^{2+} and Ca^{2+}, but in both instances so-called 6-membered semichelates result which are in equilibrium with further differently structured isomers (4). Similar isomeric equilibria are observed for M^{2+} complexes of (N3)H-deprotonated uridine (5). Furthermore, one may suggest that Mg(II), Ca(II) or Mn(II) coordination to (C2)O and/or (C4)O of an uridine residue acidifies (N3)H such that deprotonation becomes possible in the physiological pH range (5).

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