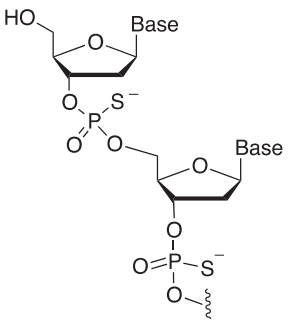
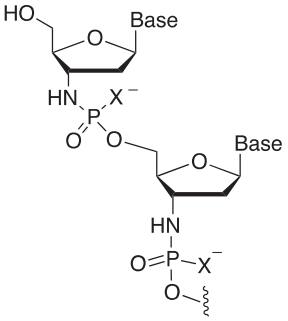
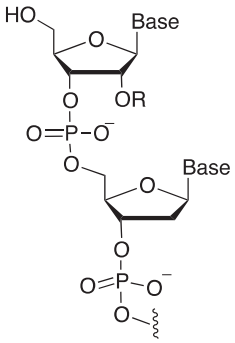


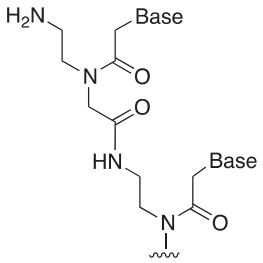
Phosphorothioates (**12.1**)



X = O Phosphoroamidates (**12.2**)
X = S Phosphorothioamidates (**12.3**)



12.4 R = CH_3
12.5 R = CH_3-O-$(CH_2)_2$



Peptide nucleic acids (**12.6**)

No antisense oligonucleotide cancer drugs have been approved to date, but several clinical trials with ASOs against different targets for different cancer types have been performed. Representative examples are summarized in Table 12.2, including many that have been mentioned previously. Here, two additional examples are studied. First, GTI-2040, which is directed against the ribonucleotide reductase M2 gene (*RRM2*) that encodes the reductase that catalyzes the formation of deoxyribonucleotides from ribonucleotides. It entered phase I/II trials in combination with docetaxel and prednisone for the treatment of patients with castration-resistant prostate cancer (CRPC).[115] Second, the GD2-targeted stabilized immunoliposome LR/INX-3001, developed for CML,[115] which contains an oligonucleotide that suppresses the expression of the c-Myb protein[116] and inhibits cell growth.[117] The disialoganglioside GD2 is an antigen found on malignant cells and is an attractive target for immunoliposomal therapy of tumors of neuroectodermal origin, and the c-Myb protein is a proto-oncogene that functions as a downstream target of PDGF-mediated survival signal.[118] Antisense nucleotide delivery from stabilized immunoliposomes with cell surface-directed antibodies is a way to overcome their low cellular uptake.