Fluorescence-based detection methods are advantageous because of their high sensitivity, rapidity and simplicity. Furthermore, various fluorescent materials and sensing mechanisms can be used in the rational design of these methods, which also demonstrate the versatility of such methods to be tailored to detect various targets with high sensitivity and selectivity. In this dissertation, we looked into the design and development of two organic PET-based probes and one FRET-based probe for the detection of a first-line antibiotic, vancomycin, and an important neurotransmitter, epinephrine, respectively.