Cambridge Isotope Laboratories, Inc.
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RESEARCH PRODUCTS

Stable Isotope Standards For Clinical Mass Spectrometry

Cambridge Isotope Laboratories, Inc.
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Ordering Information

The CIL Customer Service Department is open from 8:00 a.m. to 5:00 p.m. Eastern Time.
Orders may be placed by fax, email or via our website 24 hours a day.

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Welcome

Cambridge Isotope Laboratories, Inc. (CIL) is the world leader in the production and distribution of stable isotope-labeled compounds, providing labeled compounds for fields spanning from basic analytical chemistry to modern diagnostics. Over the years, CIL has evolved in its breadth and capacity to both produce and characterize a diverse array of organic compounds to support the development of mass spectrometry (MS) methods. Our ever-expanding product offering has been driven by close customer collaborations and partnerships that we've had the privilege of being involved in.

It is with great pride that we present CIL's new "Stable Isotope Standards for Clinical Mass Spectrometry" catalog. This compilation consists of a list of clinically relevant products and a collection of varied content pieces. The pieces comprise researcher perspectives and technical notes that highlight the utility of certain products in specific clinical MS applications. Educational articles are also included, which detail the importance and proper selection of stable isotope standards in clinical MS assays.

The clinical MS field continues to evolve in research scope and application, as well as in instrument advances and their accompanying figures of merit. CIL strives to support your growing efforts by providing well-characterized standards that facilitate your required evaluations. Our offerings in this area have been vastly enhanced by our customer interactions and close collaborations, to which we are truly appreciative of and always open to expanding. Our decades of isotope-chemistry experience in combination with our isotope-separation facility position us to respond well to the challenging problems in a collaborative manner. Our customer relationships are very important to us, and we look forward to continuing to work with you in an effort to satisfy your needs in the clinical MS field.

Respectfully,

Krista Backiel
Marketing Manager
Product Manager, Clinical Mass Spectrometry

Andrew Percy, PhD
Senior Applications Chemist, Mass Spectrometry

Crystal Belanger
Assistant Product Manager, Clinical Mass Spectrometry

You can find all of the information presented in this catalog on isotope.com. Visitors to our website can immediately access updated product information, availability, pricing, and documentation, such as a certificates of analysis (CoA) and safety data sheets (SDS). Visit isotope.com to learn more.

Cambridge Isotope Laboratories, Inc. (CIL) is the world leader in the separation and manufacture of stable isotopes and stable isotope-labeled compounds. Isotope separation is performed at Cambridge Isotope Separations (CIS) in Xenia, Ohio – home of the world's largest ^{13}C isotope separation facility, one of the world's largest ^{18}O isotope-separation facilities, and the world's only commercial large-capacity D_2O enrichment columns. For over 35 years, CIL has remained the premier supplier of stable isotope standards for MS, NMR, and MRS/MRI research applications. The clinically driven products include bile acids, drugs and their metabolites, free and protected amino acids, MS/MS screening standards and mixes, protein expression reagents and kits, steroids and hormones, and vitamins and their metabolites. Our products have been specifically designed and tested with the most discerning mass spectrometrists in mind. CIL actively supports the MS community through meeting sponsorships and customer collaborations.

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Ordering and Contact Information

Placing an Order

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CIL products are constantly updated on the website so be sure to visit https://shop.isotope.com for current information.

Please help us to expedite the shipment of your order by including the following information:

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Please note that there is a $50 minimum-order requirement. We do not require written confirmation of phone orders for established customers.

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- All prices are in US dollars. Any importation costs for international orders are not included. Please consult our Customer Service Department for pricing information or packaging options.
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- Shipping terms are FCA Andover, MA USA. Any damage to the package or product in transit is the buyer's responsibility to adjust with the carrier.

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- Shipments within the United States will be sent via UPS, FedEx, or truck.
- Orders within the United States for in-stock items placed before 2:00 p.m. (ET) can ship the same day via FedEx or on the next working day via UPS.

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- Canadian shipments will be sent via FedEx or truck.
- Please include the name of your customs broker.
- Orders to Canada for in-stock items will ship one to two working days after receipt of purchase order.

International

- International shipments will be sent via FedEx or best method.
- CIL tries to be as cost effective as possible, but the carrier may assess additional charges.

We will accommodate your shipping instructions whenever it is feasible to do so. CIL reserves the right to change the method of transportation, if required, to comply with transportation regulations. Such a change would not alter your responsibility for payment of shipping charges. Additional shipping charges may apply.

Return Shipment Policy

Returns may be made within 30 days of shipment with prior approval from CIL. We reserve the right to impose restocking charges when a return is at the sole option of the buyer. The buyer is responsible for approving the quality and quantity of any product within the 30-day period stated above. If an error by CIL results in an incorrect or duplicate shipment, a replacement will be sent or the appropriate credit allowed. We typically request return of the original product. Product returns must reference the original purchase order number, CIL order number (e.g. DB-A1000), Returned Goods Authorization (RGA) number, and the date CIL authorized the return. Under no circumstances will credit or replacement be given for products without prior authorization by CIL.

Product Information

Documentation

A Certificate of Analysis (CoA) and a Safety Data Sheet (SDS) are supplied with every shipment. Additional product information may be available upon request.

The chemical purity (CP) of CIL products is 98% unless otherwise specified.

Limited Warranty

CIL represents that the products are, as of the date of shipment, as described in CIL's applicable product literature. CIL makes no other warranty, express or implied, with respect to its products, including any warranty of merchantability or fitness for any particular purpose. CIL's maximum liability for any reason shall be to replace any nonconforming product or refund the applicable purchase price.

Research Use Statement

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It may be necessary to obtain approval for using these research products in humans from the US FDA or the comparable governmental agency in the country of use. CIL will provide supporting information, such as lot-specific analytical data and test method protocols, to assist medical research groups in obtaining approval for the desired use.

Additional Information

24-Hour Emergency Response

CIL and its direct subsidiary CIL Isotope Separations, LLC, are registered with Emergency Response CHEMTREC®. In the event of a chemical-transportation emergency, CHEMTREC provides immediate advice for those at the scene of emergencies, then promptly contacts the shipper of the chemicals for more detailed assistance and appropriate follow-up. CHEMTREC operates 24 hours a day, seven days a week to receive emergency calls. In the case of chemical-transportation emergencies, call one of the following numbers:

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Importance of Stable Isotope Standards and Their Implementation in Clinical Mass Spectrometry

Technical Note


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The implementation of mass spectrometry (MS) in the preclinical/clinical laboratory has been garnering more attention over the past couple of decades.[1] Among the reasons for this are the performance benefits that MS-based methods can afford. This pertains to the high specificity, reproducibility, and sensitivity achieved through tandem MS operations (e.g., selected or multiple reaction monitoring). As with any technology, there are a few limitations worth noting. These include the upfront instrument investment and its complexity, as well as the result turnaround time. Nonetheless, as the breadth of instruments and data analysis tools continue to advance, the limitations appear to be diminishing, while the overall merits, relative to historical clinical techniques, are amplifying. Example applications that have capitalized on the analytical power of mass spectrometry include endocrinology,[2] therapeutic drug monitoring,[3] and newborn screening (for inborn errors of metabolism).[4] The aim of these, and other clinical MS screens, is to help improve the path to diagnosis. From this, specific treatments can be effectively implemented at the earliest time leading to enhanced patient care and longevity.

To facilitate accurate MS-based measurements, stable isotope-labeled standards must be incorporated. The preferred approach here is to add the labeled standard in a precise and constant amount to both the experimental samples, as an internal standard (IS), as well as the standard curve and QC samples. For utmost accuracy, the curve samples should be generated in an equivalent sample type such that the matrix effects and extraction efficiency are identical. Only by adding the labeled standard as an IS can recovery differences be effectively resolved. With IS use, the type and its point of insertion are two critical factors that a researcher faces in designing a clinically relevant, MS-based method. This is critical to qualitatively evaluate the assay's effectiveness and to help guide corrective measures, as necessary.

The nature of IS can take many forms, but is conventionally a compound, or mixture of compounds, that has been labeled with one or more stable isotopes (e.g., ^{13}C, ^{15}N, and/or D). The position and number of stable isotopes in a given compound is predicated on the sample preparation and method of analysis. If, for instance, D-labeling is preferred for a certain metabolite, the labels must be inserted at nonexchangeable positions to mitigate the effects of hydrogen-deuterium exchange. Regardless of the type of isotope incorporated, the labeled standards should ideally bear a total mass shift of 3 Da minimum from its unlabeled counterpart (to enable swift, metabolite MS analysis) and be well characterized (e.g., for chemical and/or chiral purity, isotopic enrichment). In terms of the number of labeled standards required for a given experiment, it is recommended that this number equate to the number of target analytes. While this is generally practical for small panel analyses (as would be typical in a clinical experiment), it is common with large panels (as utilized in preclinical experiments) to select certain labeled standards as surrogates for compounds that lack a labeled analogue. This practice is considered acceptable in quantification exercises provided that the surrogates exhibit similar elution times, and thus bear similar physicochemical properties as their native targets.

Given the complexity of human biological samples, in terms of depth and breadth of analytes, it is recommended that the labeled IS be added as early as possible in the analytical workflow. In so doing, losses or modifications that occur during the sample preparation and processing steps can be adequately accounted for. Since the standard is designed to match its native analogue and behave similarly (in terms of its separation, ionization, and

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The Importance of Stable Isotope Standards and Their Implementation in Clinical Mass Spectrometry *(continued)*

fragmentation), any changes that occur on one will, in theory, be reflective on the other. Therefore, in analysis, the analyte can be quantified using relative ratios (i.e., unlabeled/labeled) of peak areas as opposed to their absolute values. In addition to the experimental samples, this approach is applied to other sample types, such as standard curve and curve QCs (at low, medium, and high concentrations). While the response of the labeled and unlabeled analyte will differ in curve and QC samples, the point of elution will not (valid particularly with ^{13}C and/or ^{15}N standards), enabling their relative ratios for quantitation or performance assessment to be effectively determined.

The importance of stable isotope-labeled standards in the rapidly evolving clinical MS field is becoming increasingly more recognized. This pertains to both small and large molecule analysis,[5] with applications covering diagnostic testing and drug therapy monitoring, among others. Regardless of the application type, a well-executed clinical MS method should be automated and well controlled. In the assays deemed fit for purpose, the highly characterized standards should be inserted for not only accurate quantitation, but also for system suitability reliance to enable complete accounting of all possible losses or errors.[6] This relates to human errors (e.g., improper pipetting), chemical errors (e.g., analyte extraction, hydrolysis), and instrument errors (e.g., ion suppression, matrix effects). The labeled standards that CIL provides can be, and have been, utilized in this realm. The product listing, perspectives, and applications herein provide such examples.

References

1. Jannetto, P.J.; Fitzgerald, R.L. **2016**. Effective use of mass spectrometry in the clinical laboratory. *Clin Chem, 62(1),* 92-98.
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Benefits of ^{13}C vs. D Standards in Clinical Mass Spectrometry Measurements

Technical Note


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The capabilities of mass spectrometry (MS) have made this analytical technique an invaluable tool in clinical-based developments and applications. As with any clinical test, accurate and precise results are paramount toward correct diagnosis and treatments. In MS testing, reliable results are best achieved by the inclusion of stable isotope-labeled standards. The utility of such standards has been demonstrated in clinical and translational research (see p. XX of this catalog for a background article), with their benefits including the ability to help compensate for matrix effects and ion suppression.[1] For optimum results, the standards should be added as early in the analytical workflow as possible, such that they can effectively normalize the variations that may arise throughout the experimental stages. The nature of labeled standards is a critical element of a method and is predicated on its availability/cost as well as the study design and research aims. Important to recognize in the standard selection process is the isotope differences (e.g., between ^{13}C and D) and the potential impact this may have in the pre-analytical (e.g., storage and handling) and analytical (e.g., sample preparation and processing) phases. As standard selection is not always a straightforward procedure, this article compares the commonly used ^{13}C and D isotopes from production to analysis in an effort to edify the callenges and guide future selections.

Standards labeled with ^{13}C (and/or ^{15}N) have demonstrated broad research utility over the past couple of decades. This stems partly from the chemical stability of its isotope. Its stability ensures that the isotope remains intact irrespective of the experimental methodology employed (e.g., multidimensional LC or derivatization-based GC prior to MS/MS). In other words, the ^{13}C (and ^{15}N) isotope remains positioned at its point of synthesis throughout all stages of an analytical workflow (includes extraction, derivatization, separation, and analysis in metabolomics). This provides flexibility to the end user as there is no limitation on the choice of sample/solution preparation nor the mode of MS/MS analysis. Since ^{13}C (and/or ^{15}N) standards have exceptional isotope stability, as compared to their deuterated counterparts, these can be inserted at an early stage of sample preparation. Of additional benefit is that this type of labeled compound co-elutes with its corresponding unlabeled (i.e., native or endogenous) analyte during chromatographic separation. This co-eluting result is optimal in correcting for both ion suppression and matrix effects. Further to the benefits, ^{13}C (and/or ^{15}N) standards are absent from isotope scrambling or loss during ionization and collisional activation in the mass spectrometer. Owing to these collective merits, ^{13}C (and/or ^{15}N) standards have incurred great value in preclinical and clinical MS applications (from qualification to absolute quantification).

Despite the benefits of ^{13}C (and ^{15}N) labeling, the production of such standards could entail complex and laborious synthesis. While carefully selected structural analogues (with ^{13}C and/or ^{15}N) may instead be used in cases where it is cost or time prohibitive to obtain or synthesize the required standard, deuterated standards are an alternate option to consider. These are comparatively straightforward to prepare, but invoke a number of potential issues at the pre-analytical and analytical phases. The first pertains to the isotope stability. If the D-label is placed at an exchangeable position (i.e., at acidic and polar groups), it could be susceptible to an isotope effect during storage and later in analysis. In this effect, the location of deuterium may scramble or undergo an exchange reaction with protium in solution or in the gas phase. Another situation to consider is deuterium loss on specific compounds from enzymatic reactions (e.g., deuterium abstraction from fatty acids due to fatty acid desaturation).[2] The impact of these collective effects could be significant and is best illustrated by a hypothetical example. In a complete exchange scenario, for instance, the labeled signal at the mass spectrometer would be unmeasurable, while the unlabeled signal (i.e., M+0) would be elevated. This would provide an invalid view of a patient's biochemistry and a false impression of the assay's fitness. A result that would clearly contribute to "imprecision medicine" in laboratory diagnostics. While this deleterious impact could be overcome by selecting alternate MRM transitions (i.e., at sites verified to have label due to consistent scrambling), a preferred approach would be to incorporate deuterium at chemically inert, nonexchangeable positions. Doing so would aid its stability, but the integrity of the deuterated standards would still need to be validated at all phases of the analytical workflow (from reconstitution through extraction to MS analysis). Complicating these assessments is the difference in physicochemical properties between deuterium and hydrogen. The difference causes deuterated standards to typically exhibit an altered chromatographic retention from its native analogues.[3] This elution impact is most pronounced in LC separations, but may also occur in GC separations. The shift could complicate the accuracy/reproducibility of identification and quantification in

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Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
For research use only. Not for use in diagnostic procedures.

Benefits of ^{13}C vs. D Standards in Clinical Mass Spectrometry Measurements *(continued)*

complex biosample analysis, such as human plasma or urine. Only if the stability and effectiveness of deuterated standards are first demonstrated can its subsequent use in large-scale analysis be considered acceptable for critical decision making studies (e.g., newborn screening, therapeutic drug monitoring, vitamin D deficiency).

To summarize, there are an array of factors to consider in designing experiments and implementing methods. Important amongst them is the type of labeled standard. As described above, ^{13}C (and ^{15}N) standards provide excellent isotope stability and analytical reliability. This means that the position of label is not impacted by the pre-analytical and analytical processes. Since this type of standard has equivalent physicochemical properties as its unlabeled counterpart, we consider these to be ideal toward the accurate and reproducible quantitation of small or large molecules.

Deuterated standards, in contrast, may exhibit isotope instability and an exchange or scrambling effect during storage and the experimental phases. These effects are magnified if the D-label is incorporated at exchangeable positions. Even if deuterium is placed at nonexchangeable positions, development time must be allotted for stability testing (e.g., at storage, in autosampler) and method evaluation (e.g., for mobile phase impact, preferable MRM transitions).[4] That said, if validations have been performed and other options (e.g., ^{13}C standards or surrogates) are absent, then this route could be suitable long-term. Overall, although Cambridge Isotope Laboratories (CIL) offer a multitude of variably labeled standards (encompasses vitamins, steroids, and fatty acids/lipids, amongst others), our recommendation is toward a ^{13}C (and/or ^{15}N) variant, when possible, for accurate/reproducible quantification in clinical MS-based analyses.

References

1. George, R.; Haywood, A.; Khan, S.; et al. **2018**. Enhancement and suppression of ionization in drug analysis using HPLC-MS/MS in support of therapeutic drug monitoring: a review of current knowledge of its minimization and assessment. *Ther Drug Monit, 40(1),* 1-8.
2. Triebl, A.; Wenk, M.R. **2018**. Analytical Considerations of Stable Isotope Labelling in Lipidomics. *Biomolecules, 8(4),* pii: E151.
3. Guo, K.; Ji, C.; Li, L. **2007**. Stable-isotope dimethylation labeling combined with LC-ESI MS for quantification of amine-containing metabolites in biological samples. *Anal Chem, 79(22),* 8631-8638.
4. Honour, J.W. **2011**. Development and validation of a quantitative assay based on tandem mass spectrometry. *Ann Clin Biochem, 48(Pt 2),* 97-111.

Free Amino Acids and Their Derivatives

Amino acids play critical roles in biological functions as building blocks of peptides and proteins, as well as intermediates of various metabolic pathways (e.g., citric acid cycle, urea cycle). These compounds are also reported to influence the pathogenesis and propagation of metabolic disorders/disease, with clinically designed biomarker research aimed to detect disease at the earliest stage.

To aid qualitative and quantitative research, CIL offers an array of unlabeled and stable isotope-labeled free amino acids. These can be used as internal standards or NMR probes in MS- and NMR-based research studies. The amino acids are canonical (e.g., arginine, lysine, phenylalanine) and noncanonical (e.g., beta-alanine, citrulline, ornithine). These are available in their uniform or specifically labeled (with ^{13}C, ^{15}N, D, and/or ^{18}O) forms, and in grades of research and MPT (microbiological and pyrogen tested).

Catalog No.	Description	Unit Size
DLM-7476	ADMA·HCl·XH_2O (2,3,3,4,4,5,5-D_7, 98%) (asymmetric dimethylarginine) (may be hydrate) CP 98%	5 mg
CLM-8755	β-Alanine (3-^{13}C, 99%)	Please inquire
CLM-8756	β-Alanine ($^{13}C_3$, 99%)	Please inquire
NLM-1656	β-Alanine (^{15}N, 98%)	0.25 g
CNLM-3440	β-Alanine (3-^{13}C, 99%; ^{15}N, 98%)	Please inquire
CNLM-8457	β-Alanine (1,2-$^{13}C_2$, 99%; ^{15}N, 98%)	Please inquire
CNLM-3946	β-Alanine ($^{13}C_3$, 98%; ^{15}N, 96-99%)	0.25 g
CLM-1655	D-Alanine (1-^{13}C, 99%)	Please inquire
CLM-2495	D-Alanine (3-^{13}C, 99%)	Please inquire
CLM-10963	D-Alanine ($^{13}C_3$, 99%)	Please inquire
DLM-7326	D-Alanine (D_7, 98%) (<5% L)	Please inquire
NLM-6762	D-Alanine (^{15}N, 98%)	Please inquire
NLM-3289	D-Alanine, *N*-acetyl (^{15}N, 98%)	Please inquire

Catalog No.	Description	Unit Size
CLM-705	DL-Alanine (1-^{13}C, 99%)	1 g
CLM-115	DL-Alanine (2-^{13}C, 99%)	0.25 g, 0.5 g
CLM-707	DL-Alanine (3-^{13}C, 99%)	0.5 g, 1 g
CLM-4514	DL-Alanine ($^{13}C_3$, 98%)	Please inquire
DLM-2760	DL-Alanine (2-D, 98%)	Please inquire
DLM-176	DL-Alanine (3,3,3-D_3, 98%)	1 g
DLM-1276	DL-Alanine (2,3,3,3-D_4, 97-98%)	1 g
NLM-706	DL-Alanine (^{15}N, 98%)	1 g
CDLM-8650	DL-Alanine (3-^{13}C, 99%; 2-D, 96%)	Please inquire
CLM-116	L-Alanine (1-^{13}C, 99%)	0.5 g, 1 g
CLM-2016	L-Alanine (2-^{13}C, 99%)	0.1 g, 0.25 g, 0.5 g
CLM-117	L-Alanine (3-^{13}C, 99%)	0.5 g, 1 g
CLM-2734	L-Alanine (2,3-$^{13}C_2$, 99%)	0.25 g, 0.5 g
CLM-2184-H	L-Alanine ($^{13}C_3$, 99%)	0.1 g, 0.25 g, 0.5 g
DLM-3101	L-Alanine (2-D, 96-98%)	Please inquire
DLM-248	L-Alanine (3,3,3-D_3, 99%)	1 g
DLM-250	L-Alanine (2,3,3,3-D_4, 98%)	0.1 g, 1 g
DLM-251	L-Alanine (D_7, 98%)	1 g
NLM-454	L-Alanine (^{15}N, 98%)	0.5 g, 1 g
OLM-7460	L-Alanine ($^{18}O_2$, 90%)	Please inquire
CDLM-8649	L-Alanine (3-^{13}C, 99%; 2-D, 96%)	1 g
CDLM-3439	L-Alanine (3-^{13}C, 99%; 3,3,3-D_3, 98%)	Please inquire
CNLM-6993	L-Alanine (1-^{13}C, 99%; ^{15}N, 98%)	0.25 g
CNLM-3594	L-Alanine (2-^{13}C, 99%; ^{15}N, 98%)	0.25 g
CNLM-534-H	L-Alanine ($^{13}C_3$, 99%; ^{15}N, 99%)	0.1 g, 0.25 g, 0.5 g
DNLM-7178	L-Alanine (2,3,3,3-D_4, 98%; ^{15}N, 98%)	0.25 g, 0.5 g
CDNLM-6800	L-Alanine ($^{13}C_3$, 97-99%; D_4, 97-99%; ^{15}N, 97-99%)	0.25 g
CNLM-10424	β-*N*-methylamino-L-Alanine ($^{13}C_3$, 99%; $^{15}N_2$, 98%) (US patent pending: 62/368,562)	0.01 g, 1.2 mL
ULM-10493	β-*N*-methylamino-L-Alanine·HCl (unlabeled) CP 97%	Please inquire
DLM-9799	DL-2-Aminoadipic acid (2,5,5-D_3, 98%)	Please inquire
CLM-1541	4-Aminobenzoic acid (PABA) (ring-$^{13}C_6$, 99%)	Please inquire
CLM-535	5-Aminolevulinic acid·HCl (4-^{13}C, 99%)	0.05 g
CLM-1371	5-Aminolevulinic acid·HCl (5-^{13}C, 99%) CP 96%	0.05 g, 0.1 g
CLM-701	Anthranilic acid (ring-$^{13}C_6$, 99%)	0.1 g, 0.25 g
NLM-3294	Anthranilic acid (^{15}N, 98%)	0.5 g
DLM-9802	DL-2-Aminobutyric acid (D_6, 98%)	Please inquire
CLM-2070	L-Arginine·HCl (guanido-^{13}C, 99%)	0.5 g
CLM-1268	L-Arginine·HCl (1-^{13}C, 99%)	0.1 g
CLM-2051	L-Arginine·HCl (1,2-$^{13}C_2$, 99%)	0.1 g
CLM-2265-H	L-Arginine·HCl ($^{13}C_6$, 99%)	0.05 g, 0.1 g, 0.25 g, 0.5 g, 1 g
DLM-6038	L-Arginine·HCl (4,4,5,5-D_4, 94%) (<5% D)	Please inquire
DLM-541	L-Arginine·HCl (D_7, 98%)	0.1 g
NLM-1267	L-Arginine·HCl (α-^{15}N, 98%)	Please inquire
NLM-395	L-Arginine·HCl (guanido-$^{15}N_2$, 98%)	0.5 g, 1 g
NLM-396	L-Arginine·HCl ($^{15}N_4$, 98%)	0.1 g
CDLM-3789	L-Arginine·HCl (5-^{13}C, 99%; 4,4,5,5-D_4, 95%)	Please inquire
CNLM-7819	L-Arginine·HCl (1-^{13}C, 99%; α-^{15}N, 98%)	Please inquire
CNLM-539-H	L-Arginine·HCl ($^{13}C_6$, 99%; $^{15}N_4$, 99%)	0.05 g, 0.1 g, 0.25 g, 0.5 g, 1 g
DNLM-7543	L-Arginine·HCl (D_7, 98%; $^{15}N_4$, 98%)	0.25 g
CDNLM-6801	L-Arginine·HCl ($^{13}C_6$, 97-99%; D_7, 97-99%; $^{15}N_4$, 97-99%)	0.25 g
ULM-8347	L-Arginine·HCl (unlabeled)	0.05 g, 0.1 g

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Free Amino Acids and Their Derivatives *(continued)*

