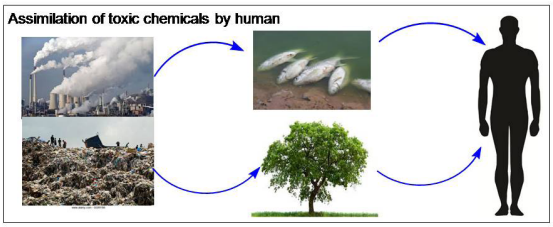
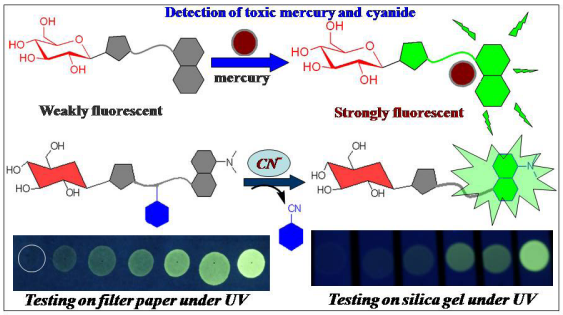
Detection of mercury/cyanide poisoning





Due to wide spread industrialisation, the environment is always challenged with the discharge of large number of chemical species, some of which are dangerous and toxic to human health. Among these, mercury and cyanide are two important ions having deleterious effect on human health. For example, cyanide compounds (like HCN, CNCl, NaCN, and KCN) are discharged into the environment due to the increased utility of these in many chemical processes (such as electroplating, plastics manufacturing, tanning, and metallurgy) to an extent of 900-1000 tons/year. These can easily pass through the gastrointestinal tract and affect the hypoxia and lactate acidosis and thereby disturb the central nervous system functioning causing respiratory arrest and death. Similarly, pollution by mercury and its compounds which are being discharged into the environment to a tune of 5000-8000 tons/year equally dangerous and pose serious threat to human health. A number of molecular probe based sensors reported in literature for sensing CN suffer from low water solubility, low sensitivity, higher detection limit and non-selectivity, besides being 'fluorescence turn-off' in nature. All this led us to explore the design of a receptor molecule containing a glyco-moiety for aqueous solubility and biological compatibility, a reaction center or a binding core and a fluorophore. While Hg^{2+} brings fluorescence changes through binding, CN brings such changes through nucleophilic reactivity. The changes in the molecular design imparted selectivity to the sensor in both the cases.

Our group has synthesised glycoconjugates and demonstrated their sensitivity and selectivity in the medium of buffer, in presence of blood serum and on test strips. In the buffer medium, the conjugate exhibited selective chromogenic as well as fluorogenic properties towards Hg^{2+} by showing 75-fold higher fluorescence emission intensity even in the presence of 13 other cations, to a minimum detection limit of 254 ppb. Hg^{2+} was also detected and quantified on the conjugate coated disposable test strips under UV lamp by switch-on fluorescence in the concentration range of 5-60 mM of Hg^{2+} even in presence of blood serum. The glycoconjugate design was further optimised in order to suit the same for detecting and quantifying CN with ~125-fold fluorescence enhancement to a lowest detection limit of 6±1 ppb, even in the presence of other anions. This technique was upgraded to work on test strips based on cellulose paper and silica gel film. This development is suitable to detect mercury or cyanide poisoning in biological fluids and/or tissue exposed to these chemicals and can be extended to high-throughput needs.

Prof. C. P. Rao, Department of Chemistry, cprao@iitb.ac.in