In this doctoral thesis we study novel analogues based on R06 aptamers and targeting TAR hairpins of the HIV virus by means of surface plasmon resonance biosensor, which allows for sensitive and real-time monitoring of molecular interactions. We investigate seven different modifications placed at nine different positions on the R06 aptamer in order to find out their applicability in the construction of efficient and stable anti-TAR oligonucleotides. We also determine which positions are suitable for substitutions with a modification and interpret the results in the context of the local nucleotide geometries and interactions in the TAR/anti-TAR complex. In this doctoral thesis we further develop a new fluidic system. This fluidic system eliminates sample dispersion and intermixing effects and thus enables accurate monitoring of molecular interactions on the surface of an SPR chip. We also characterize experimental conditions on the surface of an oligonucleotide chip and their relations towards bio-molecular assays. Specifically, we study the shielding effect of monovalent and divalent cations, which are crucial for the interaction of negatively charged oligonucleotides.