Catalog No.	Description	Unit Size
CNLM-9007-CA	Argininosuccinic acid barium salt·2H_2O (arginine-$^{13}C_6$, 99%; $^{15}N_4$, 99%) CP 90%	0.1 mg, 0.5 mg
ULM-9008-CA	Argininosuccinic acid barium salt·3H_2O (unlabeled) CP 90%	0.1 mg
CLM-8699-H	L-Asparagine·H_2O ($^{13}C_4$, 99%)	0.05 g
DLM-6844	L-Asparagine·H_2O (2,3,3-D_3, 94%)	0.1 g
NLM-120	L-Asparagine·H_2O (amide-^{15}N, 98%)	0.25 g, 0.5 g
NLM-3286	L-Asparagine·H_2O ($^{15}N_2$, 98%)	0.25 g, 0.5 g
CNLM-7818	L-Asparagine·H_2O (1,4-$^{13}C_2$, 99%; α-^{15}N, 98%)	0.25 g
CNLM-3819-H	L-Asparagine·H_2O ($^{13}C_4$, 99%; $^{15}N_2$, 99%)	0.1 g, 0.25 g, 0.5 g
DNLM-6932	L-Asparagine·H_2O (2,3,3-D_3, 98%; $^{15}N_2$, 98%)	0.25 g
CDNLM-6802	L-Asparagine·H_2O ($^{13}C_4$, 97-99%; D_3, 97-99%; $^{15}N_2$, 97-99%)	0.25 g
CLM-865	DL-Aspartic acid (3-^{13}C, 99%)	Please inquire
CLM-518	DL-Aspartic acid (4-^{13}C, 99%)	0.25 g, 0.5 g, 1 g
DLM-832	DL-Aspartic acid (2,3,3-D_3, 98%)	1 g
DLM-8599	DL-Aspartic acid, *N*-acetyl (aspartate-2,3,3-D_3, 97%)	Please inquire
CLM-3616	L-Aspartic acid (1-^{13}C, 99%)	Please inquire
CLM-3617	L-Aspartic acid (2-^{13}C, 99%)	Please inquire
CLM-627	L-Aspartic acid (3-^{13}C, 98-99%)	0.05 g, 0.1 g, 0.25 g
CLM-519	L-Aspartic acid (4-^{13}C, 99%)	Please inquire
CLM-4455	L-Aspartic acid (1,4-$^{13}C_2$, 99%)	0.5 g
CLM-1801-H	L-Aspartic acid ($^{13}C_4$, 99%)	0.25 g, 0.5 g, 1 g
DLM-546	L-Aspartic acid (2,3,3-D_3, 98%)	0.1 g, 0.25 g
NLM-718	L-Aspartic acid (^{15}N, 98%)	0.5 g, 1 g
CNLM-7817	L-Aspartic acid (1,4-$^{13}C_2$, 99%; ^{15}N, 98%)	0.25 g
CNLM-544-H	L-Aspartic acid ($^{13}C_4$, 99%; ^{15}N, 99%)	0.25 g, 0.5 g, 1 g
DNLM-6931	L-Aspartic acid (2,3,3-D_3, 98%; ^{15}N, 98%)	0.25 g, 0.5 g
CDNLM-6803	L-Aspartic acid ($^{13}C_4$, 97-99%; D_3, 97-99%; ^{15}N, 97-99%)	0.25 g
ULM-8676	L-Aspartic acid (unlabeled)	Please inquire
CNLM-9461	L-Azidohomoalanine·HCl (1,2,3,4-$^{13}C_4$; 2,4-$^{15}N_2$, 98%)	0.05 g, 0.1 g
ULM-9460	L-Azidohomoalanine·HCl (unlabeled)	0.05 g, 0.1 g
CLM-6574	1,4-Butanediamine (putrescine) ($^{13}C_4$, 98%)	0.1 g
DLM-6573	1,4-Butanediamine (putrescine) (1,1,2,2,3,3,4,4-D_8, 98%)	Please inquire
CNLM-10625	3-Chlorotyrosine·HCl ($^{13}C_9$, 98%; ^{15}N, 98%) CP 95%	1 mg
CLM-4899	L-Citrulline (ureido-^{13}C, 99%)	0.1 g
CLM-8653	L-Citrulline (1,2,3,4,5-$^{13}C_5$, 98%)	Please inquire
DLM-3860	L-Citrulline (5,5-D_2, 98%)	Please inquire
DLM-6039	L-Citrulline (4,4,5,5-D_4, 95%)	0.01 g
DLM-10776	L-Citrulline (2,3,3,4,4,5,5-D_7, 98%)	Please inquire
NLM-6850	L-Citrulline (ureido-^{15}N, 98%)	Please inquire
CDLM-7879	L-Citrulline (ureido-^{13}C, 99%; 5,5-D_2, 98%)	Please inquire
CDLM-8808	L-Citrulline (ureido-^{13}C, 99%; 3,3,4-D_3, 98%)	Please inquire
CDLM-7139	L-Citrulline (5-^{13}C, 99%; 4,4,5,5-D_4, 95%)	Please inquire
DLM-3653	Creatinine (*N*-methyl-D_3, 98%)	0.1 mg, 0.1 g
ULM-10966	Creatinine (unlabeled)	0.1 mg
CDLM-4211	Cycloleucine (carboxyl-^{13}C, 99%; 2,2,5,5-D_4, 96%)	0.25 g
DLM-6108	DL-Cystathionine (3,3,4,4-D_4, 98%)	0.01 g, 0.05 g
CLM-3790	DL-Cysteine (1-^{13}C, 99%)	Please inquire
DLM-899	DL-Cysteine (3,3-D_2, 98%)	0.5 g
CLM-404	DL-Cysteine, *S*-benzyl (1-^{13}C, 99%)	0.25 g
CLM-3852	L-Cysteine (1-^{13}C, 99%)	0.5 g
CLM-1868	L-Cysteine (3-^{13}C, 99%)	0.25 g
CLM-4320-H	L-Cysteine ($^{13}C_3$, 99%)	0.1 g
DLM-769	L-Cysteine (3,3-D_2, 98%)	0.1 g
DLM-6901	L-Cysteine (2,3,3-D_3, 98%)	0.1 g

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Catalog No.	Description	Unit Size
NLM-2295	L-Cysteine (^{15}N, 98%)	0.25 g
CNLM-7815	L-Cysteine (1-^{13}C, 99%; ^{15}N, 98%)	Please inquire
CNLM-3871-H	L-Cysteine ($^{13}C_3$, 99%; ^{15}N, 99%)	0.1 g, 0.25 g
DNLM-6902	L-Cysteine (2,3,3-D_3, 98%; ^{15}N, 98%)	0.25 g
CDNLM-6809	L-Cysteine ($^{13}C_3$, 97-99%; D_3, 97-99%; ^{15}N, 97-99%)	0.25 g
CNLM-7579	L-Cysteine, *N*-acetyl (cysteine-$^{13}C_3$, 97-99%; ^{15}N, 97-99%) CP 95%	Please inquire
CLM-2182	L-Cysteine, *S*-benzyl (3-^{13}C, 99%)	0.1 g
DLM-2942	L-Cysteine, *S*-methyl (*S*-methyl-D_3, 98%) CP 97%	0.25 g
NLM-3914	L-Cysteine, *S-P*-mebz (^{15}N, 98%)	0.1 g
DLM-8738	*S*-sulfo-DL-Cysteine (2,3,3-D_3, 99%)	Please inquire
DLM-1000	DL-Cystine (3,3,3′,3′-D_4, 98%)	1 g
NLM-1668	DL-Cystine ($^{15}N_2$, 95%)	Please inquire
CLM-520	L-Cystine (3,3′-$^{13}C_2$, 99%)	0.25 g
DLM-9812	L-Cystine (3,3,3′,3′-D_4, 98%)	0.5 g
NLM-3818	L-Cystine ($^{15}N_2$, 98%)	0.25 g
CNLM-4244-H	L-Cystine ($^{13}C_6$, 99%; $^{15}N_2$, 99%)	Please inquire
CDNLM-8659	L-Cystine ($^{13}C_6$, 98%; D_6, 98%; $^{15}N_2$, 98%) CP 95%	Please inquire
CLM-7401	L-Dihydroxyphenylalanine (L-Dopa) (1-^{13}C, 99%)	0.1 g
CLM-1007	L-Dihydroxyphenylalanine (L-Dopa) (ring-$^{13}C_6$, 99%)	0.1 g
CLM-7824	L-Dihydroxyphenylalanine (L-Dopa) (1-^{13}C, ring-$^{13}C_6$, 99%)	0.05 g
DLM-2084	L-Dihydroxyphenylalanine (L-Dopa) (ring-D_3, 98%)	1 g
COLM-2232	L-Dihydroxyphenylalanine (L-Dopa) (2,3-$^{13}C_2$, 97%; 4-hydroxy-^{18}O, 95%)	0.05 g
DLM-8516	*N,N*-Dimethylglycine·HCl (D_6, 99%)	Please inquire
CLM-7254	*O,O′*-Dityrosine (ring-$^{13}C_{12}$, 99%)	0.1 mg
CLM-3632	DL-Glutamic acid (3-^{13}C, 99%)	Please inquire
DLM-335	DL-Glutamic acid (2,4,4-D_3, 98%)	1 g
DLM-357	DL-Glutamic acid (2,3,3,4,4-D_5, 97%)	0.25 g
CLM-3721	DL-Glutamic acid·H_2O (1-^{13}C, 99%)	1 g
CLM-674	L-Glutamic acid (1-^{13}C, 99%)	1 g
CLM-2474	L-Glutamic acid (2-^{13}C, 99%)	Please inquire
CLM-4742	L-Glutamic acid (3-^{13}C, 99%)	Please inquire
CLM-2431	L-Glutamic acid (4-^{13}C, 98-99%)	Please inquire
CLM-613	L-Glutamic acid (5-^{13}C, 99%)	0.1 g
CLM-2024	L-Glutamic acid (1,2-$^{13}C_2$, 99%)	0.25 g
CLM-3646	L-Glutamic acid (3,4-$^{13}C_2$, 99%)	0.25 g
CLM-1800-H	L-Glutamic acid ($^{13}C_5$, 99%)	0.1 mg, 0.25 g, 0.5 g, 1 g
DLM-3725	L-Glutamic acid (2,4,4-D_3, 97-98%)	0.5 g
DLM-556	L-Glutamic acid (2,3,3,4,4-D_5, 97-98%)	0.05 g, 0.1 g
NLM-135	L-Glutamic acid (^{15}N, 98%)	0.5 g, 1 g
CNLM-7812	L-Glutamic acid (1-^{13}C, 99%; ^{15}N, 98%)	0.25 g
CNLM-554-H	L-Glutamic acid ($^{13}C_5$, 99%; ^{15}N, 99%)	0.25 g, 0.5 g, 1 g
DNLM-6996	L-Glutamic acid (2,3,3,4,4-D_5, 98%; ^{15}N, 98%)	0.25 g, 0.5 g
CDNLM-6804	L-Glutamic acid ($^{13}C_5$, 97-99%; D_5, 97-99%; ^{15}N, 97-99%)	0.25 g
ULM-8675	L-Glutamic acid (unlabeled)	0.1 mg
CLM-6664	L-Glutamic acid, *N*-acetyl (glutamate-$^{13}C_5$, 97-99%)	Please inquire
OLM-8028	L-Glutamic acid·HCl ($^{17}O_4$, ~30%)	Please inquire
CLM-3612	L-Glutamine (1-^{13}C, 99%)	1 g
CLM-3613	L-Glutamine (2-^{13}C, 99%)	Please inquire
CLM-770	L-Glutamine (4-^{13}C, 99%)	Please inquire
CLM-1166	L-Glutamine (5-^{13}C, 99%)	0.25 g
CLM-2001	L-Glutamine (1,2-$^{13}C_2$, 99%)	0.1 g
CLM-3641	L-Glutamine (3,4-$^{13}C_2$, 99%)	Please inquire
CLM-1822-H	L-Glutamine ($^{13}C_5$, 99%)	0.1 g, 0.25 g, 0.5 g

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Free Amino Acids and Their Derivatives *(continued)*

Catalog No.	Description	Unit Size
DLM-1826	L-Glutamine (2,3,3,4,4-D_5, 97%)	0.1 g
NLM-1016	L-Glutamine (α-^{15}N, 98%)	0.1 g, 1 g
NLM-557	L-Glutamine (amide-^{15}N, 98%)	0.5 g, 1 g
NLM-1328	L-Glutamine ($^{15}N_2$, 98%)	0.25 g
CNLM-7813	L-Glutamine (1-^{13}C, 99%; α-^{15}N, 98%)	Please inquire
CNLM-1275-H	L-Glutamine ($^{13}C_5$, 99%; $^{15}N_2$, 99%)	0.1 g, 0.25 g, 0.5 g
DNLM-6997	L-Glutamine (2,3,3,4,4-D_5, 97-98%; $^{15}N_2$, 97-98%)	0.25 g
CDNLM-6805	L-Glutamine ($^{13}C_5$, 97-99%; D_5, 97-99%; $^{15}N_2$, 97-99%)	0.25 g
CLM-422	Glycine (1-^{13}C, 99%)	1 g, 5 g
CLM-136	Glycine (2-^{13}C, 99%)	0.5 g, 1 g, 5 g
CLM-1017	Glycine ($^{13}C_2$, 97-99%)	0.5 g, 1 g, 5 g
DLM-1674	Glycine (2,2-D_2, 98%)	5 g
DLM-280	Glycine (D_5, 98%)	5 g
DLM-280-80	Glycine (D_5, 80%)	5 g
NLM-202	Glycine (^{15}N, 98%)	1 g, 5 g
CNLM-507	Glycine (1-^{13}C, 99%; ^{15}N, 98%)	1 g
CNLM-508	Glycine (2-^{13}C, 99%; ^{15}N, 98%)	0.5 g, 1 g
CNLM-1673-H	Glycine ($^{13}C_2$, 99%; ^{15}N, 99%)	0.25 g, 0.5 g, 1 g
DNLM-6862	Glycine (2,2-D_2, 98%; ^{15}N, 98%)	0.25 g, 0.5 g
CDNLM-6799	Glycine ($^{13}C_2$, 97-99%; 2,2-D_2, 97-99%; ^{15}N, 97-99%)	0.25 g
CLM-3777	Glycine, *N*-acetyl (2-^{13}C, 99%)	1 g
NLM-4464	Glycine, *N*-acetyl (^{15}N, 98%)	Please inquire
CNLM-4524	Glycine, *N*-acetyl ($^{13}C_2$, 97-99%; ^{15}N, 97-99%)	Please inquire
CLM-10468	Glycine, *N*-benzoyl (hippuric acid) (ring-$^{13}C_6$, 99%)	Please inquire
DLM-7703	Glycine, *N*-benzoyl (hippuric acid) (benzoyl-D_5, 98%)	Please inquire
NLM-2377	Glycine, *N*-benzoyl (hippuric acid) (^{15}N, 98%)	0.1 g
DLM-7248	Glycine, *N*-hexanoyl (2,2,-D_2, 98%)	Please inquire
CNLM-844	Glycine, *N*-hexanoyl ($^{13}C_2$, 97-99%; ^{15}N, 97-99%) CP 95%	Please inquire
DLM-10483	Glycine, *N*-isovaleryl (isovaleryl-D_9, 98%)	Please inquire
CNLM-9291	Glycine, *N*-isovaleryl (glycine-$^{13}C_2$, 99%; ^{15}N, 99%)	Please inquire
DLM-10822	Glycine, *N*-octanoyl (2,2-D_2, 98%)	Please inquire
DLM-9677	Glycine, *N*-propionyl (2,2-D_2, 98%)	Please inquire
CNLM-9292	Glycine, *N*-propionyl (glycine-$^{13}C_2$, 99%; ^{15}N, 99%)	Please inquire
CNLM-7175	Glycine·HCl, ethyl ester ($^{13}C_2$, 98%; ^{15}N, 98%)	Please inquire
DLM-9998	Guanidinoacetic acid (2,2-D_2, 97%)	Please inquire
CNLM-8300	Guanidinoacetic acid (1,2-$^{13}C_2$, 97-99%; 3-^{15}N, 97-99%) CP 97%	Please inquire
CLM-2636	DL-Histidine (ring-2-^{13}C, 99%)	Please inquire
NLM-10595	DL-Histidine (α-^{15}N, 98%)	Please inquire
NLM-138	DL-Histidine·2HCl (α-^{15}N, 98%)	0.25 g
NLM-4649	L-Histidine (ring-ε-^{15}N, 98%) (<5% D)	Please inquire
NLM-4457	L-Histidine (ring-π-^{15}N, 98%) (<5% D)	Please inquire
NLM-9585	L-Histidine (ring-$^{15}N_2$, 98%)	Please inquire
CLM-1512	L-Histidine·HCl·H_2O (ring-2-^{13}C, 99%)	0.1 g
CLM-2264	L-Histidine·HCl·H_2O ($^{13}C_6$, 97-99%) (<5% D)	0.05 g, 0.1 g, 0.25 g
DLM-7855	L-Histidine·HCl·H_2O (ring-2,4-D_2; α,β,β-D_3, 98%)	0.25 g
NLM-2245	L-Histidine·HCl·H_2O (α-^{15}N, 98%)	0.25 g
NLM-846	L-Histidine·HCl·H_2O (ring-π-^{15}N, 98%) (<5% D)	Please inquire
NLM-1513	L-Histidine·HCl·H_2O ($^{15}N_3$, 98%) (<5% D)	0.25 g
CNLM-758	L-Histidine·HCl·H_2O ($^{13}C_6$, 97-99%; $^{15}N_3$, 97-99%) (<5% D)	0.25 g
DNLM-7366	L-Histidine·HCl·H_2O (D_5, 98%; $^{15}N_3$, 98%)	0.25 g
CDNLM-6806	L-Histidine·HCl·H_2O ($^{13}C_6$, 97-99%; D_5, 97-99%; $^{15}N_3$, 97-99%) CP 95%	0.25 g
DLM-8691	π-methyl-L-Histidine (methyl-D_3, 98%)	0.05 g
DLM-2949	τ-methyl-L-Histidine (methyl-D_3, 98%)	0.25 g

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Catalog No.	Description	Unit Size
CNLM-4645	L-Homoarginine·HCl ($^{13}C_7$, 98%; $^{15}N_4$, 98%)	10 mg
DLM-8259	DL-Homocysteine (3,3,4,4-D_4, 98%)	0.1 g
DLM-3619	DL-Homocystine (3,3,3′,3′,4,4,4′,4′-D_8, 98%)	0.1 g, 0.5 g, 1 g
NLM-2466	L-Homoserine (^{15}N, 95-99%) CP 97%	0.5 g
CLM-1026	L-Isoleucine (1-^{13}C, 99%)	0.5 g, 1 g
CLM-2248-H	L-Isoleucine ($^{13}C_6$, 99%)	0.05 g, 0.1 g, 0.25 g
DLM-141	L-Isoleucine (D_{10}, 98%)	0.1 g, 0.25 g
NLM-292	L-Isoleucine (^{15}N, 98%)	0.25 g, 1 g
CNLM-7810	L-Isoleucine (1-^{13}C, 99%; ^{15}N, 98%)	Please inquire
CNLM-561-H	L-Isoleucine ($^{13}C_6$, 99%; ^{15}N, 99%)	0.05 g, 0.1 g, 0.25 g
DNLM-7325	L-Isoleucine (D_{10}, 98%; ^{15}N, 98%)	0.25 g
CDNLM-6807	L-Isoleucine ($^{13}C_6$, 97-99%; D_{10}, 97-99%; ^{15}N, 97-99%)	0.25 g
CLM-8742	L-allo-Isoleucine ($^{13}C_6$, 97-99%)	Please inquire
DLM-1505	L-allo-Isoleucine (D_{10}, 98%)	0.1 g
CNLM-8670	L-allo-Isoleucine ($^{13}C_6$, 97-99%; ^{15}N, 97-99%)	Please inquire
CDNLM-8911	L-allo-Isoleucine ($^{13}C_6$, 97-99%; D_{10}, 97-99%; ^{15}N, 97-99%)	Please inquire
DLM-7374	Kynurenic acid (ring-D_5, 98%)	Please inquire
DLM-7842	L-Kynurenine sulfate (ring-D_4, 3,3-D_2, 97%) CP 95%	0.1 mg, 5 mg, 10 mg
CLM-9884	L-Kynurenine sulfate·½H_2O ($^{13}C_{10}$, 99%)	0.1 mg
CLM-204	DL-Leucine (1-^{13}C, 99%)	1 g
CLM-207	DL-Leucine (2-^{13}C, 99%)	Please inquire
DLM-9423	DL-Leucine (D_{10}, 98%)	0.25 g
NLM-355	DL-Leucine (^{15}N, 98%)	Please inquire
CNLM-8679	DL-Leucine (2-^{13}C, 99%; ^{15}N, 98%)	Please inquire
CLM-468	L-Leucine (1-^{13}C, 99%)	1 g, 5 g
CLM-2014	L-Leucine (2-^{13}C, 99%)	0.5 g, 1 g
CLM-3524	L-Leucine (1,2-$^{13}C_2$, 99%)	0.25 g
CLM-2262-H	L-Leucine ($^{13}C_6$, 99%)	0.05 g, 0.1 g, 0.25 g
DLM-1259	L-Leucine (5,5,5-D_3, 99%)	1 g, 5 g
DLM-4212	L-Leucine (isopropyl-D_7, 98%)	1 g
DLM-567	L-Leucine (D_{10}, 98%)	0.25 g
NLM-142	L-Leucine (^{15}N, 98%)	0.5 g, 1 g
OLM-2041	L-Leucine ($^{18}O_2$, 94%)	0.25 g
CNLM-615	L-Leucine (1-^{13}C, 99%; ^{15}N, 98%)	1 g
CNLM-615-95	L-Leucine (1-^{13}C, 99%; ^{15}N, 93-95%)	1 g
CNLM-3450	L-Leucine (2-^{13}C, 99%; ^{15}N, 98%)	0.5 g
CNLM-281-H	L-Leucine ($^{13}C_6$, 99%; ^{15}N, 99%)	0.05 g, 0.1 g, 0.25 g
DNLM-4642	L-Leucine (D_{10}, 98%; ^{15}N, 97%)	0.25 g, 0.5 g
CDNLM-6808	L-Leucine ($^{13}C_6$, 97-99%; D_{10}, 97-99%; ^{15}N, 97-99%)	0.25 g
ULM-8203	L-Leucine (unlabeled)	Please inquire
DLM-476	L-Leucine, *N*-acetyl (D_{10}, 98%)	0.25 g
CLM-10684	L-Leucine·HCl (1-^{13}C, 99%)	Please inquire
CLM-749	DL-Lysine·2HCl (1-^{13}C, 99%)	1 g
DLM-8941	DL-Lysine·2HCl (4,4,5,5-D_4, 96-98%)	Please inquire
NLM-1031	DL-Lysine·2HCl (ε-^{15}N, 98%)	0.1 g
CNLM-3452	DL-Lysine·2HCl (1-^{13}C, 99%; ε-^{15}N, 99%)	Please inquire
CNLM-3453	DL-Lysine·2HCl (2-^{13}C, 99%; ε-^{15}N, 99%)	0.1 g
DLM-4731	L-Lysine, *N*-ε-carboxymethyl (4,4,5,5-D_4, 96-98%)	Please inquire
CLM-653	L-Lysine·2HCl (1-^{13}C, 99%)	0.25 g, 0.5 g
CLM-632	L-Lysine·2HCl (6-^{13}C, 99%)	0.25 g
CLM-2247-H	L-Lysine·2HCl ($^{13}C_6$, 99%)	0.05 g, 0.1 g, 0.25 g, 0.5 g, 1 g
DLM-2640	L-Lysine·2HCl (4,4,5,5-D_4, 96-98%)	0.1 g, 0.25 g, 0.5 g, 1 g

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Free Amino Acids and Their Derivatives *(continued)*

Catalog No.	Description	Unit Size
DLM-2641	L-Lysine·2HCl (3,3,4,4,5,5,6,6-D_8, 98%)	0.25 g
DLM-570	L-Lysine·2HCl (D_9, 98%)	0.1 g
NLM-143	L-Lysine·2HCl (α-^{15}N, 95-99%)	0.25 g, 1 g
NLM-631	L-Lysine·2HCl (ε-^{15}N, 98%)	0.5 g
NLM-1554	L-Lysine·2HCl ($^{15}N_2$, 98%)	0.1 g
CNLM-7821	L-Lysine·2HCl (1-^{13}C, 99%; α-^{15}N, 98%)	Please inquire
CNLM-3454	L-Lysine·2HCl (6-^{13}C, 99%; ε-^{15}N, 98%)	Please inquire
CNLM-291-H	L-Lysine·2HCl ($^{13}C_6$, 99%; $^{15}N_2$, 99%)	0.05 g, 0.1 g, 0.25 g, 0.5 g, 1 g
DNLM-7545	L-Lysine·2HCl (D_9, 98%; $^{15}N_2$, 98%)	0.25 g
CDNLM-6810	L-Lysine·2HCl ($^{13}C_6$, 97-99%; D_9, 97-99%; $^{15}N_2$, 97-99%)	0.25 g
ULM-8766	L-Lysine·2HCl (unlabeled)	0.05 g, 0.1 g
NLM-1683	DL-Lysine·HCl·H_2O (α-^{15}N, 99%)	1 g
CLM-7356	D-Methionine (1-^{13}C, 99%) CP 96%	Please inquire
CLM-6191	DL-Methionine (1-^{13}C, 99%)	Please inquire
DLM-10774	DL-Methionine (*S*-methyl-D_3, 98%)	Please inquire
DLM-2933	DL-Methionine (3,3,4,4-D_4, 98%)	Please inquire
DLM-9019	DL-Methionine (3,3,4,4-D_4; methyl-D_3, 98%)	Please inquire
CDNLM-8026	DL-Methionine ($^{13}C_5$, 97-99%; D_8, 97-99%; ^{15}N, 97-99%)	Please inquire
CLM-206	L-Methionine (methyl-^{13}C, 99%)	1 g
CLM-3267	L-Methionine (1-^{13}C, 99%)	0.25 g, 1 g
CLM-893-H	L-Methionine ($^{13}C_5$, 99%)	0.05 g, 0.1 g, 0.25 g
DLM-431	L-Methionine (methyl-D_3, 98%)	1 g, 5 g
DLM-6797	L-Methionine (2,3,3,4,4-D_5; methyl-D_3, 98%)	0.1 g
NLM-752	L-Methionine (^{15}N, 96-98%)	0.5 g, 1 g
CDLM-760	L-Methionine (1-^{13}C, 99%; methyl-D_3, 98%)	Please inquire
CDLM-9289	L-Methionine (methyl-^{13}C, 99%; methyl-D_3, 98%)	0.25 g, 1 g
CDLM-8885	L-Methionine (methyl-$^{13}CH_3$, 99%; 2,3,3,4,4-D_5, 98%)	0.5 g, 1 g
CNLM-7807	L-Methionine (1-^{13}C, 99%; ^{15}N, 98%)	0.25 g
CNLM-9774	L-Methionine (1,2,3,4-$^{13}C_4$, 99%; ^{15}N, 98%)	Please inquire
CNLM-759-H	L-Methionine ($^{13}C_5$, 99%; ^{15}N, 99%)	0.05 g, 0.1 g, 0.25 g
DNLM-7179	L-Methionine (D_8, 98%; ^{15}N, 98%)	0.25 g
CDNLM-6798	L-Methionine ($^{13}C_5$, 97-99%; D_8, 97-99%; ^{15}N, 97-99%)	Please inquire
CLM-8002	L-Methionine sulfone (1-^{13}C, 99%)	Please inquire
DLM-10673	3-Methylcrotonylglycine (glycine-2,2-D_2, 98%	Please inquire
CNLM-8111	3-Methylcrotonylglycine (glycine-$^{13}C_2$, 98%; ^{15}N, 98%)	Please inquire
DLM-6668	DL-Ornithine·HCl (D_7, 98%)	Please inquire
CLM-1036	L-Ornithine·HCl (1,2-$^{13}C_2$, 99%)	0.1 g
CLM-4724-H	L-Ornithine·HCl ($^{13}C_5$, 99%)	0.1 g
DLM-4261	L-Ornithine·HCl (5,5-D_2, 98%)	0.25 g
DLM-6046	L-Ornithine·HCl (4,4,5,5-D_4, 95%)	Please inquire
DLM-2969	L-Ornithine·HCl (3,3,4,4,5,5-D_6, 98%)	0.1 g, 0.25 g
DLM-6669	L-Ornithine·HCl (D_7, 98%)	0.25 g
NLM-2212	L-Ornithine·HCl (α-^{15}N, 98%)	Please inquire
NLM-2174	L-Ornithine·HCl (5-^{15}N, 98%)	Please inquire
NLM-3610	L-Ornithine·HCl ($^{15}N_2$, 98%)	0.25 g
CDLM-3873	L-Ornithine·HCl (5-^{13}C, 99%; 4,4,5,5-D_4, 95%)	Please inquire
CNLM-7578-H	L-Ornithine·HCl ($^{13}C_5$, 99%; $^{15}N_2$, 99%)	Please inquire
DLM-4526	D-Phenylalanine (ring-D_5, 97%)	Please inquire
CLM-761	DL-Phenylalanine (1-^{13}C, 99%)	Please inquire
CLM-7486	DL-Phenylalanine (ring-$^{13}C_6$, 99%)	Please inquire
DLM-2983	DL-Phenylalanine (2-D, 98%)	1 g
DLM-2986	DL-Phenylalanine (ring-D_5, 98%)	1 g

