Vertebrate haemoglobin (Hb) is often discussed using a simple two-state model of allostery, in which one structure has high oxygen affinity and one has low oxygen affinity. While the simplicity of the model is attractive, and a great deal of physiological data can be explained with it, there are many things that this model does not explain, and in some cases even very old results. As early as the 1960s, it was realised by some that a structural change is not required for allostery, but that a vibrational change can bring about very significant effects on the ability of a protein to bind a ligand. This idea disappeared from view for decades, but has gradually regained recognition. For many years, human HbA has dominated not just the study of oxygen transport, but allostery in general. However, there are many regulatory features of Hbs from other species that provide more stringent tests of the two-state model, such as the extreme pH responses of some fish Hbs. In this talk I will discuss how some of these animal Hbs, and attempts to find drugs targeting Hb, have allowed us to move outside the text-book model.