Stable Isotope-Labeled Nucleotide Triphosphates and DNA Phosphoramidites

NMR spectroscopy is an extremely powerful and versatile tool for studying the dynamics and structure of RNA and DNA molecules in solution.

The types of information gained from NMR studies of RNA and DNA include[1]:

- Base-pairing pattern
- Conformational equilibria
- Site-specific information regarding ligand binding
- Delineation of secondary structure motifs, such as hairpins and bulges
- Local structure and dynamics
- Global structure derived from RDCs

RNA Triphosphates

The most popular approaches to produce labeled RNA molecules for NMR studies use enzymatic *in vitro* transcription methods that employ labeled rNTPs, T7-RNA polymerase and either linearized plasmids or double-stranded DNA as templates. These techniques are used to construct labeled RNA molecules of which all of one type of nucleotide is labeled.

UNIFORMLY D LABELED	Perdeuterated NTPs can be used in combination with protonated NTPs to create RNA molecules in which specific types of nucleotides are protonated, thus allowing spectral editing without the significant signal broadening associated with ^{13}C incorporation.[2]
Catalog No.	**Description**
DLM-7514-CA	Adenosine 5′-triphosphate, ammonium salt (D, 97%+)
DLM-7515-CA	Cytidine 5′-triphosphate, ammonium salt (D_8, 97%+)
DLM-7516-CA	Guanosine 5′-triphosphate, ammonium salt (D, 97%+)
DLM-7517-CA	Uridine 5′-triphosphate, ammonium salt (D_8, 97%+)
DLM-7518-CA	Set of four ribonucleoside -5′-triphosphates, ammonium salt (D, 97%+)
	Note: All products are in solution and have a chemical purity >90%
SELECTIVELY DEUTERATED	Because severe signal degeneracy has hampered NMR studies of larger RNAs, key researchers in this area have utilized selectively deuterated rNTPs, in conjunction with *in vitro* synthesis methods, to reduce spectral complexity, spectral line-widths, and for observing NOEs over larger distances.[2]
DLM-7862	Equimolar Mix: ATP, GTP (ribose-3′,4′,5′,5′-D_4,98%); CTP, UTP (5-D_1, ribose-3′,4′,5′,5′-D_4,98%)
DLM-8594	Cytidine 5′-triphosphate (cytosine-5-D, 6-H; ribose-1,2,3,4,5,5-D_6, 96-97%)
DLM-8637	Uridine 5′-triphosphate (uracil-5-D, 6-H; ribose-1,2,3,4,5,5-D_6, 96-97%)
UNIFORMLY ^{15}N LABELED	
NLM-3987-CA	Adenosine 5′-triphosphate, ammonium salt ($^{15}N_5$, 98-99%)
NLM-4266-CA	Cytidine 5′-triphosphate, ammonium salt ($^{15}N_3$, 98-99%)
NLM-4268-CA	Guanosine 5′-triphosphate, ammonium salt ($^{15}N_5$, 98-99%)
NLM-4270-CA	Uridine 5′-Triphosphate, ammonium salt ($^{15}N_2$, 98-99%)
NLM-8772-CA	Set of four ribonucleotide 5′-triphosphates, ammonium salt (^{15}N, 98-99%)
	Note: All products are in solution and have a chemical purity >90%
UNIFORMLY ^{13}C, ^{15}N LABELED	
CNLM-4265-CA	Adenosine 5′-triphosphate, ammonium salt (^{13}C, ^{15}N, 98-99%)
CNLM-4267-CA	Cytidine 5′-triphosphate, ammonium salt (^{13}C, ^{15}N, 98-99%)
CNLM-4269-CA	Guanosine 5′-triphosphate, ammonium salt (^{13}C, ^{15}N, 98-99%)
CNLM-4271-CA	Uridine 5′-triphosphate, ammonium salt (^{13}C, ^{15}N, 98-99%)
CNLM-7503-CA	Set of four ribonucleoside 5′-triphosphates, ammonium salt (^{13}C, ^{15}N, 98-99%)
	Note: All products are in solution and have a chemical purity >90%

DNA Triphosphates

Labeled DNA oligonucleotides are routinely synthesized using enzymatic *in vitro* methods that require labeled dNTPs, a DNA polymerase, and a cDNA template. One particular advantage of using enzymatic methods over synthetic chemistry methods is that large oligonucleotides (e.g., >50 nucleotides in length) can be easily prepared in milligram quantities.