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
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Catalog No.	Description	Unit Size
NLM-3434	DL-Phenylalanine (^{15}N, 98%)	Please inquire
CLM-762	L-Phenylalanine (1-^{13}C, 99%)	1 g
CLM-1631	L-Phenylalanine (2-^{13}C, 99%) CP 97%	0.05 g, 0.25 g
CLM-1053	L-Phenylalanine (3-^{13}C, 99%)	0.1 g, 0.25 g
CLM-1055	L-Phenylalanine (ring-$^{13}C_6$, 99%)	0.25 g
CLM-2250-H	L-Phenylalanine ($^{13}C_9$, 99%)	0.25 g, 0.5 g, 1 g
DLM-2984	L-Phenylalanine (2-D, 95%)	0.5 g
DLM-2985	L-Phenylalanine (3,3-D_2, 98%)	0.1 g, 0.5 g, 1 g
DLM-1258	L-Phenylalanine (ring-D_5, 98%)	1 g, 5 g
DLM-372	L-Phenylalanine (D_8, 98%)	1 g
NLM-108	L-Phenylalanine (^{15}N, 98%)	0.5 g, 1 g
CNLM-7611	L-Phenylalanine (2,3-$^{13}C_2$, 99%; ^{15}N, 98%)	Please inquire
CNLM-575-H	L-Phenylalanine ($^{13}C_9$, 99%; ^{15}N, 99%)	0.1 mg, 0.1 g, 0.25 g, 0.5 g, 1 g
DNLM-7180	L-Phenylalanine (D_8, 98%; ^{15}N, 98%)	0.25 g, 0.5 g
CDNLM-6811	L-Phenylalanine ($^{13}C_9$, 97-99%; D_8, 97-99%; ^{15}N, 97-99%)	0.25 g
ULM-8205	L-Phenylalanine (unlabeled)	0.1 mg
DLM-9715	3-Phenylpropionylglycine (2,2-D_2, 98%)	Please inquire
CNLM-9169	Pipecolic acid (peperidine 2-carboxylic acid) ($^{13}C_6$, 98%; ^{15}N, 98%)	Please inquire
CLM-2479	DL-Proline (1-^{13}C, 99%)	Please inquire
DLM-2657	DL-Proline (2,3,3,4,4,5,5-D_7, 97-98%)	0.25 g
NLM-1689	DL-Proline (^{15}N, 98%)	Please inquire
CLM-510	L-Proline (1-^{13}C, 99%)	0.25 g
CLM-2260-H	L-Proline ($^{13}C_5$, 99%)	0.1 g, 0.25 g, 0.5 g
DLM-10775	L-Proline (2,5,5-D_3, 98%)	Please inquire
DLM-487	L-Proline (D_7, 97-98%)	0.1 g, 0.25 g
NLM-835	L-Proline (^{15}N, 98%)	0.25 g, 0.5 g
CNLM-7822	L-Proline (1-^{13}C, 99%; ^{15}N, 98%)	Please inquire
CNLM-436-H	L-Proline ($^{13}C_5$, 99%; ^{15}N, 99%)	0.1 g, 0.25 g, 0.5 g
DNLM-7562	L-Proline (D_7, 98%; ^{15}N, 98%)	0.25 g
CDNLM-6812	L-Proline ($^{13}C_5$, 97-99%; D_7, 97-99%; ^{15}N, 97-99%)	0.25 g
ULM-8333	L-Proline (unlabeled)	0.05 g, 0.1 g
DLM-9778	*trans*-4-Hydroxy-L-proline (2,5,5-D_3, 98%) CP 97%	Please inquire
DLM-10579	*trans*-4-Hydroxy-L-proline (3,3,4,5,6,-D_5, 96%) (contains up to 5% *cis*)	Please inquire
CLM-7944	3-(3-Methyl-1H-pyrazol-5-yl)propanoic acid (MPP) (methyl-^{13}C, pyrazolyl-$^{13}C_3$, 3-^{13}C, 99%)	0.1 mg
DLM-6874	Sarcosine·HCl (*N*-methylglycine·HCl) (methyl-D_3, 98%)	0.1 g, 0.25 g
CNLM-9699	Sarcosine·HCl (*N*-methylglycine·HCl) ($^{13}C_3$, 99%; ^{15}N, 98%)	Please inquire
CLM-1075	DL-Serine (1-^{13}C, 99%)	Please inquire
CLM-496	DL-Serine (2-^{13}C, 99%)	Please inquire
CLM-497	DL-Serine (3-^{13}C, 99%)	Please inquire
DLM-1073	DL-Serine (2,3,3-D_3, 98%)	1 g
NLM-1531	DL-Serine (^{15}N, 98%)	Please inquire
CNLM-4207	DL-Serine ($^{13}C_3$, 98%; ^{15}N, 98%)	Please inquire
CLM-1573	L-Serine (1-^{13}C, 99%)	0.25 g
CLM-2013	L-Serine (2-^{13}C, 99%)	0.1 g
CLM-1572	L-Serine (3-^{13}C, 99%)	0.1 g, 0.25 g
CLM- 1574-H	L-Serine ($^{13}C_3$, 99%)	0.1 g, 0.25 g, 0.5 g
DLM-161	L-Serine (3,3-D_2, 98%)	0.1 g
DLM-582	L-Serine (2,3,3-D_3, 98%)	0.1 g, 0.5 g
NLM-2036	L-Serine (^{15}N, 98%)	0.5 g, 1 g
OLM-9960	L-Serine (carboxyl-$^{18}O_2$, 95%)	Please inquire
CNLM-7814	L-Serine (1-^{13}C, 99%; ^{15}N, 98%)	0.25 g
CNLM-474-H	L-Serine ($^{13}C_3$, 99%; ^{15}N, 99%)	0.1 g, 0.25 g, 0.5 g

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Free Amino Acids and Their Derivatives *(continued)*

Catalog No.	Description	Unit Size
DNLM-6863	L-Serine (2,3,3-D_3, 98%; ^{15}N, 98%)	0.25 g
CDNLM-6813	L-Serine ($^{13}C_3$, 97-99%; D_3, 97-99%; ^{15}N, 97-99%)	0.25 g
DLM-10873	L-Serine, *N*-acetyl (2,3,3,-D_3, 98%)	Please inquire
CLM-3949	Sodium glutamate·XH_2O ($^{13}C_5$, 97-98%) (may be hydrate)	0.25 g
DLM-9713	*N*-Suberylglycine (2,2-D_2, 98%) CP 97%	Please inquire
CNLM-8183	Suberylglycine (glycine-$^{13}C_2$, 98%; ^{15}N, 98%)	Please inquire
DLM-8057	Taurine (D_4, 98%) CP 95%	0.1 g, 0.25 g
CLM-6622	Taurine (1,2-$^{13}C_2$, 98%)	0.25 g, 0.5 g
DLM-8057	Taurine (D_4, 98%) CP 95%	0.1 g, 0.25 g
NLM-4472	Taurine (^{15}N, 98%)	Please inquire
CNLM-10253	Taurine ($^{13}C_2$, 99%; ^{15}N, 98%)	0.01 g
CLM-447	L-Threonine (1-^{13}C, 99%)	0.5 g
CLM-2261	L-Threonine ($^{13}C_4$, 97-99%)	0.1 g, 0.25 g, 0.5 g
DLM-1693	L-Threonine (D_5, 98%)	0.1 g
NLM-742	L-Threonine (^{15}N, 98%)	0.25 g, 0.5 g
CDLM-9307	L-Threonine (4-^{13}C, 97%; 2,3-D_2, 96-98%)	0.1 g, 0.5 g
CNLM-587	L-Threonine ($^{13}C_4$, 97-99%; ^{15}N, 97-99%)	0.1 g, 0.25 g, 0.5 g
DNLM-7367	L-Threonine (D_5, 97%; ^{15}N, 98%)	0.25 g, 0.5 g
CDNLM-6814	L-Threonine ($^{13}C_4$, 97-99%; D_5, 97-99%; ^{15}N, 97-99%)	0.25 g
ULM-8800	L-Threonine (unlabeled)	Please inquire
CLM-6725	L-Thyroxine (tyrosine-ring-$^{13}C_6$, 99%) CP 90%	0.1 mg
CLM-8931	L-Thyroxine (ring-$^{13}C_{12}$, 99%) CP 97%	0.1 mg
ULM-8184	L-Thyroxine (unlabeled)	0.2 mg
CNLM-8110	Tiglylglycine (glycine-$^{13}C_2$, 98%; ^{15}N, 98%)	Please inquire
DLM-10522	D-Tryptophan (indole-D_5, 98%)	Please inquire
CLM-778	L-Tryptophan (1-^{13}C, 99%)	0.25 g
CLM-1543	L-Tryptophan (indole-2-^{13}C, 98%)	0.25 g
CLM-716	L-Tryptophan (indole-3-^{13}C, 95-99%)	0.25 g
CLM-717	L-Tryptophan (indole-4-^{13}C, 99%) CP 95%	Please inquire
CLM-4290-H	L-Tryptophan ($^{13}C_{11}$, 99%)	0.1 g
DLM-1092	L-Tryptophan (indole-D_5, 98%)	0.5 g
DLM-6903	L-Tryptophan (D_8, 97-98%)	0.25 g
NLM-1695	L-Tryptophan (α-^{15}N, 95-99%)	0.1 g
NLM-1208	L-Tryptophan (indole-^{15}N, 98%)	0.25 g, 0.5 g
NLM-800	L-Tryptophan ($^{15}N_2$, 98%)	0.25 g, 0.5 g
CNLM-2475-H	L-Tryptophan ($^{13}C_{11}$, 99%; $^{15}N_2$, 99%)	0.1 g
DNLM-6904	L-Tryptophan (D_8, 98%; $^{15}N_2$, 98%)	0.25 g
CDNLM-6816	L-Tryptophan ($^{13}C_{11}$, 97-99%; D_8, 97-99%; $^{15}N_2$, 97-99%)	0.25 g
CLM-9097	3-bromo-L-Tyrosine (ring-$^{13}C_6$, 99%)	10 mg
CLM-7103	3-chloro-L-Tyrosine (ring-$^{13}C_6$, 99%) CP 95%	10 mg
CLM-10524	3-iodo-L-Tyrosine ($^{13}C_6$, 99%)	10 mg
CLM-7104	3-nitro-L-Tyrosine (ring-$^{13}C_6$, 99%) CP 94%	10 mg
CLM-448	DL-Tyrosine (1-^{13}C, 99%)	Please inquire
DLM-137	DL-Tyrosine (3,3-D_2, 98%)	Please inquire
DLM-2914	DL-Tyrosine (ring-3,5-D_2, 98%)	Please inquire
CLM-776	L-Tyrosine (1-^{13}C, 99%)	1 g
CLM-437	L-Tyrosine (2-^{13}C, 99%)	0.1 g, 0.25 g
CLM-3378	L-Tyrosine (3-^{13}C, 99%)	0.1 g, 0.25 g
CLM-622	L-Tyrosine (phenol-4-^{13}C, 95-99%)	0.25 g
CLM-623	L-Tyrosine (phenol-3,5-$^{13}C_2$, 95-99%)	0.25 g
CLM-1542	L-Tyrosine (ring-$^{13}C_6$, 99%)	0.25 g
CLM-2263-H	L-Tyrosine ($^{13}C_9$, 99%)	0.1 g, 0.25 g, 0.5 g
DLM-2317	L-Tyrosine (3,3-D_2, 98%)	0.5 g, 1 g

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Catalog No.	Description	Unit Size
DLM-449	L-Tyrosine (ring-3,5-D_2, 98%)	1 g, 5 g
DLM-2917	L-Tyrosine (ring-2,6-D_2, 2-D, 98%)	Please inquire
DLM-451	L-Tyrosine (ring-D_4, 98%)	0.5 g, 1 g
DLM-589	L-Tyrosine (D_7, 98%)	0.05 g, 0.1 g
NLM-590	L-Tyrosine (^{15}N, 98%)	0.5 g
OLM-621	L-Tyrosine (phenol-^{17}O, 35-40%)	0.25 g, 0.5 g
OLM-8696	L-Tyrosine (phenol-^{18}O, 85-90%)	Please inquire
CDLM-2369	L-Tyrosine (ring-$^{13}C_6$, 99%; 3,3-D_2, 30%)	0.1 g
CNLM-7809	L-Tyrosine (1-^{13}C, 99%; ^{15}N, 98%)	0.25 g
CNLM-7610	L-Tyrosine (2,3-$^{13}C_2$, 99%; ^{15}N, 98%)	Please inquire
CNLM-439-H	L-Tyrosine ($^{13}C_9$, 99%; ^{15}N, 99%)	0.1 g, 0.25 g, 0.5 g
DNLM-7373	L-Tyrosine (D_7, 97-98%; ^{15}N, 98%)	0.25 g
CDNLM-6815	L-Tyrosine ($^{13}C_9$, 97-99%; D_7, 97-99%; ^{15}N, 97-99%)	0.25 g
DLM-10940	L-Tyrosine, *N*-acetyl (acetyl-D_3, 98%)	Please inquire
CLM-10543	*cis*-Urocanic acid (1,2,3-$^{13}C_3$, 99%)	1 mg, 2 mg, 5 mg
CLM-166	DL-Valine (1-^{13}C, 99%)	Please inquire
CLM-3277	DL-Valine (2-^{13}C, 99%)	Please inquire
DLM-311	DL-Valine (D_8, 98%)	0.5 g, 1 g
NLM-236	DL-Valine (^{15}N, 98%)	Please inquire
CLM-470	L-Valine (1-^{13}C, 99%)	1 g
CLM-3050	L-Valine (2-^{13}C, 99%)	0.25 g
CLM-9217	L-Valine (dimethyl-$^{13}C_2$, 99%)	0.25 g, 1 g
CLM-2249-H	L-Valine ($^{13}C_5$, 99%)	0.1 mg, 0.25 g, 1 g
DLM-7732	L-Valine (3-D, 98%)	1 g
DLM-4364	L-Valine (2,3-D_2, 98%)	0.1 g, 0.25 g
DLM-488	L-Valine (D_8, 98%)	0.25 g, 0.5 g
NLM-316	L-Valine (^{15}N, 98%)	0.5 g, 1 g
CNLM-3466	L-Valine (1-^{13}C, 99%; ^{15}N, 98%)	0.25 g
CNLM-8678	L-Valine (2-^{13}C, 99%; ^{15}N, 98%)	Please inquire
CNLM-442-H	L-Valine ($^{13}C_5$, 99%; ^{15}N, 99%)	0.25 g, 0.5 g, 1 g
DNLM-4643	L-Valine (D_8, 96%; ^{15}N, 96%)	0.25 g, 0.5 g
CDNLM-4281	L-Valine ($^{13}C_5$, 95-97%; 2,3-D_2, 97%; ^{15}N, 96-99%)	0.1 g, 0.25 g
CDNLM-6817	L-Valine ($^{13}C_5$, 97-99%; D_8, 97-99%; ^{15}N, 97-99%)	0.25 g
ULM-8202	L-Valine (unlabeled)	0.1 mg
NLM-7888	L-Valine, *N*-acetyl (^{15}N, 98%)	0.5 g

“We concluded that CIL is the best-positioned company in the world to meet our future expected demands in terms of both material quantity and material quality. As we expand the use of our SILK™-based biomarkers beyond research services and into clinical diagnostic applications, CIL will be an instrumental partner to help us qualify our test kits to produce L-leucine under GMP scaled-up conditions.”

Joel B. Braunstein, MD, MBA
Cofounder, President, and CEO, C_2N Diagnostics

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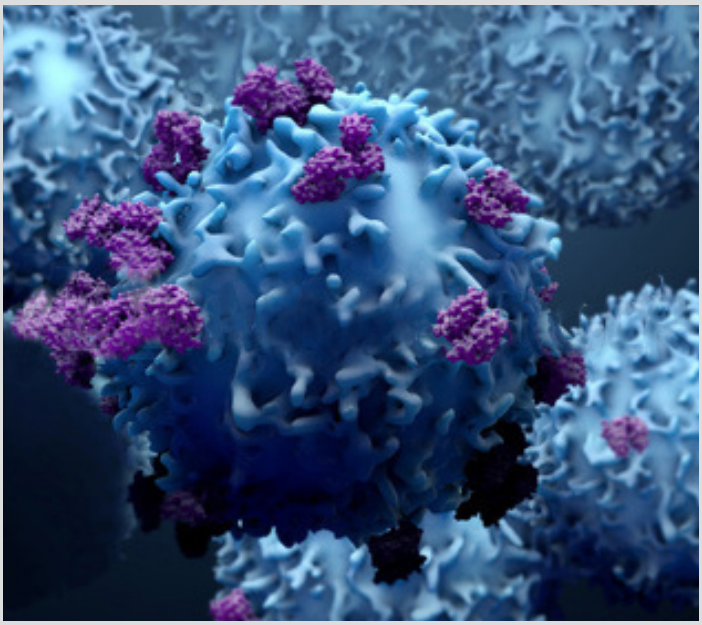
Using Stable Isotopes to Decipher Systems-Level *in vivo* Metabolism with MS and MRI

Researcher Perspective

Joseph Ippolito, MD, PhD, Assistant Professor of Radiology
Mallinckrodt Institute of Radiology, Washington University School of Medicine, St. Louis, MO USA

In my laboratory, we focus on glutamine and branched chain amino acid metabolism in mitochondria as therapeutic targets for lethal cancers of the prostate and brain. We use ^{13}C, ^{15}N, and ^{2}H stable isotopes in concert with MS- and NMR-based workflows to trace central carbon metabolism in cell culture and rodent cancer models. This allows us to combine that information with metabolic imaging strategies to understand cancer metabolism from a systems biology perspective.

Systems biology is a broad field that can be defined as the study of how complex biological systems function through the identification and integration of complex networks at the cellular and molecular levels. The recent revolution in genomics has introduced a wealth of information that has increased our understanding of health and disease. However, biological systems are regulated on multiple levels, indicating that genomics-level analyses will not be sufficient to define the function of a biological system by itself. This also has clinical implications, as the identification of tumor DNA mutations in a patient may not be associated with a readily available, clinically actionable cancer therapy. Therefore, understanding the functional readout of the genome, specifically, how downstream pathways enhance cell and organ function, may lead to new approaches for diagnosis and treatment of human disease.



One well-known functional readout of the genome is metabolism, or the summation of nutrient utilization pathways and their contributions to biosynthetic and energetic pathways in the cell. Stable isotopes, (notably ^{2}H, ^{13}C, ^{15}N, and ^{18}O), that exist in thousands of available compounds have been used for decades to probe metabolism in both health and disease on the clinical level. In this scenario, a stable isotope tracer is administered either orally or intravenously to the patient. Once *in vivo*, the labeled tracer undergoes metabolism to the same degree as its equivalent unlabeled form. Tissues or biofluids are then obtained from the patient and analyzed with a MS-based workflow to assess the isotopic enrichment of metabolites within metabolic pathways of interest. Examples of clinically applicable methods using stable isotopes and MS include a breath test for *H. pylori* infection (e.g., with ^{13}C urea), the assessment of body composition and energy expenditure (e.g., with ^{2}H or ^{18}O-labeled H_2O), and the assessment of macronutrient metabolism (e.g., with 1-^{13}C leucine, $^{2}H_5$ phenylalanine, $^{13}C_3$ glycerol, 1-^{13}C glucose).[1,2] Despite the exquisite sensitivity and the ability to resolve the tracer and its metabolites, one limitation of MS is the loss of information regarding the distribution of the tracer and its metabolites both within a specific tissue compartment and throughout the body. Imaging mass spectrometry (IMS) takes a next step toward providing this information that can spatially register isotopically labeled metabolites in tissue sections.[3,4] However, noninvasive systems-level information still cannot be obtained with this method. Thus, there is a pressing need for imaging methods to quantify tracer metabolism. Such methods should provide clinicians with information about metabolic pathways and regulatory networks to help guide the selection of appropriate therapies.

The use of stable isotopes as metabolic contrast agents in magnetic resonance spectroscopic imaging (MRSI) has been gaining traction in the research laboratory and the clinic. Hyperpolarized (HP) ^{13}C MRSI with ^{13}C pyruvate is one example. In this imaging modality, the stable isotope, 1-^{13}C pyruvate in this case, is dissolved in an aqueous solution and placed in a hyperpolarizer where the stable isotope undergoes dynamic nuclear polarization (DNP). This process "supercharges" the ^{13}C in the pyruvate resulting in signal

enhancement by a factor of ~10^5. This improves the ability to measure the *in vivo* conversion of pyruvate to its downstream metabolites including lactate. HP MRSI with ^{13}C pyruvate is currently being used in many active clinical trials for cancer with an emphasis on prostate cancer, cervical cancer, and gliomas, as well as metabolic diseases involving the heart and liver. In addition to 1-^{13}C pyruvate, additional tracers are being developed. This includes, but is not limited to, 2-^{13}C pyruvate, 1-^{13}C acetate, 1-^{13}C alanine, ^{13}C urea, $^{13}C/^{15}N_2$ urea, ^{13}C bicarbonate, and 1,4-$^{13}C_2$ fumarate.[5-7] HP MRSI still faces many limitations, including expensive instrumentation and lack of compatible isotopes for *in vivo* imaging. Because of these limitations, there is a push to develop alternate metabolic imaging methods.

An alternative to ^{13}C MRSI is ^{2}H-based MRSI or deuterium metabolic imaging (DMI). DMI is rapidly gaining traction within the metabolic imaging community.[8] Recently, DMI with 6,6′-$^{2}H_2$ glucose and $^{2}H_3$ acetate successfully demonstrated noninvasive metabolic maps with high spatial and high temporal resolution in not only rodents, but also in patients with brain tumors.[9] Although DMI has been successfully performed with only a limited number of compounds, DMI represents a new way to use deuterated stable isotopes to image glycolytic flux rates in living systems. These initial studies of stable isotope imaging focused on glucose metabolism; however, the DMI approach can be expanded to all types of stable isotopes to interrogate multiple metabolic pathways. In fact, the development of MRSI with multinuclear capabilities is already in use, suggesting that multiple metabolic pathways may be imaged simultaneously in a living system with ^{13}C, ^{15}N, and ^{2}H.

Despite the merits of metabolic imaging, there exists a prevailing need for validating the metabolite chemical shift signals that are acquired during imaging with a "gold standard" for those metabolites in the tissues. Stable isotope mass spectrometry has a clear role in this process, as tissues or biofluids obtained following imaging can then be analyzed and used to validate the imaging data obtained under currently available clinical workflows. This combination of analytical techniques is critical in my lab toward accomplishing the research aims of better understanding metabolism at the systems biology level.

In summary, the combination of conventional MS and imaging using stable isotopes has the potential to advance the research and clinical fields. The synergy of their strengths in providing spatially resolved metabolic flux in real time with coordinated validation and metabolic pathway mapping outweighs any limitations that these techniques face individually. I believe that this integration, and the use of stable isotopes therein, will only grow as the applications evolve.

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Stable Isotope Labeling Kinetics (SILK™) to Measure the Metabolism of Brain-Derived Proteins Implicated in Neurodegeneration

Researcher Perspective


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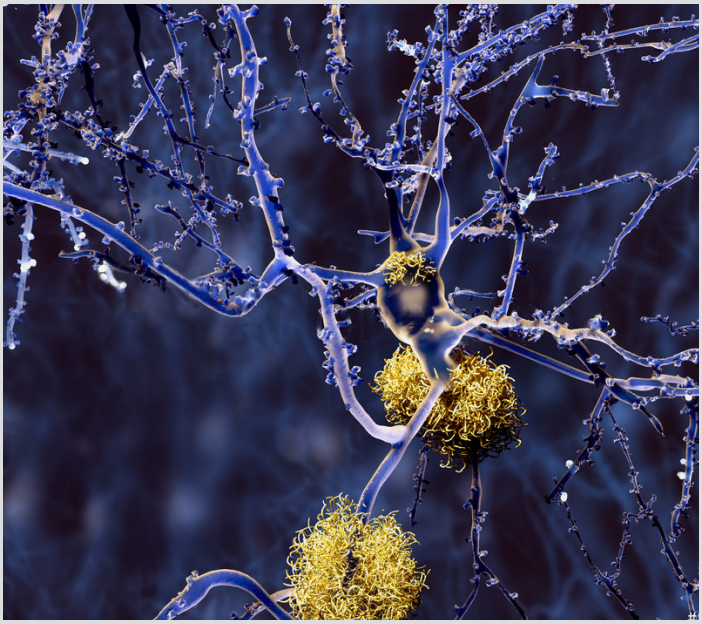
Alzheimer's disease (AD) is a progressive neurodegenerative disease on track to becoming one of the greatest challenges to the healthcare system in the 21st century. AD affects millions of people in one way or another. It causes long-term memory loss, confusion, mood swings, and, eventually, loss of bodily functions. Sufferers from Alzheimer's tend to withdraw from family, friends, and other members of society as symptoms worsen. To date, there are no known cures, and patients and families of patients struggle with symptoms until death. Recent research has shown hope for early diagnosis and treatment. Much of this research has focused on amyloid plaques that are present in the brains of Alzheimer's patients. One approach to studying this unnatural accumulation of amyloid plaques is to monitor synthesis and clearance of the beta-amyloid peptide (Aβ) using L-leucine ($^{13}C_6$, 99%) (CLM-2262-H).

Quantifying alterations in protein synthesis and clearance rates is vital to understanding disease pathogenesis. It also enables a determination of the effects of novel drug treatments on target protein metabolism. The powerful combination of *in vivo* stable isotope labeling and mass spectrometry has made this possible.



Alzheimer's neurons with amyloid plaque.

Specifically, researchers at Washington University have developed a proprietary method to measure the metabolism of Aβ and other proteins in the human central nervous system (CNS). C_2N Diagnostics, has commercialized this platform for use in CNS drug development, disease detection, and progression monitoring.

In this method, individuals receive an administration of L-leucine ($^{13}C_6$, 99%) followed by serial cerebrospinal fluid (CSF) and plasma sampling. The clinical site that obtains these biological samples then sends them off to a central laboratory (i.e., at C_2N Diagnostics) for processing and analysis. Mass spectrometry quantifies the $^{13}C_6$ leucine enrichment of Aβ to obtain rates of amyloid production and degradation. The SILK platform can also assess the kinetics of apolipoproteinE (ApoE) in cell culture as well as the human brain, among other proteins implicated in neurodegeneration. ApoE is the greatest known genetic risk factor for late-onset Alzheimer's disease. Elucidating the metabolism of the various ApoE isoforms is beginning to provide important insights about the role that ApoE plays in the disease progression of AD.

The SILK platform enables the testing of Alzheimer's drugs *in vivo* to determine the effects of the drug on the CNS and other systems in the body. This information is beneficial as a therapeutic biomarker for use in early clinical development. It has the potential to halt undeserving drug candidates early during the development process; thereby, reducing high downstream costs and wasted time to pharmaceutical companies.

Since most leucine-containing proteins are labeled after $^{13}C_6$ l eucine infusion, this robust and versatile technique can be used as a method to determine the turnover rates for many different proteins. It can identify and quantify potential biomarkers for diseases and metabolic disorders beyond Alzheimer's. Please see the list at right for peer-reviewed references that describe the utility of this method.

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Protected Amino Acids

Stable isotope-labeled peptides have demonstrated to be an effective means to quantify endogenous proteins in basic and translational bottom-up proteomics. In these experiments, the labeled peptides are employed as internal standards, where they serve as molecular surrogates of the target proteins enabling relative or absolute protein quantitation.

From a development standpoint, the peptides are produced in a step-wise manner by solid phase peptide synthesis using amino acid building blocks with *N*-terminal, 9-fluorenylmethoxycarbonyl (FMOC) or *tert*-butoxycarbonyl (*t*-BOC) protecting groups. To help facilitate the synthesis of isotopically labeled peptides, CIL offers an assortment of uniformly or partially labeled FMOC and *t*-BOC amino acids.

