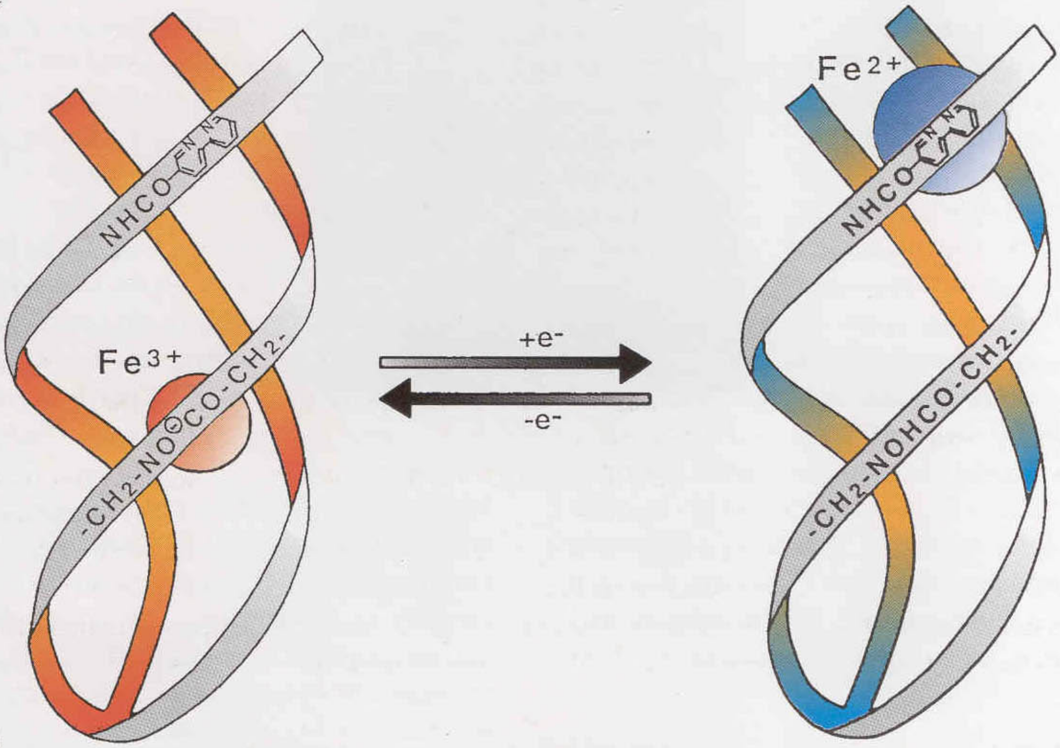
RESEARCH NOTES: Molecular Switches

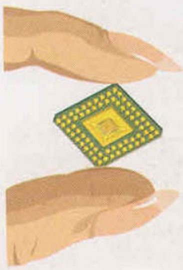
Computer chips now contain millions of tiny electronic switches and other devices only a millionth of a meter or so wide. Yet scientists are already dreaming of molecule-sized switches only a billionth of a meter (nm) or so wide. ISF grantee, Prof. Abraham Shanzer of the Weizmann Institute of Science has taken an important first step toward this goal by creating two such "switches," one of which responds to reducing or oxidizing (redox) chemicals and the other of which responds to hydrogen ions (protons).

Both switches are triple-stranded helical structures, with upper and lower "pockets" than can both accommodate a metal guest ion. For example, one redox switch has hydroxamate groups lining its lower, "hard" binding pocket (see figure); these can bind an iron (III) ion to form a light brown complex. The bipyridyl groups lining the upper, "soft" binding pocket bind iron (II) ions to form a deep purple colored complex. Thus changing the oxidation state of the iron ion triggers the switch, moving the ion up or down and changing the color of the complex (something that, via a photocell and filter, can trigger a real macroscopic electronic switch). The process is completely reversible. Other redox switches show major changes in chirality, the ability to change the polarization of light.



The proton switch has a "high pH" binding site lined with hydroxamates and a "low pH" binding site lined with N-hydroxyl succinimides. A single iron III ion shuttles back and forth between the two sites as the pH changes. A shift from pH 4.5 to 8.8 is optimal and shifts the wavelength of the complex ultraviolet absorption maximum from 470 to 424 nm.

The families of molecular switches studied to date are versatile, tunable and can form monolayers on conducting surfaces, important to eventually coupling them directly to the outside world. Most are still quite slow, with switching times of 15-45 seconds, but this is expected to improve as the field develops. These results were recently reported in the prestigious international scientific journal *Nature*.



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