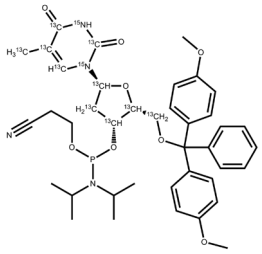
UNIFORMLY D LABELED	**(D, 97% + Enrichment)**
Catalog No.	**Description**
DLM-7507	2-Deoxyadenosine 5′-triphosphate
DLM-7508	2-Deoxycytidine 5′-triphosphate
DLM-7509	2-Deoxyguanosine 5′- triphosphate
DLM-7510	Thymidine 5′-triphosphate
DLM-7511	Set of four deoxyribonucleoside 5′-triphosophates
UNIFORMLY ^{15}N LABELED	**(^{15}N, 96-99% Enrichment)**
NLM-6215	2′-Deoxyadenonsine 5′-triphosphate
NLM-6216	2′-Deoxycytidine 5′-triphosphate
NLM-6217	2′-Deoxyguanosine 5′-triphosphate
NLM-6218	Thymidine 5′-triphosphate
NLM-7512	Set of four 2′-deoxyribonucleoside-5′-triphosphate

Catalog No.	Description
UNIFORMLY ^{13}C, ^{15}N LABELED	**(^{13}C, 98%; ^{15}N, 98%)**
CNLM-6219	2′-Deoxyadenosine 5′-triphosphate
CNLM-6220	2′-Deoxycytidine 5′-triphosphate
CNLM-6221	2′-Deoxyguanosine 5′-triphosphate
CNLM-6222	Thymidine 5′-triphosphate
CNLM-7513	Set of four 2′-deoxyribonucleoside 5′-triphosphate

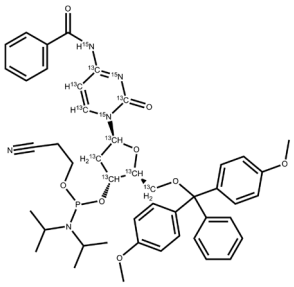
DNA Phosphoramidites

Position-specific labeled DNA molecules can be synthesized using standard phosphoramidite chemistry to overcome the limited chemical-shift dispersion of DNA, as well as to obtain residue-specific functional, structural, and dynamic information.

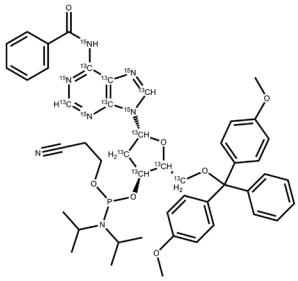
UNIFORMLY ^{15}N LABELED	**(^{15}N, 98%)**
Catalog No.	**Description**
NLM-6829	2′-Deoxyadenosine phosphoramidite
NLM-6827	2′-Deoxycytidine phosphoramidite
NLM-6826	2′-Deoxyguanosine phosphoramidite
NLM-6823	Thymidine phosphoramidite
UNIFORMLY ^{13}C, ^{15}N LABELED	**(^{13}C, 98%; ^{15}N, 98%)**
CNLM-6828	2′-Deoxyadenosine phosphoramidite
CNLM-6830	2′-Deoxycytidine phosphoramidite
CNLM-6825	2′-Deoxyguanosine phosphoramidite
CNLM-6824	Thymidine phosphoramidite



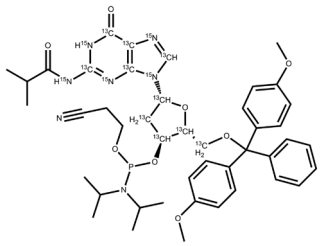
CNLM-6824
Thymidine phosphoramidite



CNLM-6830
2′-Deoxycytidine phosphoramidite



CNLM-6828
2′-Deoxyadenosine phosphoramidite



CNLM-6825
2′-Deoxyguanosine phosphoramidite

References

1. Furtig, B; Richter, C; Wohnert, J; Schwalbe, H. **2003**. NMR Spectroscopy of RNA. *Chembiochem, 4(10);* 936-962.
2. Lu, K; Miyazaki, Y; Summers, M. **2010**. Isotope Labeling Strategies for NMR Studies of RNA. *J Biomol NMR, 46(1);* 113-125.

Top 10 Reasons to Use Ammonium Salts

- Self-buffering (pH ~7.6)
- "Soft cation"
- Nucleotides of ammonium salts are active with polymerases, synthetases, and phosphatases
- Volatile counter-ion
- The ammonium cation can be easily exchanged using DOWEX cation exchange resin
- The pH does not change during drying of the nucleotide (i.e., "speed-vac," lyophilize)
- Stoichiometry between the counter-ion and the nucleotide is preserved
- Routinely compatible in down-stream syntheses
- Compatible in a variety of down-stream chromatography applications
- Tested to be comparable in side-by-side *in vitro* transcription reactions

CIL is proud to offer RNA and DNA products manufactured by or in conjunction with Cassia, LLC.

CASSIA, LLC
Nucleotides for the masses...

Cassia LLC was founded in 2005 by Dr. Lincoln Scott and noted NMR spectroscopist Dr. Jamie Williamson. CIL and Cassia have a special relationship which makes use of CIL's isotopic material production and marketing and Cassia's special knowledge of RNA and DNA biosynthesis. Since 2005, CIL and Cassia have developed the most extensive product line of stable isotope-labeled RNA and DNA triphosphates, DNA phosphoramidites and other related compounds. All of these products are routinely available for immediate shipment from stock at CIL.

For more information on any labeled RNA or DNA products, please contact your local CIL representative.

"We have enjoyed a close working relationship with CIL for the last 15 years, both as a customer and a collaborator. We've had great interactions with sales, management and the chemists from top to bottom. CIL is a great company that you can really work with in this specialized area. We've been able to do science that we couldn't have done without working with CIL."

James R. Williamson, PhD
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The Scripps Research Institute