Catalog No.	Description	Unit Size
CLM-818	L-Alanine-*N*-Fmoc (1-^{13}C, 99%)	1 g
CLM-3638	L-Alanine-*N*-Fmoc (2-^{13}C, 99%)	0.25 g
CLM-1142	L-Alanine-*N*-Fmoc (3-^{13}C, 99%)	1 g
CLM-7785	L-Alanine-*N*-Fmoc ($^{13}C_3$, 97-99%)	0.25 g
DLM-7316	L-Alanine-*N*-Fmoc (3,3,3-D_3, 98%)	1 g
DLM-8168	L-Alanine-*N*-Fmoc (2,3,3,3-D_4, 98%)	0.5 g
NLM-614	L-Alanine-*N*-Fmoc (^{15}N, 98%)	1 g
CNLM-4355-H	L-Alanine-*N*-Fmoc ($^{13}C_3$, 99%; ^{15}N, 99%)	0.1 g, 0.25 g
CDNLM-7852	L-Alanine-*N*-Fmoc ($^{13}C_3$, 97-99%; D_4, 97-99%; ^{15}N, 97-99%)	Please inquire
CLM-2150	L-Alanine-*N*-*t*-Boc (1-^{13}C, 99%)	1 g
CLM-2011	L-Alanine-*N*-*t*-Boc (2-^{13}C, 98-99%)	0.25 g
CLM-2151	L-Alanine-*N*-*t*-Boc (3-^{13}C, 99%)	0.5 g, 1 g
CLM-3589	L-Alanine-*N*-*t*-Boc ($^{13}C_3$, 97-99%)	0.25 g
DLM-649	L-Alanine-*N*-*t*-Boc (2-D, 98%)	Please inquire
DLM-2793	L-Alanine-*N*-*t*-Boc (3,3,3-D_3, 99%)	1 g
NLM-1903	L-Alanine-*N*-*t*-Boc (^{15}N, 98%)	0.25 g, 0.5 g, 1 g
CNLM-6014	L-Alanine-*N*-*t*-Boc (2-^{13}C, 99%; ^{15}N, 96-99%)	Please inquire
CNLM-2394	L-Alanine-*N*-*t*-Boc ($^{13}C_3$, 97-99%; ^{15}N, 97-99%)	0.05 g, 0.1 g
CLM-8475-H	L-Arginine-*N*-Fmoc, PBF-OH ($^{13}C_6$, 99%) contains solvent	1 g
NLM-8841	L-Arginine-*N*-Fmoc, PBF-OH ($^{15}N_4$, 98%) contains solvent	0.1 g/compound
CNLM-8474-H	L-Arginine-*N*-Fmoc, PBF-OH ($^{13}C_6$, 99%; $^{15}N_4$, 99%) contains solvent	0.1 g, 0.25 g, 0.5 g, 1 g
CNLM-4354	L-Asparagine-*N*-Fmoc ($^{13}C_4$, 97-99%; $^{15}N_2$, 97-99%)	Please inquire
CNLM-6193-H	L-Asparagine-*N*-Fmoc, *N*-β-trityl ($^{13}C_4$, 99%; $^{15}N_2$, 99%)	0.1 g
NLM-4204	L-Asparagine-*N*-Fmoc, *N*-β-trityl ($^{15}N_2$, 98%)	0.1 g

Protected Amino Acids *(continued)*

Catalog No.	Description	Unit Size
CLM-4249	L-Aspartic acid-*N*-α-CBZ ($^{13}C_4$, 97-99%)	0.1 g
CNLM-4788	L-Aspartic acid-*N*-Fmoc ($^{13}C_4$, 97-99%; ^{15}N, 97-99%)	0.05 g
NLM-3493	L-Aspartic acid-*N*-*t*-Boc (^{15}N, 98%)	1 g
NLM-1908	L-Aspartic acid-*N*-*t*-Boc, β-Bz ester (^{15}N, 98%)	0.25 g
CNLM-2392	L-Aspartic acid-*N*-*t*-Boc, β-Bz ester ($^{13}C_4$, 97-99%; ^{15}N, 97-99%)	0.05 g
NLM-647	L-Aspartic acid-*N*-Fmoc, β-*O*-*t*-butyl ester (^{15}N, 98%)	0.1 g, 0.5 g, 1 g
CNLM-4752-H	L-Aspartic acid-*N*-Fmoc, β-*O*-*t*-butyl ester ($^{13}C_4$,99%; ^{15}N, 99%)	0.1 g
CLM-2403	L-Cysteine-*N*-Fmoc, *S*-benzyl (3-^{13}C, 98%)	Please inquire
DLM-4721	L-Cysteine-*N*-Fmoc, *S*-trityl (3,3-D_2, 98%)	0.1 g, 0.25 g, 0.5 g
CNLM-4722-H	L-Cysteine-*N*-Fmoc, *S*-trityl ($^{13}C_3$, 99%; ^{15}N, 99%)	0.1 g, 0.25 g
CLM-1901	L-Cysteine-*N*-*t*-Boc, *S*-benzyl (3-^{13}C, 99%)	0.25 g
NLM-3874	L-Cysteine-*N*-*t*-Boc, *S*-*P*-mebz (^{15}N, 98%)	0.25 g
NLM-8960	L-Glutamic acid-*N*-Fmoc, γ-*t*-butyl ester (^{15}N, 98%)	0.1 g
CNLM-4753-H	L-Glutamic acid-*N*-Fmoc, γ-*t*-butyl ester ($^{13}C_5$, 99%; ^{15}N, 99%) CP 96%	0.1 g
CLM-2008	L-Glutamic acid-*N*-*t*-Boc, γ-benzyl ester (1,2-$^{13}C_2$, 99%)	0.1 g
NLM-1907	L-Glutamic acid-*N*-*t*-Boc, γ-benzyl ester (^{15}N, 98%)	Please inquire
CLM-1902	L-Glutamine-*N*-*t*-Boc (1,2-$^{13}C_2$, 99%)	0.1 g
NLM-3419	L-Glutamine-*N*-*t*-Boc (α-^{15}N, 98%)	0.5 g
CNLM-4356-H	L-Glutamine-*N*-Fmoc ($^{13}C_5$, 99%; $^{15}N_2$, 99%)	Please inquire
CNLM-7252-H	L-Glutamine-*N*-Fmoc, *N*-γ-trityl ($^{13}C_5$, 99%; $^{15}N_2$, 99%)	Please inquire
CLM-3639	Glycine-*N*-Fmoc (1-^{13}C, 99%)	1 g
CLM-2387	Glycine-*N*-Fmoc (2-^{13}C, 99%)	1 g
CLM-7547	Glycine-*N*-Fmoc ($^{13}C_2$, 97-99%)	1 g
DLM-7339	Glycine-*N*-Fmoc (2,2-D_2, 98%)	1 g
NLM-694	Glycine-*N*-Fmoc (^{15}N, 98%)	1 g
CNLM-7697	Glycine-*N*-Fmoc (1-^{13}C, 99%; ^{15}N, 98%)	0.25 g
CNLM-7698	Glycine-*N*-Fmoc (2-^{13}C, 99%; ^{15}N, 98%)	0.1 g
CNLM-4357-H	Glycine-*N*-Fmoc ($^{13}C_2$, 99%; ^{15}N, 99%)	0.1 g, 0.25 g
CDNLM-7853	Glycine-*N*-Fmoc ($^{13}C_2$, 97-99%; 2,2-D_2, 97-99%; ^{15}N, 97-99%)	Please inquire
CLM-2152	Glycine-*N*-*t*-Boc (1-^{13}C, 99%)	1 g
CLM-1900	Glycine-*N*-*t*-Boc (2-^{13}C, 99%)	1 g
DLM-2153	Glycine-*N*-*t*-Boc (2,2-D_2, 98%)	1 g
NLM-2109	Glycine-*N*-*t*-Boc (^{15}N, 98%)	1 g
CNLM-9686	Glycine-*N*-*t*-Boc (2-^{13}C, 99%; ^{15}N, 98%)	Please inquire
CNLM-2412	Glycine-*N*-*t*-Boc ($^{13}C_2$, 97-99%; ^{15}N, 97-99%)	0.1 g
NLM-8010	L-Histidine-*N*-Fmoc, *N*-Im-trityl ($^{15}N_3$, 98%)	0.1 g
CLM-8043	L-Isoleucine-*N*-Fmoc (1-^{13}C, 99%)	0.25 g
CLM-7794	L-Isoleucine-*N*-Fmoc ($^{13}C_6$, 97-99%)	Please inquire
NLM-391	L-Isoleucine-*N*-Fmoc (^{15}N, 98%)	0.25 g
CNLM-4346-H	L-Isoleucine-*N*-Fmoc ($^{13}C_6$, 99%; ^{15}N, 99%)	0.1 g, 0.25 g
NLM-2167	L-Isoleucine-*N*-*t*-Boc (^{15}N, 98%)	0.25 g
CLM-10959	D-Leucine-*N*-Fmoc ($^{13}C_6$, 97-99%)	Please inquire
CLM-3691	L-Leucine-*N*-Fmoc (1-^{13}C, 99%)	1 g
CLM-7546	L-Leucine-*N*-Fmoc (1,2-$^{13}C_2$, 99%)	0.1 g
CLM-3683	L-Leucine-*N*-Fmoc ($^{13}C_6$, 97-99%)	0.1 g
DLM-7202	L-Leucine-*N*-Fmoc (5,5,5-D_3, 98%)	1 g
DLM-7575	L-Leucine-*N*-Fmoc (D_{10}, 98%)	0.25 g
NLM-2397	L-Leucine-*N*-Fmoc (^{15}N, 98%)	1 g
CNLM-4345-H	L-Leucine-*N*-Fmoc ($^{13}C_6$, 99%; ^{15}N, 99%)	0.1 g, 0.25 g
CDNLM-7854	L-Leucine-*N*-Fmoc ($^{13}C_6$, 97-99%; D_{10}, 97-99%; ^{15}N, 97-99%)	Please inquire

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
For research use only. Not for use in diagnostic procedures.

Catalog No.	Description	Unit Size
CLM-2155	L-Leucine-*N*-*t*-Boc·H_2O (1-^{13}C, 99%)	1 g
CLM-2010	L-Leucine-*N*-*t*-Boc·H_2O (2-^{13}C, 99%)	0.25 g
DLM-2736	L-Leucine-*N*-*t*-Boc·H_2O (5,5,5-D_3, 98%)	1 g
DLM-3650	L-Leucine-*N*-*t*-Boc·H_2O (D_{10}, 98%)	0.5 g
NLM-1904	L-Leucine-*N*-*t*-Boc·H_2O (^{15}N, 98%)	1 g
CNLM-2396	L-Leucine-*N*-*t*-Boc·H_2O ($^{13}C_6$, 97-99%; ^{15}N, 97-99%)	0.05 g
CLM-6194	L-Lysine-α-*N*-Fmoc, ε-*N*-*t*-Boc (1-^{13}C, 99%)	0.1 g
CLM-7865-H	L-Lysine-α-*N*-Fmoc, ε-*N*-*t*-Boc ($^{13}C_6$, 99%)	Please inquire
NLM-4631	L-Lysine-α-*N*-Fmoc, ε-*N*-*t*-Boc ($^{15}N_2$, 96-98%)	0.1 g
CNLM-4754-H	L-Lysine-α-*N*-Fmoc, ε-*N*-*t*-Boc ($^{13}C_6$, 99%; $^{15}N_2$, 99%)	0.1 g, 0.25 g, 0.5 g, 1 g
CLM-1141	L-Methionine-*N*-Fmoc (methyl-^{13}C, 99%)	Please inquire
CLM-8166	L-Methionine-*N*-Fmoc (1-^{13}C, 99%)	Please inquire
NLM-4632	L-Methionine-*N*-Fmoc (^{15}N, 98%)	Please inquire
CNLM-4358-H	L-Methionine-*N*-Fmoc ($^{13}C_5$, 97-99%; ^{15}N, 97-99%)	0.1 g
CLM-2156	L-Methionine-*N*-*t*-Boc (methyl-^{13}C, 98%)	Please inquire
DLM-10668	D-Phenylalanine-*N*-Fmoc (D_8, 98%)	Please inquire
CLM-4824	L-Phenylalanine-*N*-Fmoc (1-^{13}C, 99%)	0.5 g
CLM-3684	L-Phenylalanine-*N*-Fmoc (ring-$^{13}C_6$, 99%)	0.1 g
DLM-7786	L-Phenylalanine-*N*-Fmoc (ring-D_5, 98%)	0.25 g
DLM-8752	L-Phenylalanine-*N*-Fmoc (D_8, 98%)	0.1 g, 0.25 g
NLM-1265	L-Phenylalanine-*N*-Fmoc (^{15}N, 98%)	1 g
CNLM-4362-H	L-Phenylalanine-*N*-Fmoc ($^{13}C_9$, 99%; ^{15}N, 99%)	0.1 g, 0.25 g
CLM-2170	L-Phenylalanine-*N*-*t*-Boc (1-^{13}C, 99%)	0.5 g
CLM-2009	L-Phenylalanine-*N*-*t*-Boc (2-^{13}C, 99%)	0.25 g
CLM-2061	L-Phenylalanine-*N*-*t*-Boc (ring-$^{13}C_6$, 99%)	0.1 g
CLM-7859	L-Phenylalanine-*N*-*t*-Boc ($^{13}C_9$, 97-99%)	0.05 g
DLM-2157	L-Phenylalanine-*N*-*t*-Boc (ring-D_5, 98%)	1 g
NLM-1905	L-Phenylalanine-*N*-*t*-Boc (^{15}N, 98%)	1 g
CNLM-2393	L-Phenylalanine-*N*-*t*-Boc ($^{13}C_9$, 97-99%; ^{15}N, 97-99%)	0.05 g
CLM-8044	L-Proline-*N*-Fmoc (1-^{13}C, 99%)	0.25 g
NLM-3906	L-Proline-*N*-Fmoc (^{15}N, 98%)	0.25 g
NLM-2329	L-Proline-*N*-*t*-Boc (^{15}N, 96%)	0.25 g
CNLM-4347-H	L-Proline-*N*-Fmoc ($^{13}C_5$, 99%; ^{15}N, 97-99%)	0.1 g, 0.25 g
CNLM-8403-H	L-Serine-*N*-Fmoc ($^{13}C_3$, 99%; ^{15}N, 99%)	1 g
CLM-8167	L-Serine-*N*-Fmoc, *O*-*t*-butyl ether (1-^{13}C, 99%)	0.25 g
NLM-4630	L-Serine-*N*-Fmoc, *O*-*t*-butyl ether (^{15}N, 98%)	0.25 g
CNLM-4755-H	L-Serine-*N*-Fmoc, *O*-*t*-butyl ether ($^{13}C_3$, 99%; ^{15}N, 99%)	0.1 g
CLM-2007	L-Serine-*N*-*t*-Boc, *O*-Bz ether (2-^{13}C, 99%)	Please inquire
CLM-756	L-Serine-*N*-*t*-Boc, *O*-Bz ether (3-^{13}C, 99%)	Please inquire
NLM-2025	L-Serine-*N*-*t*-Boc, *O*-Bz ether (^{15}N, 98%)	0.1 g
NLM-8170	L-Threonine-*N*-Fmoc, *O*-*t*-butyl ether (^{15}N, 98%)	0.1 g
CNLM-7615-H	L-Threonine-*N*-Fmoc, *O*-*t*-butyl ether ($^{13}C_4$, 99%; ^{15}N, 99%)	0.1 g
NLM-3681	L-Threonine-*N*-*t*-Boc, *O*-benzyl ether (^{15}N, 98%)	Please inquire
DLM-6113	L-Tryptophan-*N*-Fmoc (indole-D_5, 98%)	0.25 g
NLM-3423	L-Tryptophan-*N*-Fmoc (α-^{15}N, 98%)	Please inquire
CNLM-6077	L-Tryptophan-*N*-Fmoc ($^{13}C_{11}$, 97-99%; $^{15}N_2$, 97-99%)	0.1 g
CNLM-9200	L-Tryptophan-*N*-Fmoc, indole-*N*-*t*-Boc (U-$^{13}C_{11}$, 97-99%; U-$^{15}N_2$, 97-99%)	Please inquire
CLM-2194	L-Tryptophan-*N*-*t*-Boc (1-^{13}C, 99%)	Please inquire
CNLM-4349-H	L-Tyrosine-*N*-Fmoc, *O*-*t*-butyl ether ($^{13}C_9$, 99%; ^{15}N, 99%)	0.1 g, 0.25 g
NLM-8169	L-Tyrosine-*N*-Fmoc, *O*-*t*-butyl ether (^{15}N, 98%)	0.1 g
DLM-2303	L-Tyrosine-*N*-*t*-Boc, *O*-Bz ether (ring-D_4, 98%)	0.25 g
NLM-1906	L-Tyrosine-*N*-*t*-Boc, *O*-Bz ether (^{15}N, 98%)	0.25 g

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
For research use only. Not for use in diagnostic procedures.

Protected Amino Acids *(continued)*

Catalog No.	Description	Unit Size
CLM-3640	L-Valine-*N*-Fmoc (1-^{13}C, 99%)	1 g
CLM-7793	L-Valine-*N*-Fmoc ($^{13}C_5$, 97-99%)	0.1 g
DLM-7784	L-Valine-*N*-Fmoc (D_8, 98%)	0.5 g
NLM-4243	L-Valine-*N*-Fmoc (^{15}N, 98%)	1 g
CNLM-4348-H	L-Valine-*N*-Fmoc ($^{13}C_5$, 99%; ^{15}N, 99%)	0.1 g, 0.25 g
CLM-2158	L-Valine-*N*-*t*-Boc (1-^{13}C, 99%)	Please inquire
DLM-3651	L-Valine-*N*-*t*-Boc (D_8, 98%)	0.5 g
NLM-2060	L-Valine-*N*-*t*-Boc (^{15}N, 98%)	0.5 g, 1 g
CNLM-2395	L-Valine-*N*-*t*-Boc ($^{13}C_5$, 97-99%; ^{15}N, 97-99%)	0.05 g

“The commercial availability of stable isotope-labeled amino acids with very high isotopic purity has revolutionized quantitative proteomics. From their use in metabolic labeling of cells and rodents for differential discovery proteomics, to their use in synthetic peptides as internal standards for targeted analysis of proteins, isotopically labeled amino acids make it possible to measure, with very high precision, changes in the levels of peptides and the proteins they are derived from in highly complex samples such as cell lysates, tissue and plasma. Cambridge Isotope Labs has been and continues to be a leader in the commercial production of labeled amino acids and other labeled compounds.”

Stephen A. Carr, PhD
Senior Director of Proteomics
Broad Institute of MIT and Harvard

“I have been obtaining protected amino acids from CIL for well over a decade. These materials are used to synthesize isotope-enriched peptides, which customers implement in their clinically driven proteomic research. Our clinical customers demand the highest isotopic enrichment, and CIL continues to deliver. In my opinion, CIL is the best isotope company out there – best in quality, best in service.”

Samuel Massoni
Founder, President, and CEO
New England Peptide

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Antiviral Drugs

Through partnership with Alsachim, CIL is proud to now offer an assortment of antiviral drug standards and metabolites, in their stable isotope-labeled and unlabeled form. These compounds are available in 1 mg units and are adept for use as internal standards in therapeutic monitoring and quantitative analysis exercises. Please inquire for pricing or see isotope.com. ***Available in North and South America only.***

Catalog No.	Description	Drug Class
C1768	Azithromycin (^{13}C, 99%; D_3, 98%)	Antibiotic
C1746	Azithromycin dihydrate (unlabeled)	
C5023	Chloroquine oxalate salt (D_5, 98%)	Antimalarial
C1741	Chloroquine diphosphate salt (unlabeled)	
C2453	Desethylchloroquine dioxalate salt (D_5, 98%)	
C2331	Desethylchloroquine diphosphate salt (unlabeled)	
C4923	Dexamethasone (D_4, 98%)	Anti-inflammatory
C5057	Dexamethasone (unlabeled)	
C8853	Favipiravir (^{13}C, 99%; ^{15}N, 98%)	Nucleoside analogue inhibitor
C8720	Favipiravir (unlabeled)	
C6422	Hydroxychloroquine dioxalate salt (D_5, 98%)	Antimalarial
C4600	Hydroxychloroquine sulfate (unlabeled)	
C4693	Lopinavir (D_8, 98%) CP 95%	Protease inhibitor
C2745	Lopinavir (unlabeled)	
C8849	Nafamostat formate salt ($^{13}C_6$, 99%)	Anticoagulant
C8848	Nafamostat mesylate (unlabeled)	
C8845	Remdesivir (ring-$^{13}C_6$, 99%)	Nucleotide analogue inhibitor
C8854	Remdesivir mixture of diastereoisomers (ring-$^{13}C_6$, 99%)	
C8799	Remdesivir (unlabeled)	
C8855	GS 441524 ($^{13}C_5$, 99%)	
C8847	GS 441524 (unlabeled)	
C2963	Ritonavir (^{13}C, 99%; D_3, 98%)	Protease inhibitor
C2792	Ritonavir (unlabeled)	

Bile Acids

The analysis of bile acids (BAs) in biofluids is a developing and growing MS 'omics field. These steroid-like compounds act as detergent that assist in the breakdown of fats. The primary BAs are synthesized from cholesterol in the liver, while secondary BAs are converted from primary BAs in the colon. The bile acids can also be conjugated with glycine or taurine in the liver, which increase their solubility in water. Bile acids have gained clinical attention by their linkage to colon cancer, liver disease, chronic diarrhea, cholestasis, hyperlipidemia, and gallstones. CIL is pleased to offer an extensive panel of primary and secondary BAs, in their free acid and conjugated salt forms. These research-grade products are available as isotopically labeled and/or unlabeled standards in solution (at 100 µg/mL in methanol) and/or neat form.

Primary Bile Acids and Their Conjugated Salts

Catalog No.	Description	Abbreviation	Concentration	Unit Size
CLM-2709	Chenodeoxycholic acid (24-^{13}C, 99%)	CDCA	neat	0.1 g, 0.5 g
DLM-6780-C	Chenodeoxycholic acid (2,2,4,4-D_4, 98%)	CDCA	100 µg/mL in methanol	1 mL
DLM-6780	Chenodeoxycholic acid (2,2,4,4-D_4, 98%)	CDCA	neat	50 mg
DLM-9327	Chenodeoxycholic acid (2,2,3,4,4-D_5, 98%)	CDCA	neat	0.05 g, 0.1 g
DLM-9541-C	Chenodeoxycholic acid (2,2,3,4,4,6,6,7,8-D_9, 98%)	CDCA	100 µg/mL in methanol	1 mL
DLM-9541	Chenodeoxycholic acid (2,2,3,4,4,6,6,7,8-D_9, 98%)	CDCA	neat	10 mg
ULM-9540	Chenodeoxycholic acid (unlabeled)	CDCA	neat	50 mg
CLM-2710	Cholic acid (24-^{13}C, 99%)	CA	neat	0.1 g, 0.5 g
DLM-2611-C	Cholic acid (2,2,4,4-D_4, 98%)	CA	100 µg/mL in methanol	1 mL
DLM-2611	Cholic acid (2,2,4,4-D_4, 98%)	CA	neat	50 mg
DLM-9549	Cholic acid (2,2,3,4,4-D_5, 98%)	CA	neat	50 mg
DLM-10997	Cholic acid (3,6,6,7,8,11,11,12-D_8, 98%) CP 95%	CA	neat	Please inquire
ULM-9543	Cholic acid (unlabeled)	CA	neat	50 mg

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
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Bile Acids *(continued)*

Catalog No.	Description	Abbreviation	Concentration	Unit Size
DLM-7804-C	Glycochenodeoxycholic acid (2,2,4,4-D_4, 98%) CP 97%	GCDCA	100 µg/mL in methanol	1 mL
DLM-7804	Glycochenodeoxycholic acid (2,2,4,4-D_4, 98%) CP 97%	GCDCA	neat	10 mg
DLM-9550-C	Glycochenodeoxycholic acid (2,2,3,4,4,6,6,7,8-D_9, 98%) CP 97%	GCDCA	100 µg/mL in methanol	1 mL
DLM-9550	Glycochenodeoxycholic acid (2,2,3,4,4,6,6,7,8-D_9, 98%) CP 97%	GCDCA	neat	10 mg
ULM-9942	Glycochenodeoxycholic acid, sodium salt (unlabeled)	GCDCA	neat	10 mg
CLM-191	Glycocholic acid (glycine-1-^{13}C, 99%)	GCA	neat	Please inquire
DLM-2742-C	Glycocholic acid (2,2,4,4-D_4, 98%)	GCA	100 µg/mL in methanol	1 mL
DLM-2742	Glycocholic acid (2,2,4,4-D_4, 98%) (contains ~4% water)	GCA	neat	10 mg
ULM-9551	Glycocholic acid, hydrate (unlabeled)	GCA	neat	50 mg
DLM-10627	α-Muricholic acid (2,2,3,4,4-D_5, 99%)	MCA (α)	neat	1 mg
ULM-10621	α-Muricholic acid (unlabeled)	MCA (α)	neat	1 mg
DLM-10626	β-Muricholic acid (2,2,3,4,4-D_5, 99%)	MCA (β)	neat	1 mg
ULM-10620	β-Muricholic acid (unlabeled)	MCA (β)	neat	1 mg
DLM-10628	γ-Muricholic acid (2,2,3,4,4-D_5, 99%)	MCA (γ)	neat	2 mg
ULM-10622	γ-Muricholic acid (unlabeled)	MCA (γ)	neat	1 mg
DLM-10629	ω-Muricholic acid (2,2,3,4,4-D_5, 99%)	MCA (ω)	neat	1 mg
ULM-10623	ω-Muricholic acid (unlabeled)	MCA (ω)	neat	1 mg
DLM-9562-C	Taurochenodeoxycholic acid, sodium salt (2,2,4,4-D_4, 98%) CP 97%	TCDCA	100 µg/mL in methanol	1 mL
DLM-9562	Taurochenodeoxycholic acid, sodium salt (2,2,4,4-D_4, 98%) CP 97%	TCDCA	neat	10 mg
DLM-9563-C	Taurochenodeoxycholic acid, sodium salt (2,2,3,4,4,6,6,7,8-D_9, 98%)	TCDCA	100 µg/mL in methanol	1 mL
DLM-9563	Taurochenodeoxycholic acid, sodium salt (2,2,3,4,4,6,6,7,8-D_9, 98%)	TCDCA	neat	5 mg
ULM-9561	Taurochenodeoxycholic acid, sodium salt (unlabeled)	TCDCA	100 µg/mL in methanol	1 mL
ULM-9561	Taurochenodeoxycholic acid, sodium salt (unlabeled)	TCDCA	neat	50 mg
DLM-9572-C	Taurocholic acid, sodium salt (2,2,4,4-D_4, 98%)	TCA	100 µg/mL in methanol	1 mL
DLM-9572	Taurocholic acid, sodium salt (2,2,4,4-D_4, 98%)	TCA	neat	10 mg
CNLM-10251	Taurocholic acid, sodium salt (taurine-$^{13}C_2$, 99%; ^{15}N, 98%)	TCA	neat	10 mg
ULM-9571	Taurocholic acid, sodium salt hydrate (unlabeled) CP 97%	TCA	neat	50 mg

