Two types of dinuclear copper(II) and nickel(II) complexes with two tetradeutate N$_2$O$_2$ donor ligands 1,4-bis(1-anthranoylhydrazonoethyl)benzene (L$^1$), 1,4-bis(1-salicyloylhydrazonoethyl)benzene (L$^2$) and N,N'-bidentate heterocyclic base [1,10-phenanthroline (phen)] have been synthesized and characterized by elemental analysis, infrared spectra, UV–vis electronic absorption spectra and magnetic susceptibility measurements. The reaction of metal(II) acetates with the solution containing ligand and 1,10-phenanthroline in methanol gives mixed-ligand dinuclear metal(II) complexes with general formula [M$_2$L(phen)$_2$]Cl$_2$ (L = L$^1$ or L$^2$), whereas, the ligands react with metal(II) acetates to form polymeric dinuclear complexes with general formula [(M$_2$L$_2$)$_n$] (L = L$^1$ or L$^2$). In the complexes, the ligands act as dianionic tetradentate and coordination takes place in the enol tautomeric form with the enolic oxygen and azomethine nitrogen atoms while the phenolic hydroxyl and amino groups of aroylhydrazone moiety do not participate in coordination. The effect of varying pH and solvent on the absorption behavior of both ligands and complexes has been investigated.