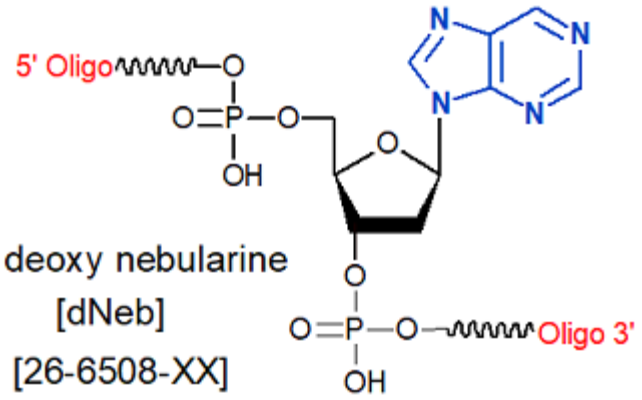
Oligo Modifications

Nebularine deoxy

Category	Duplex Stability
Modification Code	dNeb
Reference Catalog Number	26-6508
5 Prime	Y
3 Prime	Y
Internal	Y
Molecular Weight(mw)	298.19



Click here for a complete list of Degenerate Bases & Spiking Oligo Modifications

The design of primers is frequently complicated by the degeneracy of the genetic code. Three strategies are now available to confront this problem. In the first, a mixed base addition (N) is used to form the degenerate site. This approach is best if the number of degenerate sites is small. A second option is the use of 2'-deoxyInosine or 2'-deoxyNebularine which exhibit low, but unequal, hydrogen bonding to the other four bases. The third option is the use of a universal nucleoside. In this strategy, the base analog does not hybridize significantly to the other four bases and makes up some of the duplex destabilization by acting as an intercalating agent. 3-Nitropyrrole 2'-deoxynucleoside (M) is the first example of a set of universal bases. Subsequently, 5-nitroindole was determined to be an effective universal base and to be superior to 3-nitropyrrole, based on duplex melting experiments. The modified bases designated P and K show considerable promise as degenerate bases. The pyrimidine derivative P, when introduced into oligonucleotides, base pairs with either A or G, while the purine derivative K base pairs with either C or T. A dP+dK mix also can serve as a mixed base with much less degeneracy than dA+dC+dG+dT (N).

5-Nitroindole is a hydrophobic aromatic compound, and can be used as a **universal base analog** in oligonucleotides. The term "universal base" refers to a base with the ability to replace any of the four natural bases without significantly destabilizing either neighboring base-pair interactions or disrupting the expected functional capability of the resulting modified oligonucleotide. Incorporation of universal bases into oligos is desirable in cases when either imprecise or random base-pairing is required, and the resulting "mis-matched" complements need to be stable. Examples of such situations include reverse-translation of known protein sequence for oligo design (oligos to be used as primers or probes), development of an *in vitro* or *in vivo* oligo probe able to hybridize to related but distinct genes (for example, viral sub-strains or allelic variants--SNPs, indels, etc.), *in vitro* mutagenesis and motif cloning.

5-Nitroindole does not discriminate between the four natural nucleotide bases in duplex formation.

This is in contrast to deoxyinosine (dI), which, although often used as a "universal" base, actually shows fairly strong base-pair bias. 5-Nitroindole's lack of discrimination ("universality") is a consequence of the fact that it does not form hydrogen bonds with natural bases. Instead, 5-nitroindole stabilizes the duplex via base-stacking interactions, and is superior in this regard than 3-nitropyrrole, which also has been used as a universal base (1,2). Much research work on 5-nitroindole has focused on its potential as an alternative to the used of mixed bases in PCR or Sanger sequencing primers. The ability of 5-nitroindole to function in this way, however, is strongly dependent on where it is located in the primer. Based on the results of several research studies (reviewed in 3), the following guidelines may be useful in optimizing the utility of this base analog for these applications: 1. Substitution of 5-nitroindole as a universal base is less destabilizing towards the ends of oligos than towards the center. 2. Grouped substitutions are more easily tolerated than spaced ones, that is, contiguous rather than codon third substitutions. 3. If **more than two codon third substitutions** are incorporated into a PCR/sequencing primer, priming generally is poor. 4. Up to four contiguous substitutions in the middle or 5'-end of a PCR/sequencing primer generally yield acceptable amounts of PCR product or sequencing ladder. Above that priming is poor, due to the run of 5-nitroindoles forming undesirable secondary structures in the primer. 5. Substitutions at, or within eight bases of, the 3'-end produce primers that generally are ineffective at priming.

Beyond primers, nested sets of universal oligonucleotide probes containing 5-nitroindole have been successfully used to target regions of rRNA in a variety of microorganism species, in order to ensure equal probe specificity in all target organisms (4). 5-nitroindole has also been used to examine protein-DNA interactions relevant to nucleotide excision repair (NER) (5) and RNA polymerase binding (6). In addition, the potential of 5-nitroindole to enhance the stability of duplexes formed between a target DNA and octa-/decanucleotide probes immobilized on DNA microarrays has been investigated (7). Finally, 5-nitroindole often has been used to stabilize DNA structures of different types (3). **References**

1. Van Aerschot,A., Peeters,B. and Van Derhaeghe,H. (1987) Hybridisation probes with deoxyinosine, deoxyxanthosine or deoxynebularine at ambiguous codon positions. Nucleoside and Nucleotides (1987) 6, 437–439.
2. Loakes, D.; Brown, D.M. 5-Nitroindole as a universal base analogue. *Nucleic Acids Res.* (1994), **22**: 4039-4043.
3. Loakes, D.; Hill, F.; Brown, D.M.; Salisbury, S.A. Stability and structure of DNA oligonucleotides containing non-specific base analogues. *J. Mol. Biol.* (1997), **270**: 426-435.
4. Loakes, D. The applications of universal DNA base analogues.*Nucleic Acids Res.* (2001), **29**: 2437-2447.
5. Zheng, D.; Raskin, L. Quantification of *Methanosaeta* species in anaerobic bioreactors using genus- and species-specific hybridization probes. *Microb. Ecol.* (2000), **39**: 246-262.
6. Buschta-Hedayat, N.; Buterin, T.; Hess, M.T.; Missura, M.; Naegeli, H.Recognition of non-hybridizing base pairs during nucleotide excision repair of DNA. *Proc. Natl Acad. Sci. USA* (1999), **96**: 6090-6095. 7. Matlock, D.L.; Heyduk, T. Sequence determinants for the recognition of the fork junction DNA containing the -10 region of promoter DNA by E. coli *RNA* polymerase *Biochemistry* (2000), **39**: 12274-12283. 8. Parinov, S.; Barsky, V.; Yershov, G.; Kirillov, E.; Timofeev, E.; Belgovskiy, A.; Mirzabekov, A. DNA sequencing by hybridization to microchip octa- and decanucleotides extended by stacked pentanucleotides. *Nucleic Acids Resl.* (1996), **24**: 2998-3004.