Secondary Bile Acids and Their Conjugated Salts

Catalog No.	Description	Abbreviation	Concentration	Unit Size
CLM-3364	Deoxycholic acid (24-^{13}C, 98%) CP 97%	DCA	neat	0.1 g, 0.5 g
DLM-2824-C	Deoxycholic acid (2,2,4,4-D_4, 98%)	DCA	100 µg/mL in methanol	1 mL
DLM-2824	Deoxycholic acid (2,2,4,4-D_4, 98%)	DCA	neat	10 mg
DLM-9546-C	Deoxycholic acid (2,2,4,4,11,11-D_6, 98%)	DCA	100 µg/mL in methanol	1 mL
DLM-9546	Deoxycholic acid (2,2,4,4,11,11-D_6, 98%)	DCA	neat	10 mg
ULM-9545	Deoxycholic acid (unlabeled)	DCA	neat	50 mg
DLM-9554-C	Glycodeoxycholic acid (2,2,4,4-D_4, 98%)	GDCA	100 µg/mL in methanol	1 mL
DLM-9554	Glycodeoxycholic acid (2,2,4,4-D_4, 98%)	GDCA	neat	10 mg
DLM-9553-C	Glycodeoxycholic acid (2,2,4,4,11,11-D_6, 98%)	GDCA	100 µg/mL in methanol	1 mL
DLM-9553	Glycodeoxycholic acid (2,2,4,4,11,11-D_6, 98%)	GDCA	neat	10 mg
ULM-9552	Glycodeoxycholic acid, sodium salt (unlabeled)	GDCA	neat	50 mg
DLM-9556-C	Glycolithocholic acid (2,2,4,4-D_4, 98%)	GLCA	100 µg/mL in methanol	1 mL
DLM-9556	Glycolithocholic acid (2,2,4,4-D_4, 98%)	GLCA	neat	10 mg
ULM-9555	Glycolithocholic acid (unlabeled)	GLCA	neat	50 mg
DLM-9558-C	Glycoursodeoxycholic acid (2,2,4,4-D_4, 98%) CP 97%	GUDCA	100 µg/mL in methanol	1 mL
DLM-9558	Glycoursodeoxycholic acid (2,2,4,4-D_4, 98%) CP 97%	GUDCA	neat	10 mg
CNLM-10252	Glycoursodeoxycholic acid (glycine-$^{13}C_2$, 99%; ^{15}N, 98%)	GUDCA	neat	10 mg
ULM-9557	Glycoursodeoxycholic acid (unlabeled)	GUDCA	neat	50 mg
DLM-9560-C	Lithocholic acid (2,2,4,4-D_4, 98%)	LCA	100 µg/mL in methanol	1 mL
DLM-9560	Lithocholic acid (2,2,4,4-D_4, 98%)	LCA	neat	50 mg

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Catalog No.	Description	Abbreviation	Concentration	Unit Size
ULM-9559	Lithocholic acid (unlabeled)	LCA	neat	50 mg
DLM-9568-C	Taurodeoxycholic acid, sodium salt (2,2,4,4-D_4, 98%)	TDCA	100 µg/mL in methanol	1 mL
DLM-9568	Taurodeoxycholic acid, sodium salt (2,2,4,4-D_4, 98%)	TDCA	neat	10 mg
DLM-9567-C	Taurodeoxycholic acid, sodium salt (2,2,4,4,11,11-D_6, 98%)	TDCA	100 µg/mL in methanol	1 mL
DLM-9567	Taurodeoxycholic acid, sodium salt (2,2,4,4,11,11-D_6, 98%)	TDCA	neat	5 mg
ULM-9943	Taurodeoxycholic acid, sodium salt, hydrate (unlabeled)	TDCA	neat	50 mg
DLM-9570-C	Taurolithocholic acid, sodium salt (2,2,4,4-D_4, 98%)	TLCA	100 µg/mL in methanol	1 mL
DLM-9570	Taurolithocholic acid, sodium salt (2,2,4,4-D_4, 98%)	TLCA	neat	10 mg
ULM-9569	Taurolithocholic acid, sodium salt (unlabeled)	TLCA	neat	50 mg
DLM-9882-C	Tauroursodeoxycholic acid, sodium salt (2,2,4,4-D_4, 98%)	TUDCA	100 µg/mL in methanol	1 mL
DLM-9882	Tauroursodeoxycholic acid, sodium salt (2,2,4,4-D_4, 98%)	TUDCA	neat	10 mg
CNLM-10250	Tauroursodeoxycholic acid, sodium salt (taurine-$^{13}C_2$, 99%; ^{15}N, 98%)	TUDCA	neat	10 mg
ULM-9885	Tauroursodeoxycholic acid, dihydrate (unlabeled)	TUDCA	neat	50 mg
DLM-9574-C	Ursodeoxycholic acid (2,2,4,4-D_4, 98%)	UDCA	100 µg/mL in methanol	1 mL
DLM-9574	Ursodeoxycholic acid (2,2,4,4-D_4, 98%)	UDCA	neat	50 mg
ULM-9573	Ursodeoxycholic acid (unlabeled)	UDCA	neat	50 mg

Caffeine and Its Metabolites

Caffeine is a psychoactive stimulant of the central nervous system that is extensively consumed worldwide. MS-based research into the kinetics/metabolism of this compound and its metabolites (e.g., paraxanthine, theobromine, theophylline) has revealed insight into its health impact and abuse in humans. Studies further suggest an influence on pharmacological activity and neurodegeneration (e.g., Parkinson's disease); thus, strengthening a need for its robust clinical analyses.

CIL offers stable isotope-labeled caffeine and a collection of isotopically labeled metabolites for basic and translational quantitative research. These standards are available in various labeling patterns, with alternate compounds or labels evaluated upon request.

Catalog No.	Description	Unit Size
CNLM-9240	5-Acetylamino-6-amino-3-methyluracil (AAMU) (2,4,5,6-$^{13}C_4$, 99%; 1,3-$^{15}N_2$, 6-amino-^{15}N, 98%) CP 97%	1 mg, 2 mg, 5 mg
CLM-728	Caffeine (3-methyl-^{13}C, 99%)	0.5 g
CLM-514	Caffeine (trimethyl-$^{13}C_3$, 99%)	1 g
NLM-332	Caffeine (1,3-$^{15}N_2$, 99%)	Please inquire
CNLM-333	Caffeine (2-^{13}C, 99%; 1,3-$^{15}N_2$, 98%)	0.1 g
CNLM-9241	1,3-Dimethyluric acid (2,4,5,6-$^{13}C_4$, 99%; 1,3,9-$^{15}N_3$, 98%)	1 mg, 2 mg, 5 mg
CNLM-9242	1,7-Dimethyluric acid (2,4,5,6-$^{13}C_4$, 99%; 1,3,9-$^{15}N_3$, 98%)	1 mg, 2 mg, 5 mg
DLM-9245	1,7-Dimethylxanthine (paraxathine) (dimethyl-D_6, 98%) CP 97%	2 mg, 5 mg
CNLM-9243	1,7-Dimethylxanthine (paraxanthine) (2,4,5,6-$^{13}C_4$, 99%; 1,3,9-$^{15}N_3$, 98%)	2 mg, 5 mg
CLM-522	Ethyl acetoacetate (1,3-$^{13}C_2$, 99%)	0.5 g, 1 g
CLM-523	Ethyl acetoacetate (2,4-$^{13}C_2$, 99%)	0.5 g, 1 g
CNLM-9247	3-Methyluric acid (2,4,5,6-$^{13}C_4$, 99%; 1,3,9-$^{15}N_3$, 98%)	2 mg, 5 mg
CNLM-9248	7-Methyluric acid (2,4,5,6-$^{13}C_4$, 99%; 1,3,9-$^{15}N_3$, 98%)	Please inquire
CDLM-9249	1-Methylxanthine (1-methyl, 6-$^{13}C_2$, 99%; 1-methyl-D_3, 98%) CP 97%	1 mg, 5 mg
CNLM-9252	1-Methylxanthine (2,4,5,6-$^{13}C_4$, 99%; 1,3,9-$^{15}N_3$, 98%)	2 mg, 5mg
CNLM-9250	3-Methylxanthine (2,4,5,6-$^{13}C_4$, 99%; 1,3,9-$^{15}N_3$, 98%)	2 mg, 5 mg
CNLM-9251	7-Methylxanthine (2,4,5,6-$^{13}C_4$, 99%; 1,3,9-$^{15}N_3$, 98%)	Please inquire
DLM-10436	Theobromine (3,7-dimethylxanthine) (7-methyl-D_3, 98%)	Please inquire
DLM-8565	Theobromine (3,7-dimethylxanthine) (dimethyl-D_6, 98%)	5 mg
CLM-6154	Theophylline (dimethyl-$^{13}C_2$, 99%)	0.1 g
CNLM-444	Theophylline (2-^{13}C, 99%; 1,3-$^{15}N_2$, 98%)	0.05 g, 0.1 g
CNLM-9253	1,3,7-Trimethyluric acid (2,4,5,6-$^{13}C_4$, 99%; 1,3,9-$^{15}N_3$, 98%)	Please inquire
NLM-1697	Uric acid (1,3-$^{15}N_2$, 98%)	0.1 g, 0.5 g

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
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Carbohydrates

Carbohydrates are integral biomolecules to the function and process of living systems (e.g., in cell-to-cell signaling, immune responses, protein folding). Although this family of compounds is structurally diverse and complex, analysis by LC- and GC-MS techniques has been well adopted in the metabolomics field. Clinically, the quantitative analysis of sugars in human biosamples is of increasing importance for such disease screenings as cardiovascular and nonalcoholic fatty liver disease (NAFLD).

In addition to the classic monosaccharides (e.g., glucose, fructose, ribose) and sugar alcohols (e.g., erythritol, sorbitol, xylitol), CIL offers a number of other stable isotope-labeled carbohydrates. The list includes monosaccharides, under the pentose (e.g., arabinose, erythrose) and hexose (e.g., galactose, mannose) classes, disaccharides (e.g., lactose, maltose, sucrose), and polysaccharides (e.g., starch). These compounds are supplied with various labeling patterns as neat standards in research or MPT (microbiological or pyrogen tested) grade.

Catalog No.	Description	Unit Size
CLM-1220	*N*-Acetylglucosamine (*N*-acetyl-1-^{13}C, 99%)	Please inquire
CLM-1827	*N*-Acetylglucosamine ($^{13}C_6$, 99%)	Please inquire
NLM-8810	*N*-Acetylglucosamine (^{15}N, 98%)	0.1 g
CLM-1699	Algal starch (U-^{13}C, 98%)	0.1 g, 0.5 g, 1 g
ULM-7806	Algal starch (unlabeled)	1 g
CLM-7642	D-Arabinitol (U-$^{13}C_5$, 98%)	Please inquire
CLM-715	D-Arabinose (1-^{13}C, 99%)	0.25 g, 0.5 g, 1 g
CLM-1288	D-Arabinose (2-^{13}C, 98%)	Please inquire
CLM-8477	D-Arabinose (U-$^{13}C_5$, 99%)	0.1 g, 0.25 g
DLM-1379	D-Arabinose (2-D, 97%)	Please inquire
CLM-7266	2-Deoxyribose (1-^{13}C, 99%)	Please inquire
CLM-9207	Erythritol (U-$^{13}C_4$, 99%)	Please inquire
CLM-1118	D-Erythrose (1-^{13}C, 99%) (1.2% in H_2O)	Please inquire
CLM-1387	D-Erythrose (2-^{13}C, 99%) (1.2% in H_2O)	Please inquire
CLM-8944	D-Erythrose (4-^{13}C, 99%) (1.2% in H_2O)	Please inquire
CLM-7863	D-Erythrose (U-$^{13}C_4$, 98%) (1.2% in H_2O)	Please inquire
CLM-1201	D-Fructose (1-^{13}C, 99%)	0.25 g, 0.5 g, 1 g
CLM-1527	D-Fructose (2-^{13}C, 99%)	0.25 g, 0.5 g, 1 g
CLM-7660	D-Fructose (3-^{13}C, 99%)	Please inquire
CLM-7661	D-Fructose (4-^{13}C, 99%)	Please inquire
CLM-7662	D-Fructose (5-^{13}C, 99%)	Please inquire
CLM-1388	D-Fructose (6-^{13}C, 99%)	Please inquire
CLM-2462	D-Fructose (1-^{13}C, 99%; 6-^{13}C, 97%)	Please inquire
CLM-528	D-Fructose (1,2-$^{13}C_2$, 99%)	0.1 g, 0.25 g, 0.5 g
CLM-10546	D-Fructose (4,5-$^{13}C_2$, 99%)	Please inquire
CLM-8415	D-Fructose (1,2,3-$^{13}C_3$, 99%)	Please inquire
CLM-10223	D-Fructose (4,5,6-$^{13}C_3$, 98%)	Please inquire
CLM-1553	D-Fructose (U-$^{13}C_6$, 99%)	0.1 g, 0.25 g, 0.5 g, 1 g
DLM-6050	D-Fructose (1-D, 97%)	Please inquire
DLM-1389	D-Fructose (6,6-D_2, 98%)	Please inquire
CLM-6678	D-Fructose-1,6-bisphosphate, sodium salt hydrate (1-^{13}C, 99%)	Please inquire
CLM-8962	D-Fructose-1,6-bisphosphate, sodium salt hydrate (U-$^{13}C_6$, 98%)	0.05 g
CLM-8616	D-Fructose-6-phosphate·$2Na^+$·xH_2O ($^{13}C_6$, 99%) (may contain up to ~10% $^{13}C_6$ glucose-6-phosphate)	Please inquire
CLM-3705	L-Fucose (1-^{13}C, 99%)	Please inquire
CLM-219	L-Fucose (6-^{13}C, 99%)	Please inquire
CLM-9605	L-Fucose (U-$^{13}C_6$, 99%)	Please inquire
CLM-529	D-Galactitol (1-^{13}C, 99%)	Please inquire
CLM-2199	D-Galactitol (U-$^{13}C_6$, 99%)	Please inquire
CLM-11003	D-Galactonate, sodium salt (U-$^{13}C_6$, 99%) CP 97%	Please inquire
CLM-10786	*N*-Acetyl-D-galactosamine (galactose-$^{13}C_6$, 99%)	Please inquire
CLM-744	D-Galactose (1-^{13}C, 99%)	0.25 g, 0.5 g, 1 g
CLM-745	D-Galactose (2-^{13}C, 99%)	Please inquire

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Catalog No.	Description	Unit Size
CLM-4217	D-Galactose (1,2-$^{13}C_2$, 99%)	Please inquire
CLM-1570	D-Galactose (U-$^{13}C_6$, 99%)	0.1 g
DLM-1390	D-Galactose (1-D, 98%)	0.5 g, 1 g
DLM-1391	D-Galactose (2-D, 98%)	Please inquire
CLM-8998	D-Galactose-1-phosphate, dipotassium salt (1-^{13}C, 99%)	0.01 g, 0.05 g, 0.1 g
CLM-9873	D-Galactose-1-phosphate, dipotassium salt (1,2-$^{13}C_2$, 99%)	Please inquire
CLM-9874	D-Galactose-1-phosphate, dipotassium salt (galactose-$^{13}C_6$, 99%)	Please inquire
CLM-9657	1,5-Anhydro-D-glucitol (U-$^{13}C_6$, 98%)	Please inquire
CLM-9452	α-D-Glucopyranosyl-1-phosphate, dipotassium salt, monohydrate ($^{13}C_6$, 99%)	Please inquire
CLM-9938	D-Glucuronic acid, sodium salt monohydrate (U-$^{13}C_6$, 98%)	Please inquire
CLM-9883	D-Glucosamine·HCl ($^{13}C_6$, 99%)	Please inquire
NLM-11018	D-Glucosamine·HCl (^{15}N, 98%)	Please inquire
CLM-4819	D-Glucose (U-$^{12}C_6$, 99.9%)	1 g
CLM-420	D-Glucose (1-^{13}C, 98-99%)	0.25 g, 0.5 g, 1 g, 5 g, 10 g
CLM-746	D-Glucose (2-^{13}C, 99%)	0.25 g, 0.5 g, 1 g
CLM-1393	D-Glucose (3-^{13}C, 99%)	0.25 g, 0.5 g, 1 g
CLM-1394	D-Glucose (4-^{13}C, 99%)	0.25 g, 0.5 g, 1 g
CLM-1395	D-Glucose (5-^{13}C, 98%)	0.25 g, 0.5 g, 1 g
CLM-481	D-Glucose (6-^{13}C, 99%)	0.25 g, 0.5 g, 1 g
CLM-2717	D-Glucose (1-^{13}C, 99%; 6-^{13}C, 97%)	0.1 g, 0.25 g, 1 g
CLM-504	D-Glucose (1,2-$^{13}C_2$, 99%)	0.25 g, 0.5 g, 1 g
CLM-8942	D-Glucose (2,3-$^{13}C_2$, 99%)	Please inquire
CLM-6750	D-Glucose (3,4-$^{13}C_2$, 99%)	Please inquire
CLM-8787	D-Glucose (4,5-$^{13}C_2$, 99%)	Please inquire
CLM-4673	D-Glucose (1,2,3-$^{13}C_3$, 99%)	0.05 g, 0.1 g, 0.25 g
CLM-8770	D-Glucose (4,5,6-$^{13}C_3$, 98%)	0.1 g
CLM-8946	D-Glucose (2,3,4,5,6-$^{13}C_5$, 99%)	Please inquire
CLM-1396	D-Glucose (U-$^{13}C_6$, 99%)	0.1 mg, 0.25 g, 0.5 g, 1 g, 2 g, 5 g, 10 g, 25 g, 50 g
CLM-1396-25	D-Glucose ($^{13}C_6$, 24-25%)	1 g
DLM-1150	D-Glucose (1-D, 98%)	0.25 g, 0.5 g, 1 g
DLM-1271	D-Glucose (2-D, 98%)	0.25 g, 0.5 g, 1 g
DLM-3557	D-Glucose (3-D, 97-98%)	0.1 g, 0.5 g
DLM-9294	D-Glucose (4-D, 98%)	Please inquire
DLM-6754	D-Glucose (5-D, 98%)	0.1 g, 0.25 g, 0.5 g
DLM-349	D-Glucose (6,6-D_2, 99%)	1 g, 5 g, 10 g
DLM-2062	D-Glucose (1,2,3,4,5,6,6-D_7, 97-98%)	0.5 g, 1 g, 5 g, 10 g, 20 g
DLM-9047	D-Glucose (U-D_{12}, 98%)	1 g
CDLM-6064	D-Glucose (1-^{13}C, 99%; 1-D, 98%)	Please inquire
CDLM-999	D-Glucose (1-^{13}C, 98%; 2-D, 98%)	Please inquire
CDLM-4895	D-Glucose (1-^{13}C, 99%; 6-^{13}C, 97%; 6,6-D_2, 98%)	Please inquire
CDLM-3813	D-Glucose (U-$^{13}C_6$, 99%; 1,2,3,4,5,6,6-D_7, 97-98%)	1 g, 2 g, 10 g
CLM-8813	D-Glucose-1-phosphate, dicyclohexylammonium salt monohydrate (U-$^{13}C_6$, 99%) CP 95%	Please inquire
CLM-8367	D-Glucose-6-phosphate, disodium salt hydrate (U-$^{13}C_6$, 99%)	0.1 mg, 0.01 g, 0.05 g, 0.1 g
CLM-1966	L-Glucose (1-^{13}C, 99%)	Please inquire
CLM-1399	L-Glucose (2-^{13}C, 99%)	Please inquire
CLM-1824	2-deoxy-D-Glucose (1-^{13}C, 99%)	0.1 g, 0.25 g
CLM-2122	2-deoxy-D-Glucose (6-^{13}C, 99%)	0.25 g, 0.5 g, 1 g
CLM-10466	2-deoxy-D-Glucose (U-$^{13}C_6$, 99%)	Please inquire
DLM-6732	2-deoxy-D-Glucose (1-D, 98%)	Please inquire
DLM-6940	2-deoxy-D-Glucose (D_8, 98%)	Please inquire
CLM-9601	2-deoxy-D-Glucose-6-phosphate, disodium salt (6-^{13}C, 99%)	Please inquire

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
For research use only. Not for use in diagnostic procedures.

Carbohydrates *(continued)*

Catalog No.	Description	Unit Size
CLM-10491	3-*O*-methyl-D-Glucose ($^{12}C_6$, 99.99%) ^{13}C depleted	Please inquire
CLM-10492	3-*O*-methyl-D-Glucose ($^{13}C_6$, 99%)	Please inquire
DLM-7826	*myo*-Inositol (2-D, 91%)	Please inquire
DLM-2725	*myo*-Inositol (1,2,3,4,5,6-D_6, 98%)	Please inquire
CLM-4518	Lactose ureide·XH_2O (ureide-^{13}C, 99%)	1 g, 10 g
ULM-4519	Lactose ureide·$2H_2O$ (unlabeled)	10 g
CLM-4423	Lactose·H_2O (glucose-$^{13}C_6$, 98%)	Please inquire
CLM-1127	D-Lyxose (1-^{13}C, 99%)	Please inquire
CLM-1525	D-Lyxose (2-^{13}C, 99%)	Please inquire
CLM-1128	D-Lyxose (5-^{13}C, 99%)	Please inquire
DLM-1187	D-Lyxose (1-D, 98%)	Please inquire
DLM-1188	D-Lyxose (2-D, 98%)	Please inquire
CLM-2470	L-Lyxose (1,2-$^{13}C_2$, 99%)	Please inquire
CLM-2642	D-Maltose·H_2O (U-$^{13}C_{12}$, 99%)	Please inquire
CLM-10759	Maltotetraose (U-$^{13}C_{24}$, 99%) CP 90%	Please inquire
CLM-1189	D-Mannitol (1-^{13}C, 98%)	0.25 g, 0.5 g, 1 g
CLM-4416	D-Mannitol (2-^{13}C, 99%)	Please inquire
CLM-10764	D-Mannitol (1,2-$^{13}C_2$, 99%)	Please inquire
CLM-6733	D-Mannitol (U-$^{13}C_6$, 99%)	0.1 g
CLM-9393	L-Mannitol (1-^{13}C, 99%)	Please inquire
CLM-358	D-Mannose (1-^{13}C, 99%)	0.25 g, 0.5 g, 1 g
CLM-1523	D-Mannose (2-^{13}C, 99%)	Please inquire
CLM-9064	D-Mannose (3-^{13}C, 99%)	Please inquire
CLM-9394	D-Mannose (4-^{13}C, 99%)	Please inquire
CLM-9063	D-Mannose (5-^{13}C, 99%)	Please inquire
CLM-1192	D-Mannose (6-^{13}C, 99%)	Please inquire
CLM-6567	D-Mannose (U-$^{13}C_6$, 99%)	0.1 g, 0.25 g, 0.5 g
DLM-1193	D-Mannose (1-D, 98%)	Please inquire
DLM-1194	D-Mannose (2-D, 98%)	Please inquire
DLM-1195	D-Mannose (6,6-D_2, 98%)	Please inquire
CLM-1218	L-Mannose (1-^{13}C, 99%)	Please inquire
CLM-8597	*N*-Acetyl-D-neuraminic acid (4,5,6,7,8,9-$^{13}C_6$, 98%)	Please inquire
CLM-10568	L-Rhamnose·H_2O (U-$^{13}C_6$, 99%)	Please inquire
CLM-1196	D-Ribitol (1-^{13}C, 99%)	Please inquire
CLM-768	D-Ribose (1-^{13}C, 99%)	0.25 g, 0.5 g, 1 g
CLM-1069	D-Ribose (2-^{13}C, 99%)	Please inquire
CLM-1066	D-Ribose (5-^{13}C, 99%)	0.25 g, 0.5 g, 1 g
CLM-4602	D-Ribose (1,2-$^{13}C_2$, 99%)	Please inquire
CLM-4830	D-Ribose (2,3,4,5-$^{13}C_4$, 99%)	Please inquire
CLM-3652	D-Ribose (U-$^{13}C_5$, 98%)	0.1 mg, 0.1 g
DLM-1070	D-Ribose (1-D, 98%)	0.25 g, 0.5 g, 1 g
DLM-1197	D-Ribose (2-D, 98%)	Please inquire
DLM-6559	D-Ribose (3-D, 98%)	Please inquire
DLM-7778	D-Ribose (5,5-D_2, 98%)	Please inquire
DLM-4750	2-deoxy-D-Ribose (5,5-D_2, 98%)	Please inquire
CLM-8780	Sodium D-gluconate (1-^{13}C, 99%)	Please inquire
CLM-8781	Sodium D-gluconate (U-$^{13}C_6$, 99%)	Please inquire
CLM-1565	D-Sorbitol (1-^{13}C, 99%)	Please inquire
CLM-8529	D-Sorbitol (U-$^{13}C_6$, 98%)	0.1 g, 0.25 g
DLM-3320	Sorbitol (1,1'-D_2, 98%)	Please inquire
CLM-10823	D-Sucrose (glucose-1,2-$^{13}C_2$, 99%)	Please inquire

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For research use only. Not for use in diagnostic procedures.

Catalog No.	Description	Unit Size
CLM-10823	D-Sucrose (glucose-1,2-$^{13}C_2$, 99%)	Please inquire
CLM-9811	D-Sucrose (fructose-$^{13}C_6$, 98%)	Please inquire
CLM-8091	D-Sucrose (glucose-$^{13}C_6$, 98%)	Please inquire
CLM-7757	D-Sucrose ($^{13}C_{12}$, 98%)	Please inquire
DLM-10939	D-Sucrose (U-D_{22}, 98%	Please inquire
CLM-1203	D-Talitol (1-^{13}C, 99%)	Please inquire
CLM-1204	D-Talose (2-^{13}C, 99%)	Please inquire
CLM-1139	D-Threose (1-^{13}C, 99%) 1.8% in H_2O	Please inquire
CLM-1207	D-Threose (2-^{13}C, 99%) 1.8% in H_2O	Please inquire
CLM-1295	D-Xylitol (1-^{13}C, 99%)	Please inquire
CLM-1214	D-Xylitol (5-^{13}C, 99%)	Please inquire
CLM-7608	D-Xylitol (U-$^{13}C_5$, 99%)	Please inquire
DLM-9656	D-Xylitol (1,1',2,3,4,5,5'-D_7, 98%)	Please inquire
CLM-1140	D-Xylose (1-^{13}C, 99%)	0.25 g, 0.5 g, 1 g
CLM-1524	D-Xylose (2-^{13}C, 99%)	0.25 g, 0.5 g, 1 g
CLM-8593	D-Xylose (3-^{13}C, 99%)	Please inquire
CLM-9083	D-Xylose (4-^{13}C, 99%)	Please inquire
CLM-1219	D-Xylose (5-^{13}C, 99%)	0.25 g, 0.5 g, 1 g
CLM-2456	D-Xylose (1,2-$^{13}C_2$, 99%)	0.25 g, 0.5 g, 1 g
CLM-6140	D-Xylose (U-$^{13}C_5$, 99%)	0.25 g, 0.5 g, 1 g
DLM-1215	D-Xylose (1-D, 99%)	Please inquire
DLM-1216	D-Xylose (2-D, 98%)	Please inquire
DLM-7121	D-Xylose (D_6, 98%)	Please inquire
CLM-11008	D-Xylulose (U-$^{13}C_5$, 98%)	Please inquire

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
For research use only. Not for use in diagnostic procedures.

Carnitine and Acylcarnitines

Carnitine and acylcarnitines play an essential role in fatty acid metabolism. Metabolism disorders of fatty acid oxidation and several organic acidurias impose major clinical manifestations (e.g., hypoketotic hypoglycemia, skeletal myopathy, liver disease, and/or failure). These are largely attributed to enzymatic deficiencies and can be monitored through carnitine/acylcarnitine measurement.

To help facilitate metabolic screening exercises, CIL is pleased to offer a variety of stable isotope-labeled and unlabeled carnitine/acylcarnitine standards. Please refer to page 59 for a list of mix offerings; individual standards are noted below.

Catalog No.	Description	Abbreviation	Unit Size
ULM-7801	L-Carnitine (unlabeled)	C0	Please inquire
DLM-1871	L-Carnitine·HCl (methyl-D_3, 98%)	C0	0.1 g
DLM-3820	L-Carnitine·HCl (dimethyl-D_6, 98%)	C0	Please inquire
DLM-10962	L-Carnitine·HCl (trimethyl-D_9, 98%)	C0	5 mg
DLM-3555	L-Carnitine (trimethyl-D_9, 98%)	C0	Please inquire
DNLM-10613	L-Carnitine (*N,N,N*-trimethyl-D_9, 98%; ^{15}N, 98%)	C0	Please inquire
ULM-9173	L-Carnitine·HCl (unlabeled)	C0	Please inquire
ULM-10431	DL-Carnitine·HCl, *O*-acetyl (unlabeled)	C2	Please inquire
DLM-754	L-Carnitine·HCl, *O*-acetyl (*N*-methyl-D_3, 98%)	C2	0.05 g
DLM-3821	L-Carnitine·HCl, *O*-acetyl (*N,N*-dimethyl-D_6, 98%) CP 97%	C2	Please inquire
ULM-7802	L-Carnitine·HCl, *O*-acetyl (unlabeled)	C2	Please inquire
ULM-10702	DL-Carnitine·HCl, *O*-propionyl (unlabeled)	C3	Please inquire
DLM-3973	L-Carnitine·HCl, *O*-propionyl (*N*-methyl-D_3, 98%)	C3	10 mg
ULM-7705	L-Carnitine·HCl, *O*-propionyl (unlabeled)	C3	Please inquire
ULM-8743	L-Carnitine·ClO_4, *O*-malonyl (unlabeled) CP 97%	C3-DC	0.1 mg
ULM-10703	DL-Carnitine·HCl, *O*-butyrl (unlabeled)	C4	Please inquire
DLM-3861	L-Carnitine·HCl, *O*-butyryl (*N*-methyl-D_3, 98%)	C4	10 mg
ULM-7704	L-Carnitine·HCl, *O*-butyryl (unlabeled)	C4	Please inquire
ULM-8621	L-Carnitine (mono)·ClO_4, *O*-3-DL-hydroxybutyryl (unlabeled)	C4-OH	0.1 mg
ULM-10704	DL-Carnitine·HCl, *O*-isovaleryl (unlabeled)	C5	Please inquire
DLM-3974	L-Carnitine·HCl, *O*-isovaleryl (*N,N,N*-trimethyl-D_9, 98%)	C5	5 mg
ULM-4697	L-Carnitine·HCl, *O*-isovaleryl (unlabeled)	C5	Please inquire
DLM-3975	L-Carnitine (mono)·ClO_4, *O*-glutaryl (*N*-methyl-D_3, 98%) CP 97%	C5-DC	0.1 mg
ULM-7594	L-Carnitine (mono)·ClO_4, *O*-glutaryl (unlabeled)	C5-DC	10 mg
DLM-8272	L-Carnitine·ClO_4, 3-hydroxyisovaleryl (*N*-methyl-D_3, 98%)	C5-OH	1 mg
ULM-8237	L-Carnitine·ClO_4, 3-hydroxyisovaleryl (unlabeled)	C5-OH	0.1 mg
DLM-9276	L-Carnitine·HCl, *O*-hexanoyl (*N*-methyl-D_3, 98%)	C6	0.1 mg
ULM-7198	L-Carnitine·HCl, *O*-hexanoyl (unlabeled)	C6	Please inquire
ULM-10432	DL-Carnitine·HCl, *O*-octanoyl (unlabeled)	C8	Please inquire
DLM-755	L-Carnitine·HCl, *O*-octanoyl (*N*-methyl-D_3, 98%)	C8	10 mg
ULM-7770	L-Carnitine·HCl, *O*-octanoyl (unlabeled)	C8	Please inquire
DLM-9067	L-Carnitine·HCl, *O*-decanoyl (*N*-methyl-D_3, 98%)	C10	0.1 mg
ULM-7195	L-Carnitine·HCl, *O*-decanoyl (unlabeled)	C10	Please inquire
DLM-8746	L-Carnitine·HCl, *O*-2-decenoyl (*N,N,N*-trimethyl-D_9, 98%) (95% E)	C10:1	Please inquire
ULM-8198	L-Carnitine·HCl, *O*-2-decenoyl (unlabeled)	C10:1	0.1 mg
DLM-8162	L-Carnitine·HCl, *O*-dodecanoyl (*N*-methyl-D_3, 98%)	C12	0.1 mg
DLM-8215	L-Carnitine·HCl, *O*-dodecanoyl (*N,N,N*-trimethyl-D_9, 98%)	C12	0.1 mg
ULM-7199	L-Carnitine·HCl, *O*-dodecanoyl (unlabeled)	C12	0.1 mg
ULM-10705	DL-Carnitine·HCl, *O*-myristoyl (unlabeled)	C14	Please inquire
DLM-4425	L-Carnitine·HCl, *O*-myristoyl (*N,N,N*-trimethyl-D_9, 98%)	C14	5 mg
ULM-7737	L-Carnitine·HCl, *O*-myristoyl (unlabeled)	C14	Please inquire

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
For research use only. Not for use in diagnostic procedures.

Catalog No.	Description	Abbreviation	Unit Size
ULM-10433	DL-Carnitine·HCl, *O*-palmitoyl (unlabeled) CP 97%	C16	Please inquire
DLM-1263	L-Carnitine·HCl, *O*-palmitoyl (*N*-methyl-D_3, 98%)	C16	10 mg
ULM-7738	L-Carnitine·HCl, *O*-palmitoyl (unlabeled)	C16	Please inquire
DLM-9189	L-Carnitine (mono)·ClO_4, *O*-3-DL-hydroxypalmitoyl (*N*-methyl-D_3, 98%)	C16-OH	0.1 mg
ULM-8620	L-Carnitine (mono)·ClO_4, *O*-3-DL-hydroxypalmitoyl (unlabeled) CP 97%	C16-OH	0.1 mg
DLM-8271	L-Carnitine·HCl, *O*-octadecanoyl (*N*-methyl-D_3, 98%)	C18	0.1 mg
ULM-7196	L-Carnitine·HCl, *O*-octadecanoyl (unlabeled) CP 97%	C18	0.1 mg
DLM-6718	L-Carnitine·HCl, *O*-hexacosanoyl (*N*-methyl-D_3, 98%) CP 95%	C26	Please inquire
ULM-6719	L-Carnitine·HCl, *O*-hexacosanoyl (unlabeled) CP 95%	C26	Please inquire

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
For research use only. Not for use in diagnostic procedures.

Drugs and Their Metabolites

The field and scope of drug screening/analysis continues to expand worldwide. Example areas of focus include therapeutic drug monitoring, drugs of abuse, prescription monitoring, and clinical toxicology. The nature of those monitored or identified in the MS-based analysis include psychoactive drugs (e.g., benzodiazepines, cannabinoids, hallucinogens), pain-management drugs (e.g., analgesics, opiates, skeletal muscle relaxants), disorder-related treatment drugs (e.g., anticonvulsants/antiepileptics, antipsychotics, erectile dysfunction), and infectious disease or disease-related treatment drugs (e.g., antibiotics, antiarrhythmics).

CIL is pleased to offer a broad collection of unlabeled and stable isotope-labeled standards to aid the qualitative/quantitative analysis of drugs and their metabolites. These encompass a multitude of classes (e.g., analgesics, benzodiazepines, cannabinoids and its agonists, opiate and opioid analgesics, stimulants). The offerings are individual standards and/or class-specific mixtures in predominantly their concentrated solution form.

Available from CIL for customers in the US, Australia, Canada, and Switzerland. Contact us for sourcing details for other destinations. Products listed with an asterisk are available globally.

Alchohol Compounds

Catalog No.	Description	Concentration	Unit Size
E-053	Ethanol-500 (unlabeled)	500 mg/dL in water	10 × 1.2 mL
E-036	Ethanol-400 (unlabeled)	400 mg/dL in water	10 × 1.2 mL
E-033	Ethanol-300 (unlabeled)	300 mg/dL in water	10 × 1.2 mL
E-041	Ethanol-150 (unlabeled)	150 mg/dL in water	10 × 1.2 mL
E-031	Ethanol-100 (unlabeled)	100 mg/dL in water	10 × 1.2 mL
E-029	Ethanol-50 (unlabeled)	50 mg/dL in water	10 × 1.2 mL
E-064	Ethyl sulfate sodium salt (unlabeled)	1 mg/mL in methanol	1 mL
E-063	Ethyl-β-D-glucuronide (D_5, 98%)	1 mg/mL in methanol	1 mL
E-048	Ethyl-β-D-glucuronide (D_5, 98%)	100 µg/mL in methanol	1 mL
E-015	Ethyl-β-D-glucuronide (unlabeled)	1 mg/mL in methanol	1 mL
E-016	Ethyl-β-D-glucuronide (unlabeled)	100 µg/mL in methanol	1 mL
A-056	Multicomponent Alcohol Mix 1000 (unlabeled)	1000 µg/mL of each component in water	1.2 mL

Amphetamines

Catalog No.	Description	Concentration	Unit Size
B-907	Benzyl piperazine·2HCl (D_7, 98%)	100 µg/mL in methanol (as free base)	1 mL
B-906	Benzyl piperazine·2HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
B-046	Butylone·HCl (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
B-045	Butylone·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
C-028	2*R*-Cathinone·HCl (unlabeled)	1 mg/mL in methanol	1 mL
C-019	2*S*-Cathinone·HCl (unlabeled)	1 mg/mL in methanol	1 mL
C-155	Cathinone·HCl (D_5, 98%)	100 µg/mL in methanol (as free base)	1 mL
C-080	Clenbuterol·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
B-026	4-bromo-2,5-Dimethoxyphenethylamine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
E-018	(±)-*N*-Ethylamphetamine (unlabeled)	1 mg/mL in methanol	1 mL
E-072	Ethylone·HCl (D_5, 98%)	100 µg/mL in methanol (as free base)	1 mL
E-071	Ethylone·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
F-015	4-Fluoromethcathinone·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
M-102	DL-MBDB·HCl (unlabeled)	1 mg/mL in methanol	1 mL
M-010	DL-MDA (D_5, 98%)	100 µg/mL in methanol	1 mL
M-012	DL-MDA (unlabeled)	1000 µg/mL in methanol	1 mL
CLM-10394-B*	DL-MDA·HCl (ring-$^{13}C_6$, 98%) CP 95%	50 µg/mL in methanol	1 mL
M-067	DL-MDEA (D_5, 98%)	100 µg/mL in methanol	1 mL
M-065	DL-MDEA (unlabeled)	1000 µg/mL in methanol	1 mL
CLM-10393-B*	DL-MDEA·HCl (ring-$^{13}C_6$, 98%) CP 95%	50 µg/mL in methanol	1 mL
M-011	DL-MDMA (D_5, 98%)	100 µg/mL in methanol	1 mL
M-013	DL-MDMA (unlabeled)	1000 µg/mL in methanol	1 mL

**Products listed with an asterisk are available globally.*

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
For research use only. Not for use in diagnostic procedures.

Catalog No.	Description	Concentration	Unit Size
M-060	DL-Methamphetamine (D_{11}, 98%)	1000 µg/mL in methanol	1 mL
M-059	DL-Methamphetamine (D_{11}, 98%)	100 µg/mL in methanol	1 mL
M-023	DL-Methamphetamine (D_5, 98%)	1000 µg/mL in methanol	1 mL
M-004	DL-Methamphetamine (D_5, 98%)	100 µg/mL in methanol	1 mL
M-009	DL-Methamphetamine (unlabeled)	1000 µg/mL in methanol	1 mL
CLM-10390-B*	DL-Methamphetamine·HCl (ring-$^{13}C_6$, 98%) CP 95%	50 µg/mL in methanol	1 mL
M-024	*R*(-)Methamphetamine (unlabeled)	1 mg/mL in methanol	1 mL
M-189	(±)-Methcathinone·HCl (D_3, 98%)	100 µg/mL in acetonitrile (as free base)	1 mL
M-061	2*R*-Methcathinone·HCl (unlabeled)	1 mg/mL in methanol	1 mL
M-055	2*S*-Methcathinone·HCl (unlabeled)	1 mg/mL in methanol	1 mL
M-139	Mephedrone·HCl (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
M-138	Mephedrone·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
M-147	Methedrone·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
M-164	Methiopropamine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
M-129	Methylephedrine (unlabeled)	1 mg/mL in methanol	1 mL
M-174	Methylhexanamine·HCl (DMAA HCl) (D_4, 98%)	100 µg/mL in methanol (as free base)	1 mL
M-157	Methylhexanamine·HCl (DMAA HCl) (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
M-141	Methylone·HCl (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
M-140	Methylone·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
H-115	25H-NBOMe·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
I-019	25I-NBOH·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
I-017	25I-NBOMe·HCl (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
N-046	(+)-Norpseudoephedrine·HCl (cathine·HCl) (unlabeled)	100 µg/mL in methanol (as free base)	1 mL
N-087	(±)-Norpseudoephedrine·HCl (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
P-050	PMA·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
P-051	PMMA·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
P-035	(+)-Pseudoephedrine (unlabeled)	1 mg/mL in methanol	1 mL
P-036	(-)-Pseudoephedrine (unlabeled)	1 mg/mL in methanol	1 mL
P-056	Pseudoephedrine·HCl (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
P-079	(±)-Phenylephrine·HCl (D_3, 98%)	100 µg/mL in methanol with 5% 1 M HCl (as free base)	1 mL
P-078	*R*(-)-Phenylephrine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
T-920	3-Trifluoromethylphenylpiperazine·HCl (D_4, 98%)	100 µg/mL in methanol (as free base)	1 mL
T-045	3-Trifluoromethylphenylpiperazine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL

Analgesics

Catalog No.	Description	Concentration	Unit Size
CLM-2436*	Acetaminophen (carbonyl-^{13}C, 99%)	neat	Please inquire
CLM-10619*	Acetaminophen (ring-$^{13}C_6$, 98%)	neat	1 mg
CNLM-3726*	Acetominophen (acetyl-$^{13}C_2$, 99%; ^{15}N, 98%)	neat	1 g
ULM-7629-1.2*	Acetominophen (unlabeled)	100 µg/mL in acetonitrile	1.2 mL
CLM-630*	Aminopyrine (*N,N*-dimethyl-$^{13}C_2$, 99%)	neat	1 g
N-083	Normeperidine (D_4, 98%)	1 mg/mL in methanol	1 mL
N-020	Normeperidine (D_4, 98%)	100 µg/mL in methanol	1 mL
N-089	Normeperidine (unlabeled)	1 mg/mL in methanol	1 mL
N-017	Normeperidine (unlabeled)	100 µg/mL in methanol	1 mL
N-061	Nortilidine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
CLM-1296*	Phenacetin (ethoxy-1-^{13}C, 99%)	neat	0.5 g, 1 g

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Drugs and Their Metabolites *(continued)*

Anesthetics

Catalog No.	Description	Concentration	Unit Size
A-071	Alfentanil·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
D-046	Dehydronorketamine·HCl (unlabeled)	100 µg/mL in acetonitrile	1 mL
K-003	Ketamine·HCl (D_4, 98%)	100 µg/mL in methanol (as free base)	1 mL
K-002	Ketamine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
L-050	Lidocaine (D_{10}, 98%)	100 µg/mL in methanol	1 mL
L-018	Lidocaine (unlabeled)	1 mg/mL in methanol	1 mL
M-156	Methoxetamine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
N-037	(±)-Norketamine·HCl (D_4, 98%)	100 µg/mL in methanol (as free base)	1 mL
N-036	(±)-Norketamine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
N-124	Norlidocaine (unlabeled)	1 mg/mL in methanol	1 mL
P-077	Propofol (D_{17}, 98%)	100 µg/mL in methanol	1 mL
P-076	Propofol (unlabeled)	1 mg/mL in methanol	1 mL
G-006	Sodium γ-hydroxybutyrate (2,2,3,3,4,4-D_6, 98%)	1000 µg/mL in methanol	1 mL
G-003	Sodium γ-hydroxybutyrate (2,2,3,3,4,4-D_6, 98%)	100 µg/mL in methanol	1 mL
G-001	Sodium γ-hydroxybutyrate (unlabeled)	1 mg/mL in methanol	1 mL

Antibiotics

Catalog No.	Description	Concentration	Unit Size
CLM-123*	Erythromycin (*N*-methyl-^{13}C, 99%)	neat	1 g
CDLM-10030-MT-1.2*	Erythromycin (*N*-methyl-^{13}C, 99%; D_3, 98%) CP 97%	100 µg/mL in methyl-*tert* butyl ester (MTBE)	1.2 mL
CLM-3758*	Erythromycin, lactobionate salt (*N,N*-dimethyl-$^{13}C_2$, ~90%)	neat	Please inquire
CLM-165*	Erythromycin, lactobionate salt (*N*-methyl-^{13}C, 99%)	neat	1 g
M-183	Metronidazole (unlabeled)	2 mg/mL in methanol	1 mL
CLM-3045-1.2*	Sulfamethazine (phenyl-$^{13}C_6$, 99%)	100 µg/mL in acetonitrile	1.2 mL
CLM-3045*	Sulfamethazine (phenyl-$^{13}C_6$, 99%)	neat	10 mg
ULM-7220-1.2*	Sulfamethazine (unlabeled)	100 µg/mL in acetonitrile	1.2 mL
CLM-7988-A-1.2*	Trimethoprim (pyrimidine-4,5,6-$^{13}C_3$, 99%)	50 µg/mL in methanol	1.2 mL
ULM-7989-A-1.2*	Trimethoprim (unlabeled)	50 µg/mL in methanol	1.2 mL

Anticonvulsants/Antiepileptics

Catalog No.	Description	Concentration	Unit Size
DLM-3025*	5,5-Diphenylhydantoin (phenyl-D_5, 98%)	neat	10 mg
DLM-324*	5,5-Diphenylhydantoin (diphenyl-D_{10}, 98%)	neat	0.01 g, 0.1 g
CNLM-411-1.2*	5,5-Diphenylhydantoin (2-^{13}C, 99%; 1,3-$^{15}N_2$, 98%)	100 µg/mL in methanol	1.2 mL
CNLM-411*	5,5-Diphenylhydantoin (2-^{13}C, 99%; 1,3-$^{15}N_2$, 98%)	neat	0.01 g, 0.05 g
ULM-8533-1.2*	5,5-Diphenylhydantoin (unlabeled)	100 µg/mL in methanol	1.2 mL
C-121	Carbamazepine-10,11-epoxide (unlabeled)	1 mg/mL in methanol	1 mL
G-007	Gabapentin (unlabeled)	1 mg/mL in methanol	1 mL
G-021	Gabapentin (unlabeled)	10 mg/mL in methanol	1 mL
G-901	Gabapentin (D_{10}, 98%)	100 µg/mL in methanol	1 mL
L-029	Lacosamide (unlabeled)	1 mg/mL in acetonitrile	1 mL
CNLM-7633*	Lamotrigine (5,6-$^{13}C_2$, 99%; 5-amino-^{15}N, 98%)	neat	10 mg
L-019	Lamotrigine (unlabeled)	1 mg/mL in methanol	1 mL
L-031	Levetiracetam (D_6, 98%)	1 mg/mL in methanol	1 mL
L-023	Levetiracetam (D_6, 98%)	100 µg/mL in methanol	1 mL
L-020	Levetiracetam (unlabeled)	1 mg/mL in methanol	1 mL
O-025	Oxcarbazepine (unlabeled)	1 mg/mL in acetonitrile	1 mL
P-067	Phenytoin (D_{10}, 98%)	100 µg/mL in methanol	1 mL
P-063	Phenytoin (unlabeled)	1 mg/mL in methanol	1 mL

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Catalog No.	Description	Concentration	Unit Size
P-106	Pregabalin ($^{13}C_3$, 98%)	100 µg/mL in methanol	1 mL
P-072	Pregabalin (D_6, 98%)	100 µg/mL in methanol	1 mL
P-066	Pregabalin (unlabeled)	1 mg/mL in methanol	1 mL
P-075	Primidone (unlabeled)	1 mg/mL in methanol	1 mL
T-041	Topiramate (D_{12}, 98%)	100 µg/mL in methanol	1 mL
T-039	Topiramate (unlabeled)	1000 µg/mL in methanol	1 mL
V-029	Valproic acid (D_6, 98%)	1 mg/mL in methanol	1 mL
V-006	Valproic acid (unlabeled)	1 mg/mL in methanol	1 mL
Z-005	Zonisamide (unlabeled)	1 mg/mL in methanol	1 mL

Antidepressants

Catalog No.	Description	Concentration	Unit Size
A-121	Amitriptyline·HCl (D_3, 98%)	1 mg/mL in methanol (as free base)	1 mL
A-085	Amitriptyline·HCl (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
DLM-2762*	Amitriptyline·HCl (*N*-methyl-D_3, 98%)	neat	Please inquire
A-923	Amitriptyline·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
B-034	Bupropion·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
DLM-2790*	Buspirone·HCl (butyl-D_8, 98%)	neat	Please inquire
C-090	Citalopram hydrobromide (D_6, 98%)	100 µg/mL in methanol (as free base)	1 mL
C-095	Citalopram hydrobromide (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
C-057	Citalopram hydrobromide (unlabeled)	100 µg/mL in methanol (as free base)	1 mL
C-116	Clomipramine·HCl (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
C-118	Clomipramine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
D-116	Desipramine·HCl (D_3, 98%)	1 mg/mL in methanol (as free base)	1 mL
D-903	Desipramine·HCl (D_3, 98%)	100 µg/mL in methanol	1 mL
DLM-3020*	Desipramine·HCl (2,4,6,8-D_4, 98%)	neat	5 mg
D-906	Desipramine·HCl (unlabeled)	1 mg/mL in methanol	1 mL
D-047	*N*-Desmethylcitalopram·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
D-916	*N*-Desmethylclomipramine (unlabeled)	1 mg/mL in methanol	1 mL
D-113	*N*-Desmethylclomipramine·HCl (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
D-007	Desmethyldoxepin (unlabeled)	1 mg/mL in methanol	1 mL
D-075	*N*-Desmethyldoxepin·HCl (*cis*/*trans*) (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
D-012	(±)-*N*-Desmethylselegiline (unlabeled)	1 mg/mL in methanol	1 mL
D-920	*N*-Desmethyltrimipramine, maleate salt (unlabeled)	1 mg/mL in methanol	1 mL
V-027	(±)-*O*-Desmethylvenlafaxine (D_6, 98%)	100 µg/mL in methanol	1 mL
V-007	*O*-Desmethylvenlafaxine (unlabeled)	100 µg/mL in methanol	1 mL
D-173	Dothiepin·HCl (*cis*/*trans*) (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
D-060	Doxepin·HCl (*cis*/*trans*) (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
D-927	Doxepin·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
D-068	Duloxetine·HCl (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
D-044	Duloxetine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
F-038	Fluoxetine oxalate (D_6, 98%)	1 mg/mL in methanol (as free base)	1 mL
F-919	Fluoxetine oxalate (D_6, 98%)	100 µg/mL in methanol	1 mL
F-918	Fluoxetine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
F-045	Fluvoxamine maleate (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
F-040	Fluvoxamine maleate (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
H-062	(±)-Hydroxybupropion (D_6, 98%)	100 µg/mL in acetonitrile	1 mL
H-066	(±)-Hydroxybupropion (unlabeled)	1 mg/mL in acetonitrile	1 mL
I-902	Imipramine (unlabeled)	1 mg/mL in methanol	1 mL
DLM-3035*	Imipramine·HCl (2,4,6,8-D_4, 98%) CP 97%	neat	2 mg
I-903	Imipramine maleate (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
M-920	Maprotiline·HCl	1 mg/mL in methanol (as free base)	1 mL

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Drugs and Their Metabolites *(continued)*

Catalog No.	Description	Concentration	Unit Size
M-901	Mianserin (D_3, 98%)	100 µg/mL in methanol	1 mL
M-919	Mianserin·HCl (unlabeled)	1000 µg/mL in methanol (as free base)	1 mL
M-191	Mirtazapine (D_3, 98%)	100 µg/mL in methanol	1 mL
M-128	Mirtazapine (unlabeled)	1 mg/mL in methanol	1 mL
N-102	Norfluoxetine oxalate (D_6, 98%)	1 mg/mL in methanol (as free base)	1 mL
N-922	Norfluoxetine oxalate (D_6, 98%)	100 µg/mL in methanol	1 mL
N-923	Norfluoxetine oxalate (unlabeled)	1000 µg/mL in methanol	1 mL
N-049	Norsertraline·HCl (unlabeled)	100 µg/mL in methanol (as free base)	1 mL
N-090	Nortriptyline·HCl (D_3, 98%)	1 mg/mL in methanol (as free base)	1 mL
N-902	Nortriptyline·HCl (D_3, 98%)	100 µg/mL in methanol	1 mL
DLM-3038*	Nortriptyline·HCl (methyl-D_3, 98%)	neat	5 mg, 0.1 g
N-907	Nortriptyline·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
P-915	Paroxetine maleate (D_6, 98%)	100 µg/mL in methanol	1 mL
P-916	Paroxetine maleate (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
P-088	Protriptyline·HCl (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
P-903	Protriptyline·HCl (unlabeled)	1 mg/mL in methanol	1 mL
S-003	*R*(-)-Selegiline (unlabeled)	1 mg/mL in methanol	1 mL
S-021	Sertraline (unlabeled)	1 mg/mL in methanol	1 mL
S-026	Sertraline·HCl (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
T-079	Trazodone·HCl (D_6, 98%)	100 µg/mL in methanol (as free base)	1 mL
T-030	Trazodone·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
T-904	Trimipramine (unlabeled)	1 mg/mL in methanol	1 mL
V-009	Venlafaxine·HCl (D_6, 98%)	100 µg/mL in methanol (as free base)	1 mL
V-004	Venlafaxine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL

Antipsychotics

Catalog No.	Description	Concentration	Unit Size
A-081	Aripiprazole (D_8, 98%)	100 µg/mL in acetonitrile	1 mL
A-119	Aripiprazole (unlabeled)	1 mg/mL in methanol:water (1:1) with 1% 1 N HCl	1 mL
C-904	Chlorpromazine·HCl (unlabeled)	1 mg/mL in methanol	1 mL
C-107	Chlorpromazine maleate (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
C-091	Clozapine (D_4, 98%)	100 µg/mL in methanol	1 mL
DLM-2816*	Clozapine (4-methylpiperazinyl-D_4, 97%)	neat	5 mg, 10 mg
C-059	Clozapine (unlabeled)	1000 µg/mL in methanol	1 mL
D-169	*N*-Desmethylclozapine (D_8, 98%)	100 µg/mL in methanol	1 mL
D-048	*N*-Desmethylclozapine (unlabeled)	1 mg/mL in methanol	1 mL
D-069	*N*-Desmethylolanzapine (unlabeled)	1 mg/mL in acetonitrile:water (1:1) (as free base)	1 mL
F-903	Fluphenazine dihydrochloride (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
H-002	Haloperidol (D_4, 98%)	100 µg/mL in methanol	1 mL
H-030	Haloperidol (unlabeled)	1 mg/mL in methanol	1 mL
H-081	7-Hydroxyquetiapine (unlabeled)	1 mg/mL in methanol	1 mL
H-076	9-Hydroxyrisperidone (unlabeled)	1 mg/mL in methanol	1 mL
L-035	Lurasidone·HCl (D_8, 98%)	100 µg/mL in methanol (as free base)	1 mL
N-070	Norquetiapine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
O-035	Olanzapine (D_8, 98%)	100 µg/mL in acetonitrile	1 mL
O-024	Olanzapine (unlabeled)	1 mg/mL in acetonitrile	1 mL
Q-002	Quetiapine hemifumarate (D_8, 98%)	100 µg/mL in methanol (as free base)	1 mL
Q-001	Quetiapine hemifumarate (unlabeled)	1 mg/mL in methanol	1 mL
R-006	Risperidone (unlabeled)	1 mg/mL in methanol	1 mL
T-905	Thioridazine (unlabeled)	1 mg/mL in methanol	1 mL
Z-018	Ziprasidone·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL

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Barbituates

Catalog No.	Description	Concentration	Unit Size
A-102	Amobarbital (D_5, 98%)	100 µg/mL in methanol	1 mL
A-020	Amobarbital (unlabeled)	1 mg/mL in methanol	1 mL
B-041	Barbiturate mix – 5 (unlabeled)	250 µg/mL in methanol	1 mL
B-024	Butabarbital (unlabeled)	1 mg/mL in methanol	1 mL
B-030	Butalbital (D_5, 98%)	1000 µg/mL in methanol	1 mL
B-005	Butalbital (D_5, 98%)	100 µg/mL in methanol	1 mL
B-006	Butalbital (unlabeled)	1 mg/mL in methanol	1 mL
H-013	Hexobarbital (unlabeled)	1 mg/mL in methanol	1 mL
M-079	Methohexital (D_5, 98%)	100 µg/mL in methanol	1 mL
P-013	Pentobarbital (D_5, 98%)	1000 µg/mL in methanol	1 mL
P-009	Pentobarbital (D_5, 98%)	100 µg/mL in methanol	1 mL
P-010	Pentobarbital (unlabeled)	1 mg/mL in methanol	1 mL
P-017	Phenobarbital (2-methylbutyl-3,3,4,4,4-D_5, 98%)	1 mg/mL in methanol	1 mL
P-004	Phenobarbital (2-methylbutyl-3,3,4,4,4-D_5, 98%)	100 µg/mL in methanol	1 mL
P-019	Phenobarbital (5-ethyl-D_5, 98%)	1000 µg/mL in methanol	1 mL
P-018	Phenobarbital (5-ethyl-D_5, 98%)	100 µg/mL in methanol	1 mL
DLM-433*	Phenobarbital (ethyl-D_5, 98%)	neat	0.1 g
P-008	Phenobarbital (unlabeled)	1000 µg/mL in methanol	1 mL
DLM-2659*	DL-Secobarbital (1-methyl-D_3, butyl-2,2-D_2, 98%)	neat	Please inquire
S-048	Secobarbital (D_5, 98%)	1 mg/mL in methanol	1 mL
S-001	Secobarbital (D_5, 98%)	100 µg/mL in methanol	1 mL
S-002	Secobarbital (unlabeled)	1 mg/mL in methanol	1 mL

Benzodiazepines

Catalog No.	Description	Concentration	Unit Size
A-910	Alprazolam (D_5, 98%)	1 mg/mL in methanol	1 mL
A-902	Alprazolam (D_5, 98%)	100 µg/mL in methanol	1 mL
A-903	Alprazolam (unlabeled)	1000 µg/mL in methanol	1 mL
A-924	7-Aminoclonazepam (D_4, 98%)	1 mg/mL in acetonitrile	1 mL
A-917	7-Aminoclonazepam (D_4, 98%)	100 µg/mL in acetonitrile	1 mL
A-916	7-Aminoclonazepam (unlabeled)	1 mg/mL in acetonitrile	1 mL
A-915	7-Aminoclonazepam (unlabeled)	100 µg/mL in acetonitrile	1 mL
A-925	7-Aminoflunitrazepam (D_7, 98%)	1 mg/mL in acetonitrile	1 mL
A-921	7-Aminoflunitrazepam (D_7, 98%)	100 µg/mL in acetonitrile	1 mL
A-911	7-Aminoflunitrazepam (unlabeled)	1 mg/mL in acetonitrile	1 mL
A-912	7-Aminoflunitrazepam (unlabeled)	100 µg/mL in acetonitrile	1 mL
A-913	7-Aminonitrazepam (unlabeled)	1 mg/mL in acetonitrile	1 mL
A-914	7-Aminonitrazepam (unlabeled)	100 µg/mL in acetonitrile	1 mL
B-033	Benzodiazepine Multi-component Mixture – 8 (unlabeled)	250 µg/mL in acetonitrile	1 mL
B-903	Bromazepam (unlabeled)	1 mg/mL in methanol	1 mL
C-912	Chlordiazepoxide (D_5, 98%)	100 µg/mL in methanol	1 mL
C-022	Chlordiazepoxide (unlabeled)	1 mg/mL in methanol	1 mL
C-149	Clobazam ($^{13}C_6$, 98%)	100 µg/mL in methanol	1 mL
CLM-10630-B*	Clobazam (ring-[χ]-$^{13}C_6$, 98%) CP 95%	50 µg/mL in methanol	1 mL
C-909	Clobazam (unlabeled)	1 mg/mL in methanol	1 mL
C-906	Clonazepam (D_4, 98%)	1 mg/mL in methanol	1 mL
C-905	Clonazepam (D_4, 98%)	100 µg/mL in methanol	1 mL
CLM-10631-B*	Clonazepam (ring-[α]-$^{13}C_6$, 98%) CP 95%	50 µg/mL in methanol	1 mL
C-907	Clonazepam (unlabeled)	1 mg/mL in methanol	1 mL
D-142	Delorazepam (unlabeled)	100 µg/mL in acetonitrile	1 mL
D-079	Demoxepam (unlabeled)	1 mg/mL in acetonitrile	1 mL
D-924	Desalkylflurazepam (D_4, 98%)	100 µg/mL in methanol	1 mL

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Drugs and Their Metabolites *(continued)*

Catalog No.	Description	Concentration	Unit Size
D-915	Desalkylflurazepam (unlabeled)	1 mg/mL in methanol	1 mL
D-145	*N*-Desmethylclobazam (unlabeled)	1 mg/mL in 10% dimethyl sulfoxide (DMSO) in acetonitrile	1 mL
D-049	*N*-Desmethylclobazam (unlabeled)	100 µg/mL in acetonitrile	1 mL
D-925	*N*-Desmethylflunitrazepam (D_4, 98%)	100 µg/mL in methanol	1 mL
D-918	*N*-Desmethylflunitrazepam (unlabeled)	1 mg/mL in methanol	1 mL
D-910	Diazepam (D_5, 98%)	1 mg/mL in methanol	1 mL
D-902	Diazepam (D_5, 98%)	100 µg/mL in methanol	1 mL
DLM-1886*	Diazepam (phenyl-D_5, 98%)	neat	Please inquire
CLM-10632-B*	Diazepam (ring-[α]-$^{13}C_6$, 98%) CP 95%	50 µg/mL in methanol	1 mL
D-907	Diazepam (unlabeled)	1000 µg/mL in methanol	1 mL
D-159	Diclazepam (unlabeled)	1 mg/mL in acetonitrile	1 mL
E-903	Estazolam (D_5, 98%)	100 µg/mL in methanol	1 mL
E-901	Estazolam (unlabeled)	1 mg/mL in methanol	1 mL
F-915	Flunitrazepam (D_7, 98%)	100 µg/mL in methanol	1 mL
F-907	Flunitrazepam (unlabeled)	1 mg/mL in methanol	1 mL
F-003	Flurazepam (unlabeled)	1 mg/mL in methanol	1 mL
H-919	2-Hydroxyethylflurazepam (D_4, 98%)	100 µg/mL in methanol	1 mL
F-902	2-Hydroxyethylflurazepam (unlabeled)	1 mg/mL in methanol	1 mL
A-908	α-Hydroxyalprazolam (D_5, 98%)	1000 µg/mL in methanol	1 mL
A-904	α-Hydroxyalprazolam (D_5, 98%)	100 µg/mL in methanol	1 mL
A-907	α-Hydroxyalprazolam (unlabeled)	1 mg/mL in methanol	1 mL
A-905	α-Hydroxyalprazolam (unlabeled)	100 µg/mL in methanol	1 mL
H-921	α-Hydroxymidazolam (D_4, 98%)	100 µg/mL in methanol	1 mL
H-922	α-Hydroxymidazolam (unlabeled)	1 mg/mL in methanol	1 mL
H-902	α-Hydroxymidazolam (unlabeled)	100 µg/mL in methanol	1 mL
T-916	α-Hydroxytriazolam (D_4, 98%)	1 mg/mL in methanol	1 mL
T-909	α-Hydroxytriazolam (D_4, 98%)	100 µg/mL in methanol	1 mL
T-911	α-Hydroxytriazolam (unlabeled)	1 mg/mL in methanol	1 mL
CLM-10633-B*	Lorazepam (ring-[α]-$^{13}C_6$, 98%) CP 95%	50 µg/mL in methanol	1 mL
L-911	Lorazepam (D_4, 98%)	1 mg/mL in acetonitrile	1 mL
L-902	Lorazepam (D_4, 98%)	100 µg/mL in acetonitrile	1 mL
L-901	Lorazepam (unlabeled)	1 mg/mL in acetonitrile	1 mL
L-021	Lorezapam glucuronide (unlabeled)	100 µg/mL acetonitrile:water (1:1)	1 mL
L-907	Lormetazepam (unlabeled)	1 mg/mL in methanol	1 mL
M-908	Midazolam (unlabeled)	1 mg/mL in methanol	1 mL
M-918	Midazolam maleate (D_4, 98%)	100 µg/mL in methanol	1 mL
N-073	Nimetazepam (unlabeled)	1 mg/mL in methanol	1 mL
N-901	Nitrazepam (D_5, 98%)	100 µg/mL in acetonitrile	1 mL
N-906	Nitrazepam (unlabeled)	1 mg/mL in methanol	1 mL
CLM-10635-B*	Nordiazepam (ring-[α]-$^{13}C_6$, 98%) CP 95%	50 µg/mL in methanol	1 mL
N-911	Nordiazepam (D_5, 98%)	1 mg/mL in methanol	1 mL
N-903	Nordiazepam (D_5, 98%)	100 µg/mL in methanol	1 mL
DLM-1885*	Nordiazepam (phenyl-D_5, 98%)	neat	Please inquire
N-905	Nordiazepam (unlabeled)	1000 µg/mL in methanol	1 mL
CLM-10636-B*	Oxazepam (ring-[α]-$^{13}C_6$, 98%) CP 95%	50 µg/mL in methanol	1 mL
O-904	Oxazepam (D_5, 98%)	1000 µg/mL in methanol	1 mL
O-901	Oxazepam (D_5, 98%)	100 µg/mL in acetonitrile	1 mL
DLM-1888*	Oxazepam (phenyl-D_5, 98%)	neat	Please inquire
O-902	Oxazepam (unlabeled)	1 mg/mL in acetonitrile	1 mL
O-038	Oxazepam glucuronide (D_5, 98%)	100 µg/mL in methanol	1 mL

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Catalog No.	Description	Concentration	Unit Size
O-023	Oxazepam glucuronide (unlabeled)	100 µg/mL in methanol	1 mL
P-080	Phenazepam (unlabeled)	1 mg/mL in acetonitrile	1 mL
CLM-10637-B*	Prazepam (ring-[α]-$^{13}C_6$, 98%) CP 95%	50 µg/mL in methanol	1 mL
P-906	Prazepam (unlabeled)	1 mg/mL in methanol	1 mL
CLM-10638-B*	Temazepam (ring-[α]-$^{13}C_6$, 98%) CP 95%	50 µg/mL in methanol	1 mL
T-912	Temazepam (D_5, 98%)	1 mg/mL in methanol	1 mL
T-902	Temazepam (D_5, 98%)	100 µg/mL in methanol	1 mL
T-907	Temazepam (unlabeled)	1000 µg/mL in methanol	1 mL
T-050	Temazepam glucuronide, lithium salt (unlabeled)	100 µg/mL in methanol (as free acid)	1 mL
CLM-10640-B*	Triazolam (ring-[α]-$^{13}C_6$, 98%) CP 95%	50 µg/mL in methanol	1 mL
T-908	Triazolam (D_4, 98%)	100 µg/mL in methanol	1 mL
T-910	Triazolam (unlabeled)	1 mg/mL in methanol	1 mL

Cannabinoids and its Agonists

Catalog No.	Description	Concentration	Unit Size
S-065	AB-FUBINACA (unlabeled)	100 µg/mL in methanol	1 mL
S-059	AM-2201 4-hydroxypentyl metabolite (unlabeled)	100 µg/mL in methanol	1 mL
S-088	Apinaca (AKB-48) 5-hydroxypentyl metabolite (D_4, 98%)	100 µg/mL in methanol	1 mL
S-087	Apinaca (AKB-48) 5-hydroxypentyl metabolite (unlabeled)	100 µg/mL in methanol	1 mL
DLM-10854*	Cannabichromene (CPC) (methyl-D_3, 98%)	neat	Please inquire
ULM-10878*	Cannabichromene (CPC) (unlabeled)	neat	Please inquire
C-150	Cannabichromenic acid (CBCA) (unlabeled)	1 mg/mL in acetonitrile	1 mL
C-154	(±)-Cannabicyclol (CBL) (unlabeled)	1 mg/mL in acetonitrile	1 mL
C-045	(±)-Cannabidiol (unlabeled)	1000 µg/mL in methanol	1 mL
DLM-10855*	Cannabidiol (D_3, 98%)	neat	Please inquire
ULM-10875*	Cannabidiol (unlabeled)	neat	Please inquire
DLM-10853*	Cannabigerol (CBG) (methyl-D_3, 98%)	neat	Please inquire
ULM-10877*	Cannabigerol (CBG) (unlabeled)	neat	Please inquire
DLM-10847*	Cannabinol (methyl-D_3, 98%)	neat	Please inquire
C-046	Cannabinol (unlabeled)	1000 µg/mL in methanol	1 mL
DLM-10915*	Cannabivarin (methyl D_3, 98%) CP 97%	neat	Please inquire
ULM-10916*	Cannabivarin (unlabeled) CP 97%	neat	Please inquire
C-152	Cannabidivarinic acid (CBDVA) (unlabeled)	1 mg/mL in acetonitrile	1 mL
S-024	HU-210 spice cannabinoid (unlabeled)	100 µg/mL in methanol	1 mL
S-035	JWH-018 3-Hydroxypentyl metabolite (unlabeled)	100 µg/mL in methanol	1 mL
S-039	JWH-018 4-Hydroxypentyl metabolite (indole-D_5, 98%)	100 µg/mL in methanol	1 mL
S-054	JWH-018 5-Hydroxypentyl metabolite (unlabeled)	100 µg/mL in methanol	1 mL
S-033	JWH-018 5-Pentanoic acid metabolite (unlabeled)	100 µg/mL in methanol	1 mL
S-025	JWH-018 Spice cannabinoid (unlabeled)	100 µg/mL in methanol	1 mL
S-043	JWH-019 6-Hydroxyhexyl metabolite (unlabeled)	100 µg/mL in methanol	1 mL
S-040	JWH-073 3-Hydroxybutyl metabolite (indole-D_5, 98%)	100 µg/mL in methanol	1 mL
S-037	JWH-073 3-Hydroxybutyl metabolite (unlabeled)	100 µg/mL in methanol	1 mL
S-036	JWH-073 4-Butanoic acid metabolite (unlabeled)	100 µg/mL in methanol	1 mL
S-053	JWH-073 4-Hydroxybutyl metabolite (unlabeled)	100 µg/mL in methanol	1 mL
S-027	JWH-073 Spice cannabinoid (unlabeled)	100 µg/mL in acetonitrile	1 mL
S-056	JWH-122 4-Hydroxypentyl metabolite (indole-D_5, 98%)	100 µg/mL in methanol	1 mL
S-049	JWH-122 4-Hydroxypentyl metabolite (unlabeled)	100 µg/mL in methanol	1 mL
S-046	JWH-250 4-Hydroxypentyl metabolite (unlabeled)	100 µg/mL in methanol	1 mL
S-045	JWH-250 5-Hydroxypentyl metabolite (unlabeled)	100 µg/mL in methanol	1 mL
S-093	Mam2201 4-hydroxypentyl metabolite (indole-D_5, 98%)	100 µg/mL in methanol	1 mL
S-075	5-fluoro PB-22 (unlabeled)	100 µg/mL in acetonitrile	1 mL
S-095	PB-22 4-hydroxypentyl metabolite (indole-D_5, 98%)	100 µg/mL in acetonitrile	1 mL

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Drugs and Their Metabolites *(continued)*

Catalog No.	Description	Concentration	Unit Size
S-094	PB-22 4-hydroxypentyl metabolite (unlabeled)	100 µg/mL in acetonitrile	1 mL
S-097	PB-22 5-pentanoic acid metabolite (indole-D_5, 98%)	100 µg/mL in methanol	1 mL
S-096	PB-22 5-pentanoic acid metabolite (unlabeled)	100 µg/mL in methanol	1 mL
S-076	PB-22 (unlabeled)	100 µg/mL in acetonitrile	1 mL
S-038	Spice cannabinoid mix (unlabeled)	100 µg/mL of each component in acetonitrile	1 mL
DLM-10846*	δ-9-*trans*-tetrahydrocannabinol (THC) (methyl-D_3, 98%)	neat	Please inquire
ULM-10874*	δ-9-*trans*-tetrahydrocannabinol (THC) (unlabeled)	neat	Please inquire
T-032	(-)-δ-8-THC (unlabeled)	1 mg/mL in methanol	1 mL
T-011	(-)-δ-9-THC (D_3, 98%)	1 mg/mL in methanol	1 mL
T-003	(-)-δ-9-THC (D_3, 98%)	100 µg/mL in methanol	1 mL
T-005	(-)-δ-9-THC (unlabeled)	1 mg/mL in methanol	1 mL
T-047	(±)-δ-9-THC (for qualitative use only) (unlabeled)	100 µg/mL in heptane	1 mL
H-041	(±)-11-hydroxy-δ-9-THC (D_3, 98%)	100 µg/mL in methanol	1 mL
H-027	(±)-11-hydroxy-δ-9-THC (unlabeled)	1 mg/mL in methanol	1 mL
H-026	(±)-11-hydroxy-δ-9-THC (unlabeled)	100 µg/mL in methanol	1 mL
T-019	(-)-11-nor-9-carboxy-δ-9-THC (unlabeled)	1 mg/mL in methanol	1 mL
T-018	(-)-11-nor-9-carboxy-δ-9-THC (unlabeled)	100 µg/mL in methanol	1 mL
T-008	DL-11-nor-9-carboxy-δ-9-THC (D_3, 98%)	1000 µg/mL in methanol	1 mL
T-004	DL-11-nor-9-carboxy-δ-9-THC (D_3, 98%)	100 µg/mL in methanol	1 mL
T-009	DL-11-nor-9-carboxy-δ-9-THC (D_9, 98%)	1 mg/mL in methanol	1 mL
T-007	DL-11-nor-9-carboxy-δ-9-THC (D_9, 98%)	100 µg/mL in methanol	1 mL
T-006	DL-11-nor-9-carboxy-δ-9-THC (unlabeled)	100 µg/mL in methanol	1 mL
T-038	(+)-11-nor-δ-9-THC-9-carboxylic acid glucuronide (unlabeled)	100 µg/mL in methanol	1 mL
T-080	(±)-*cis*-11-nor-δ-9-THC-9-carboxy glucuronide (D_3, 98%)	100 µg/mL in methanol	1 mL
T-033	*exo*-THC (unlabeled)	1 mg/mL in methanol	1 mL
T-108	THC Cannabinoids Mixture – 3 (unlabeled)	1 mg/mL of each component in methanol	0.5 mL
S-077	UR-144 5-Hydroxypentyl metabolite (unlabeled)	100 µg/mL in methanol	1 mL
S-090	UR-144 5-Pentanoic acid metabolite (indole-D_5, 98%)	100 µg/mL in methanol	1 mL
S-078	UR-144 5-Pentanoic acid metabolite (unlabeled)	100 µg/mL in methanol	1 mL

Cardiac Drugs

Catalog No.	Description	Concentration	Unit Size
A-083	Amiodarone·HCl (D_4, 98%)	100 µg/mL in methanol (as free base)	1 mL
A-060	Amiodarone·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
A-072	Atenolol (unlabeled)	1 mg/mL in acetonitrile	1 mL
A-046	Atropine (unlabeled)	1 mg/mL in methanol	1 mL
DLM-1287*	Clonidine·HCl (4,4,5,5-imidazoline-D_4, 98%)	100 µg/mL in methanol	1.2 mL
DLM-1287*	Clonidine·HCl (4,4,5,5-imidazoline-D_4, 98%) CP 95%	neat	Please inquire
D-029	Digoxin (unlabeled)	1 mg/mL in methanol	1 mL
D-035	Diltiazem·HCl (unlabeled)	1000 µg/mL in acetonitrile	1 mL
DLM-2745*	Enalapril maleate (phenyl-D_5, 98%)	neat	Please inquire
F-017	(±)-Flecainide (unlabeled)	1 mg/mL in methanol	1 mL
F-005	Furosemide (unlabeled)	1 mg/mL in methanol	1 mL
H-001	Hydrochlorothiazide (unlabeled)	1 mg/mL in methanol	1 mL
CNLM-10539	Mecamylamine·HCl (tetramethyl-$^{13}C_4$, 99%; ^{15}N, 98%)	neat	1 mg, 10 mg
M-123	Metoprolol tartrate (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
M-001	1-Mononitroglycerin (unlabeled)	100 µg/mL in acetonitrile	1 mL
DLM-10407*	Moricizine hydrochloride (D_8, 98%) CP 95%	neat	1 mg
P-055	Propranolol·HCl (unlabeled)	100 µg/mL in methanol	1 mL
V-002	Verapamil·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
W-003	Warfarin (unlabeled)	1 mg/mL in acetonitrile	1 mL

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Cocaine and its Metabolites

Catalog No.	Description	Concentration	Unit Size
A-034	Anhydroecgonine, methyl ester (unlabeled)	1 mg/mL in acetonitrile	1 mL
B-008	Benzoylecgonine (D_3, 98%)	1000 µg/mL in methanol	1 mL
B-001	Benzoylecgonine (D_3, 98%)	100 µg/mL in methanol	1 mL
B-014	Benzoylecgonine (D_8, 98%)	1 mg/mL in methanol	1 mL
B-013	Benzoylecgonine (D_8, 98%)	100 µg/mL in methanol	1 mL
B-004	Benzoylecgonine (unlabeled)	1000 µg/mL in methanol	1 mL
B-007	Benzoylecgonine (unlabeled)	100 µg/mL in methanol	1 mL
C-009	Cocaethylene (D_3, 98%)	100 µg/mL in acetonitrile	1 mL
C-024	Cocaethylene (D_8, 98%)	100 µg/mL in acetonitrile	1 mL
C-010	Cocaethylene (unlabeled)	1 mg/mL in acetonitrile	1 mL
C-014	Cocaine (D_3, 98%)	1000 µg/mL in acetonitrile	1 mL
C-004	Cocaine (D_3, 98%)	100 µg/mL in acetonitrile	1 mL
C-008	Cocaine (unlabeled)	1000 µg/mL in acetonitrile	1 mL
C-088	Cocaine Multi-component Mixture – 4 (unlabeled)	250 µg/mL of each component in acetonitrile	1 mL
E-019	Ecgonine, ethyl ester (unlabeled)	1 mg/mL in acetonitrile	1 mL
E-002	Ecgonine, methyl ester (D_3, 98%)	100 µg/mL in acetonitrile	1 mL
E-001	Ecgonine, methyl ester (unlabeled)	1000 µg/mL in acetonitrile	1 mL
E-008	Ecgonine, methyl ester (unlabeled)	100 µg/mL in acetonitrile	1 mL
E-004	Ecgonine·HCl (unlabeled)	1000 µg/mL in methanol	1 mL
H-017	m-Hydroxybenzoylecgonine (unlabeled)	1 mg/mL in methanol	1 mL
H-119	m-Hydroxycocaine (unlabeled)	1 mg/mL in acetonitrile	1 mL
N-034	Norcocaine·HCl (D_3, 98%)	100 µg/mL in acetonitrile (as free base)	1 mL
N-003	Norcocaine·HCl (unlabeled)	1 mg/mL in acetonitrile	1 mL
NMID855	3,4,5-Trimethoxy-cocaine·HCl (unlabeled)	neat	20 mg

Hallucinogens

Catalog No.	Description	Concentration	Unit Size
B-022	Bufotenine (unlabeled)	1 mg/mL in acetonitrile	1 mL
D-102	*N,N*-Dimethyltryptamine (DMT) (unlabeled)	1 mg/mL in methanol	1 mL
L-004	Lampa (unlabeled)	1 mg/mL in acetonitrile	1 mL
O-013	2-oxo-3-hydroxy-LSD (unlabeled)	100 µg/mL in acetonitrile	1 mL
L-002	LSD (D_3, 98%)	100 µg/mL in acetonitrile	1 mL
L-005	LSD (unlabeled)	25 µg/mL in acetonitrile	1 mL
M-051	Mescaline·HCl (D_9, 98%)	100 µg/mL in methanol (as free base)	1 mL
M-047	Mescaline·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
DLM-2646*	5-Methoxytryptamine·HCl ($\alpha,\alpha,\beta,\beta$-$D_4$, 98%)	neat	0.01 g, 0.1 g
P-006	Phencyclidine (D_5, 98%)	1000 µg/mL in methanol	1 mL
P-003	Phencyclidine (D_5, 98%)	100 µg/mL in methanol	1 mL
P-007	Phencyclidine (unlabeled)	1000 µg/mL in methanol	1 mL
P-098	Psilocin (unlabeled)	100 µg/mL in acetonitrile	1 mL
S-012	Salvinorin A (unlabeled)	1 mg/mL in acetonitrile	1 mL

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Drugs and Their Metabolites *(continued)*

Immunosuppressants

Catalog No.	Description	Concentration	Unit Size
B-058	Busulfan (unlabeled)	1 mg/mL in methanol	1 mL
C-139	Cyclosporin A (^{15}N, 98%)	100 µg/mL in acetonitrile	1 mL
C-093	Cyclosporin A (unlabeled)	1 mg/mL in acetonitrile	1 mL
DLM-9855*	Everolimus (2-hydroxyethyl-D_4, 98%)	neat	1 mg
ULM-9856-C*	Everolimus (unlabeled)	100 µg/mL in methanol	1 mL
ULM-9856*	Everolimus (unlabeled)	neat	10 mg
M-136	Methotrexate (unlabeled)	1 mg/mL in methanol with 0.1 N sodium hydroxide	1 mL
M-106	Mycophenolic acid (unlabeled)	1 mg/mL in acetonitrile	1 mL
DLM-9220*	Rapamycin (D_3, 98%)	neat	1 mg, 5 mg, 10 mg
S-015	Sirolimus (rapamycin) (unlabeled)	1 mg/mL in acetonitrile	1 mL
T-049	Tacrolimus (unlabeled)	1 mg/mL in acetonitrile	1 mL

Opiate and Opiod Analgesics

Catalog No.	Description	Concentration	Unit Size
A-053	6-Acetylcodeine (unlabeled)	1 mg/mL in acetonitrile	1 mL
A-010	6-Acetylmorphine (D_3, 98%)	1000 µg/mL in acetonitrile	1 mL
A-006	6-Acetylmorphine (D_3, 98%)	100 µg/mL in acetonitrile	1 mL
A-027	6-Acetylmorphine (D_6, 98%)	1 mg/mL in acetonitrile	1 mL
A-026	6-Acetylmorphine (D_6, 98%)	100 µg/mL in acetonitrile	1 mL
A-009	6-Acetylmorphine (unlabeled)	1 mg/mL in acetonitrile	1 mL
A-003	6-Acetylmorphine (unlabeled)	100 µg/mL in acetonitrile	1 mL
A-140	Acryl fentanyl·HCl (unlabeled)	100 µg/mL in methanol (as free base)	0.5 mL
A-113	AH-7921·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
B-079	Benzyl fentanyl (unlabeled)	100 µg/mL in methanol	0.5 mL
B-908	Buprenorphine (D_4, 98%)	1 mg/mL in methanol	1 mL
B-901	Buprenorphine (D_4, 98%)	100 µg/mL in methanol	1 mL
B-044	Buprenorphine (unlabeled)	1 mg/mL in methanol	1 mL
B-902	Buprenorphine (unlabeled)	100 µg/mL in methanol	1 mL
B-035	Buprenorphine glucuronide (unlabeled)	100 µg/mL in methanol	1 mL
B-037	Butorphanol tartrate (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
B-066	Butyryl fentanyl (unlabeled)	100 µg/mL in methanol	0.5 mL
C-163	Carfentanil oxalate (D_5, 98%)	100 µg/mL in methanol (as free base)	0.5 mL
C-007	Codeine (D_3, 98%)	1000 µg/mL in methanol	1 mL
C-005	Codeine (D_3, 98%)	100 µg/mL in methanol	1 mL
C-041	Codeine (D_6, 98%)	1 mg/mL in methanol	1 mL
C-040	Codeine (D_6, 98%)	100 µg/mL in methanol	1 mL
CNLM-10389-B*	Codeine (9,10,15,16-$^{13}C_4$, 98%; ^{15}N, 98%) CP 95%	50 µg/mL in methanol	1 mL
C-006	Codeine (unlabeled)	1 mg/mL in methanol	1 mL
C-015	Codeine (unlabeled)	100 µg/mL in methanol	1 mL
C-138	Codeine-6-β-D-glucuronide (D_3, 98%)	100 µg/mL in methanol:water (4:1)	1 mL
CNLM-10388-B*	Codeine-6-β-D-glucuronide ($^{13}C_{10}$, 98%; ^{15}N, 98%) CP 95%	50 µg/mL in methanol:water (4:1)	1 mL
C-126	Codeine-6-β-D-glucuronide (unlabeled)	1 mg/mL in methanol:water (4:1)	1 mL
C-087	Codeine-6-β-D-glucuronide (unlabeled)	100 µg/mL in methanol:water (4:1)	1 mL
C-182	Cyclopentyl fentanyl·HCl (unlabeled)	100 µg/mL in methanol (as free base)	0.5 mL
C-177	Cyclopropyl fentanyl·HCl (unlabeled)	100 µg/mL in methanol (as free base)	0.5 mL
D-052	*N*-Desmethyltapentadol (unlabeled)	1 mg/mL in methanol	1 mL
D-071	Dextromethorphan (D_3, 98%)	100 µg/mL in methanol	1 mL
D-013	Dextromethorphan (unlabeled)	1 mg/mL in methanol	1 mL
D-041	Dextrorphan (D_3, 98%)	100 µg/mL in methanol	1 mL
D-034	Dextrorphan tartrate (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
D-021	Dihydrocodeine·HCl (D_6, 98%)	100 µg/mL in methanol (as free base)	1 mL
D-019	Dihydrocodeine·HCl (unlabeled)	1 mg/mL in methanol	1 mL

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Catalog No.	Description	Concentration	Unit Size
D-033	Dihydromorphine (unlabeled)	1 mg/mL in methanol	1 mL
D-143	Diphenoxylate·HCl (unlabeled)	1 mg/mL in acetonitrile (as free base)	1 mL
E-021	EDDP perchlorate (D_3, 98%)	100 µg/mL in methanol	1 mL
E-022	EDDP perchlorate (unlabeled)	1000 µg/mL in methanol	1 mL
E-012	EDDP perchlorate (unlabeled)	100 µg/mL in methanol	1 mL
E-006	EDDP perchlorate (unlabeled)	neat	10 mg
E-057	EMDP·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
E-052	Ethylmorphine (unlabeled)	1 mg/mL in methanol	1 mL
F-001	Fentanyl (D_5, 98%)	100 µg/mL in methanol	1 mL
F-013	Fentanyl (unlabeled)	1000 µg/mL in methanol	1 mL
F-002	Fentanyl (unlabeled)	100 µg/mL in methanol	1 mL
F-046	Furanyl fentanyl·HCl (unlabeled)	100 µg/mL in methanol (as free base)	0.5 mL
F-048	para-fluorobutyryl Fentanyl (PFBF) (unlabeled)	100 µg/mL in methanol	0.5 mL
H-037	Heroin (D_9, 98%)	1 mg/mL in acetonitrile	1 mL
H-036	Heroin (D_9, 98%)	100 µg/mL in acetonitrile	1 mL
H-038	Heroin (unlabeled)	1 mg/mL in acetonitrile	1 mL
H-008	Hydrocodone (D_3, 98%)	1000 µg/mL in methanol	1 mL
H-005	Hydrocodone (D_3, 98%)	100 µg/mL in methanol	1 mL
H-048	Hydrocodone (D_6, 98%)	1 mg/mL in methanol	1 mL
H-047	Hydrocodone (D_6, 98%)	100 µg/mL in methanol	1 mL
H-003	Hydrocodone (unlabeled)	1000 µg/mL in methanol	1 mL
H-010	Hydromorphone (D_3, 98%)	1000 µg/mL in methanol	1 mL
H-006	Hydromorphone (D_3, 98%)	100 µg/mL in methanol	1 mL
H-049	Hydromorphone (D_6, 98%)	100 µg/mL in methanol	1 mL
H-004	Hydromorphone (unlabeled)	1000 µg/mL in methanol	1 mL
H-051	Hydromorphone-3-β-D-glucuronide (unlabeled)	100 µg/mL in methanol:water (1:1)	1 mL
IMPM-005-05	10-Hydroxymorphine (unlabeled)	100 µg/mL in methanol	1 mL
I-038	Isobutryl fentanyl·HCl (unlabeled)	100 µg/mL in methanol (as free base)	0.5 mL
L-010	Levomethorphan (unlabeled)	neat	10 mg
L-044	Levorphanol tartrate (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
M-038	Meperidine (D_4, 98%)	1000 µg/mL in methanol	1 mL
M-036	Meperidine (D_4, 98%)	100 µg/mL in methanol	1 mL
M-035	Meperidine (unlabeled)	1000 µg/mL in methanol	1 mL
M-021	(±)-Methadone (D_3, 98%)	1 mg/mL in methanol	1 mL
M-008	(±)-Methadone (D_3, 98%)	100 µg/mL in methanol	1 mL
M-089	(±)-Methadone (D_9, 98%)	1 mg/mL in methanol	1 mL
M-088	(±)-Methadone (D_9, 98%)	100 µg/mL in methanol	1 mL
M-019	(±)-Methadone (unlabeled)	100 µg/mL in methanol	1 mL
M-007	DL-Methadone (unlabeled)	1000 µg/mL in methanol	1 mL
M-194	(±)-*cis*-3-Methylfentanyl·HCl (unlabeled)	100 µg/mL in methanol (as free base)	0.5 mL
M-214	α-Methylfentanyl·HCl (unlabeled)	100 µg/mL in methanol (as free base)	0.5 mL
M-006	Morphine (D_3, 98%)	1000 µg/mL in methanol	1 mL
M-003	Morphine (D_3, 98%)	100 µg/mL in methanol	1 mL
M-086	Morphine (D_6, 98%)	1 mg/mL in methanol	1 mL
M-085	Morphine (D_6, 98%)	100 µg/mL in methanol	1 mL
CNLM-10392-B*	Morphine (9,10,15,16-$^{13}C_4$, 98%; ^{15}N, 98%) CP 95%	50 µg/mL in methanol	1 mL
M-005	Morphine (unlabeled)	1 mg/mL in methanol	1 mL
M-030	Morphine (unlabeled)	100 µg/mL in methanol	1 mL
DLM-1881SA*	Morphine·H_2O (*N*-methyl-D_3, 98%)	0.1 mg/mL in methanol	Please inquire
M-017	Morphine-3-β-D-glucuronide (D_3, 98%)	100 µg/mL in methanol	1 mL
M-031	Morphine-3-β-D-glucuronide (unlabeled)	1 mg/mL in methanol:water (1:1)	1 mL
M-018	Morphine-3-β-D-glucuronide (unlabeled)	100 µg/mL in methanol	1 mL

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Drugs and Their Metabolites *(continued)*

Catalog No.	Description	Concentration	Unit Size
M-120	Morphine-6-β-D-glucuronide (D_3, 98%)	100 µg/mL in methanol:water (1:1)	1 mL
CNLM-10391-B*	Morphine-6-β-D-glucuronide ($^{13}C_{10}$, 98%; ^{15}N, 98%) CP 95%	50 µg/mL in methanol:water (1:4)	1 mL
M-046	Morphine-6-β-D-glucuronide (unlabeled)	1 g/mL in methanol:water (1:1)	1 mL
M-096	Morphine-6-β-D-glucuronide (unlabeled)	100 µg/mL in methanol:water (1:4)	1 mL
M-188	MT-45 dihydrochloride (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
N-051	Nalbuphine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
N-924	Nalorphine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
N-004	Naloxone (unlabeled)	1 mg/mL in methanol	1 mL
N-109	Naloxone-3β-D-glucuronide (D_5, 98%)	100 µg/mL in methanol:water (9:1)	1 mL
N-081	6β-Naltrexol (D_3, 98%)	100 µg/mL in methanol	1 mL
N-038	6β-Naltrexol (unlabeled)	1 mg/mL in methanol	1 mL
N-104	6β-Naltrexol-3-β-D-glucuronide (unlabeled)	1 mg/mL in methanol:water (4:1)	1 mL
N-047	Naltrexone (D_3, 98%)	100 µg/mL in methanol	1 mL
CNLM-10639-B*	Naltrexone (9,15,16-$^{13}C_3$, 98%;$^{17\text{-}15}N$, 98%) CP 95%	50 µg/mL in methanol	1 mL
N-007	Naltrexone (unlabeled)	1 mg/mL in methanol	1 mL
N-106	Naltrexone-3-β-D-glucuronide (unlabeled)	100 µg/mL in methanol	1 mL
N-921	Norbuprenorphine (D_3, 98%)	1 mg/mL in methanol	1 mL
N-920	Norbuprenorphine (D_3, 98%)	100 µg/mL in methanol	1 mL
N-059	Norbuprenorphine (unlabeled)	1 mg/mL in methanol	1 mL
N-912	Norbuprenorphine (unlabeled)	100 µg/mL in methanol	1 mL
N-045	Norbuprenorphine glucuronide (unlabeled)	100 µg/mL in methanol	1 mL
N-082	Norcodeine (D_3, 98%)	1 mg/mL in methanol	1 mL
N-005	Norcodeine (unlabeled)	1 mg/mL in methanol	1 mL
N-055	Norfentanyl oxalate (D_5, 98%)	1 mg/mL in methanol (as free base)	1 mL
N-030	Norfentanyl oxalate (D_5, 98%)	100 µg/mL in methanol	1 mL
N-031	Norfentanyl oxalate (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
N-054	Norhydrocodone·HCl (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
N-053	Norhydrocodone·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
N-006	Normorphine (unlabeled)	1 mg/mL in methanol	1 mL
N-012	Noroxymorphone·HCl (unlabeled)	100 µg/mL in methanol:dimethyl sulfoxide (DMSO) (4:1) (as free base)	1 mL
N-919	(±)-Norpropoxyphene maleate (D_5, 98%)	1 mg/mL in methanol	1 mL
N-913	D-Norpropoxyphene maleate (unlabeled)	1000 µg/mL in methanol (as free base)	1 mL
N-904	DL-Norpropoxyphene maleate (D_5, 98%)	100 µg/mL in methanol	1 mL
O-020	Opiate Multi-component Mixture – 5 (unlabeled)	250 µg/mL in methanol	1 mL
O-006	Oxycodone (D_3, 98%)	1 mg/mL in methanol	1 mL
O-005	Oxycodone (D_3, 98%)	100 µg/mL in methanol	1 mL
O-008	Oxycodone (D_6, 98%)	1 mg/mL in methanol	1 mL
O-007	Oxycodone (D_6, 98%)	100 µg/mL in methanol	1 mL
O-002	Oxycodone (unlabeled)	1000 µg/mL in methanol	1 mL
O-019	Oxymorphone (D_3, 98%)	1 mg/mL in methanol	1 mL
O-003	Oxymorphone (D_3, 98%)	100 µg/mL in methanol	1 mL
O-004	Oxymorphone (unlabeled)	1000 µg/mL in methanol	1 mL
O-031	Oxymorphone-3-β-D-glucuronide (internal standard) (D_3, 98%)	100 µg/mL in methanol:water (1:1)	1 mL
O-030	Oxymorphone-3-β-D-glucuronide (unlabeled)	100 µg/mL in methanol:water (1:1)	1 mL
P-071	Pain Management Multi-component Opiate Mixture – 13 (unlabeled)	100 µg/mL each component; 10 µg/mL fentanyl in methanol	1 mL
P-073	Pentazocine (unlabeled)	1 mg/mL in methanol	1 mL
P-913	(±)-Propoxyphene (D_{11}, 98%)	100 µg/mL in methanol	1 mL
P-011	D-Propoxyphene (unlabeled)	1000 µg/mL in acetonitrile	1 mL
P-904	DL-Propoxyphene (D_5, 98%)	1 mg/mL in methanol	1 mL
P-901	DL-Propoxyphene (D_5, 98%)	100 µg/mL in methanol	1 mL

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Catalog No.	Description	Concentration	Unit Size
R-026	Remifentanil acid (unlabeled)	100 µg/mL in acetonitrile	1 mL
S-008	Sufentanil citrate (unlabeled)	100 µg/mL in methanol (as free base)	1 mL
T-058	Tapentadol·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
T-116	Thebaine (unlabeled)	1 mg/mL in methanol	1 mL
T-068	Tilidine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
CLM-7491*	*cis*-(±)-Tramadol·HCl (methoxy-^{13}C, 99%)	neat	Please inquire
T-027	*cis*-Tramadol·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
D-110	*N*-desmethyl-*cis*-Tramadol·HCl (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
D-023	*N*-desmethyl-*cis*-Tramadol·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
D-058	*O*-desmethyl-*cis*-Tramadol·HCl (D_6, 98%)	100 µg/mL in methanol (as free base)	1 mL
T-035	*O*-desmethyl-*cis*-Tramadol·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
T-020	Tramadol·HCl (^{13}C, 99%; D_3, 98%)	1 mg/mL in methanol (as free base)	1 mL
T-029	Tramadol·HCl (^{13}C, 98%; D_3, 98%)	100 µg/mL in methanol	1 mL
V-048	Valeryl fentanyl·HCl (unlabeled)	100 µg/mL in methanol (as free base)	0.5 mL

Other Compounds

Catalog No.	Description	Concentration	Unit Size
DLM-10575*	Aldox (D_6, 98%) CP 96%	neat	Please inquire
DLM-10574*	Alexidine·2HCl (D_{10}, 98%) CP 97%	neat	Please inquire
A-040	Aminorex (unlabeled)	1 mg/mL in acetonitrile	1 mL
A-075	Androstenedione (unlabeled)	1 mg/mL in acetonitrile	1 mL
A-139	4-ANPP (unlabeled)	100 µg/mL in methanol	0.5 mL
CLM-6585*	Aspirin (acetyl-1-^{13}C, 99%)	neat	Please inquire
CLM-3655*	Azidothymidine (AZT) (methyl-^{13}C, 99%) CP 96%	neat	10 mg
B-067	(±)-Baclofen (D_4, 98%)	100 µg/mL in methanol	1 mL
CLM-10608*	1,2-Benzisothiazol-3(2H)-one (ring-$^{13}C_6$, 99%)	neat	Please inquire
DLM-1566*	Benztropine mesylate (*N*-methyl-D_3, 98%) CP 95%	neat	10 mg
B-043	Brompheniramine maleate (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
B-023	BSTFA (with 1% TMCS)	–	10 × 1 mL
V-059	β-Carotene (10,10′,11,11′-$^{13}C_4$, 99%)	100 µg/mL in tetrahydrofurn:ethanol (7:3) with 0.1% butylated hydroxytoluene (BHT) (w/v)	1 mL
CLM-1608*	Chloral hydrate (trichloromethyl-^{13}C, 97%)	neat	10 mg
DLM-10609*	5-Chloro-2-methyl-4-isothiazolin-3-one (*N*-methyl-D_3, 98%)	neat	Please inquire
C-086	Chlorpheniramine maleate (D_6, 98%)	1 mg/mL in methanol (as free base)	1 mL
C-036	Chlorpheniramine maleate (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
V-060	Coenzyme Q10 (unlabeled)	1 mg/mL in ethanol	1 mL
C-164	Creatinine (unlabeled)	2 mg/mL in methanol:water (1:1)	1 mL
C-114	Cyclobenzaprine·HCl (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
C-060	Cyclobenzaprine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
D-039	*N*-Desethylamodiaquine dihydrochloride (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
D-088	*N*-Desmethylcyclobenzaprine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
DLM-7504*	Dexamethasone (4,6α,21,21-D_4, 96%) may contain D at C-2	neat	Please inquire
D-085	Dexamethasone (unlabeled)	1 mg/mL in methanol	1 mL
D-077	5α-Dihydrotestosterone (16,16,17-D_3, 98%)	100 µg/mL in methanol	1 mL
D-017	Diphenhydramine (D_3, 98%)	100 µg/mL in methanol	1 mL
D-015	Diphenhydramine·HCl (unlabeled)	1 mg/mL in methanol	1 mL
CLM-3369*	Dopamine·HCl (ring-$^{13}C_6$, 99%)	neat	Please inquire
DLM-2181*	Dopamine·HCl (ring-D_3, 98%)	neat	0.1 g
D-072	Dopamine·HCl (D_4, 98%)	100 µg/mL in methanol with 5% 1 M HCl (as free base)	1 mL
DLM-2498*	Dopamine·HCl (1,1,2,2-D_4, 97-98%)	neat	0.01 g, 0.1 g
D-051	Doxylamine (D_5, 98%)	100 µg/mL in acetonitrile	1 mL

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Drugs and Their Metabolites *(continued)*

Catalog No.	Description	Concentration	Unit Size
D-045	Doxylamine succinate (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
DLM-2744*	Enalaprilat·H_2O (phenyl-D_5, 98%)	neat	Please inquire
E-058	Epitestosterone (unlabeled)	1 mg/mL in acetonitrile	1 mL
E-060	17β-Estradiol (unlabeled)	1 mg/mL in acetonitrile	1 mL
CLM-10404-C*	Estradiol undecanoate (2,3,4-$^{13}C_3$, 98%) CP 95%	100 µg/mL in methanol	1 mL
CLM-10404*	Estradiol undecanoate (2,3,4-$^{13}C_3$, 98%) CP 95%	neat	1 mg
CLM-10405*	Fenoprofen, sodium salt hydrate (ring-$^{13}C_6$, 99%)	neat	1 mg
F-035	Fluconazole ($^{13}C_3$, 99%)	1 mg/mL in methanol	1 mL
F-031	Fluconazole (unlabeled)	2 mg/mL in methanol	1 mL
G-005	Glutethimide (unlabeled)	1 mg/mL in methanol	1 mL
DLM-3996*	Glybenclamide (cyclohexylamine-D_{11}, 98%)	neat	Please inquire
CLM-373*	Homovanillic acid (1,2-$^{13}C_2$, 98-99%)	neat	0.1 g
DLM-2738*	Homovanillic acid (phenyl-D_3, 2,2-D_2, 96-98%)	neat	0.1 g
COLM-376*	Homovanillic acid (ring-$^{13}C_6$, 99%; 4-hydroxy-^{18}O, 90-95%)	neat	10 mg
H-096	17α-Hydroxyprogesterone (2,2,4,6,6,21,21,21-D_8, 98%)	100 µg/mL in methanol	1 mL
DLM-10541*	Iopromide (*N*-methyl-D_3, 98%)	neat	1 mg
I-021	Itraconazole (D_4, 98%)	1 mg/mL in methanol with 1% in 1 M HCl	1 mL
CLM-7118*	Ketoconazole (carbonyl-^{13}C, 99%)	neat	Please inquire
CNLM-10406*	Kevetrin·HCl ($^{13}C_2$, 98%; $^{15}N_3$, 98%) CP 95%	neat	1 mg
L-025	(-)-Levamisole·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
M-095	Melatonin (unlabeled)	1 mg/mL in methanol	1 mL
M-039	Meprobamate (unlabeled)	1 mg/mL in methanol	1 mL
M-148	(±)-Metanephrine·HCl (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
DLM-7861*	Metformin·HCl (dimethyl-D_6, 99%)	neat	Please inquire
M-072	Metformin·HCl (unlabeled)	1 mg/mL (as free base)	1 mL
CLM-1280*	Methacetin (methoxy-^{13}C, 99%)	neat	1 g, 10 g
M-025	Methamphetamine/Cocaine/Heroin Mix (unlabeled)	250 µg/mL in acetonitrile	1 mL
M-912	Methandienone (unlabeled)	1 mg/mL in 1,2-dimethoxyethane	1 mL
M-014	Methaqualone (D_7, 98%)	100 µg/mL in methanol	1 mL
M-015	Methaqualone (unlabeled)	1000 µg/mL in methanol	1 mL
M-192	Methoxyphenidine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
M-080	Methylmalonic acid (unlabeled)	1 mg/mL in acetonitrile	1 mL
M-906	17α-Methyltestosterone (unlabeled)	1 mg/mL in 1,2-dimethoxyethane	1 mL
N-050	Nandrolone (unlabeled)	1 mg/mL in acetonitrile	1 mL
CLM-7522*	Naproxen, sodium salt (*O*-methyl-^{13}C, 98%)	neat	Please inquire
V-016	Nicotinamide (vitamin B_3) (unlabeled)	1 mg/mL in methanol	1 mL
V-035	Nicotinic acid (vitamin B_3) ($^{13}C_6$, 99%)	100 µg/mL in methanol	1 mL
V-017	Nicotinic acid (vitamin B_3) (unlabeled)	1 mg/mL in methanol	1 mL
N-043	(±)-Norephedrine·HCl (D_3, 98%)	1 mg/mL in methanol (as free base)	1 mL
N-069	(±)-Norepinephrine·HCl (D_6, 98%)	100 µg/mL in methanol (as free base)	1 mL
N-068	(±)-Normetanephrine·HCl (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
DLM-8609*	DL-Normetanephrine·HCl (α,β,β-D_3, 98%)	neat	5 mg, 10 mg
DLM-10618*	Obeticholic acid (2,2,4,4-D_4, 98%)	neat	1 mg
O-021	Omeprazole (unlabeled)	1 mg/mL in methanol	1 mL
O-034	Over-the-Counter Multi-component Mixture – 6 (unlabeled)	100 µg/mL in acetonitrile	1 mL
P-045	Pheniramine (unlabeled)	1 mg/mL in methanol	1 mL
P-038	(±)-Phenylpropanolamine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
P-119	Pholcodine (unlabeled)	1 mg/mL in methanol	1 mL
P-108	Posaconazole (D_4, 98%)	1 mg/mL in methanol	1 mL
CLM-10557*	Probucol (propyl-$^{13}C_3$, 99%) CP 96%	neat	0.01 g, 0.05 g

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Catalog No.	Description	Concentration	Unit Size
V-011	Retinol (vitamin A) (unlabeled)	100 µg/mL in ethanol with 0.1% (w/v) butylated hydroxytoluene (BHT)	1 mL
V-067	(-)-Riboflavin (vitamin B_2) (unlabeled)	100 µg/mL in 1% ammonium acetate in methanol:water (1:1)	1 mL
S-042	Salicylic acid (D_4, 98%)	100 µg/mL in acetonitrile	1 mL
S-019	Salicylic acid (unlabeled)	1 mg/mL in acetonitrile	1 mL
S-098	(-)-Scopolamine HBR (unlabeled)	1 mg/mL in 10% water in acetonitrile (as free base)	1 mL
S-011	Sibutramine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
S-010	Sildenafil (unlabeled)	1 mg/mL in methanol	1 mL
ULM-10473-C*	Stanozolol (unlabeled)	100 µg/mL in methanol	1 mL
CLM-7119*	Temozolomide (methyl-^{13}C, 99%)	neat	Please inquire
T-037	Testosterone (unlabeled)	1 mg/mL in acetonitrile	1 mL
V-014	Thiamine·HCl (vitamin B_1) (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
T-085	Tizanidine·HCl (unlabeled)	500 µg/mL in methanol	1 mL
V-021	(+)-γ-Tocopherol (vitamin E) (unlabeled)	1 mg/mL in methanol	1 mL
V-020	(±)-α-Tocopherol (vitamin E) (unlabeled)	1 mg/mL in methanol	1 mL
CNLM-9258*	1,2,4-Triazole (3,5-$^{13}C_2$, 99%; 1,2,4-$^{15}N_3$, 98%)	neat	1 mg, 5 mg
V-902	Vardenafil dihydrochloride (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
V-042	Vitamin K_2 (MK-4) ($^{13}C_6$, 99%)	10 µg/mL in acetonitrile	1 mL
V-036	(±)-Voriconazole (D_3, 98%)	1 mg/mL in methanol	1 mL
CDLM-10540*	Yohimbine (methyl-^{13}C, 99%; methyl-D_3 ester, 98%)	neat	5 mg, 10 mg
Z-010	Zaleplon (D_4, 98%)	100 µg/mL in methanol	1 mL
Z-004	Zaleplon (unlabeled)	1 mg/mL in methanol	1 mL
Z-001	Zolpidem (D_6, 98%)	100 µg/mL in methanol	1 mL
Z-008	Zolpidem (D_7, 98%)	100 µg/mL in methanol	1 mL
CNLM-10641-B*	Zolpidem (carbonyl-1,2-$^{13}C_2$, 98%; amide-^{15}N, 98%) CP 95%	50 µg/mL in methanol	1 mL
Z-017	Zolpidem (unlabeled)	1 mg/mL in methanol	1 mL
Z-007	Zolpidem phenyl-4-carboxylic acid (unlabeled)	500 µg/mL in acetonitrile:water (1:1)	1 mL
Z-902	Zopiclone (D_4, 98%)	1 mg/mL in acetonitrile	1 mL
Z-003	Zopiclone (unlabeled)	1 mg/mL in acetonitrile	1 mL

Stimulants

Catalog No.	Description	Concentration	Unit Size
A-050	Amine Mixture – 6 (unlabeled)	250 µg/mL in methanol	1 mL
A-013	(±)-Amphetamine (D_5, 98%)	1000 µg/mL in methanol	1 mL
A-005	(±)-Amphetamine (D_5, 98%)	100 µg/mL in methanol	1 mL
A-002	(±)-Amphetamine (ring-D_5, 98%)	100 µg/mL in methanol	1 mL
A-038	(±)-Amphetamine (D_{10}, 98%)	100 µg/mL in methanol	1 mL
A-008	(±)-Amphetamine (unlabeled)	1 mg/mL in methanol	1 mL
A-045	DL-Amphetamine (D_6, 98%)	1000 µg/mL in methanol	1 mL
A-044	DL-Amphetamine (D_6, 98%)	100 µg/mL in methanol	1 mL
A-018	DL-Amphetamine (D_8, 98%)	1000 µg/mL in methanol	1 mL
A-017	DL-Amphetamine (D_8, 98%)	100 µg/mL in methanol	1 mL
A-019	DL-Amphetamine (D_{11}, 98%)	1000 µg/mL in methanol	1 mL
A-016	DL-Amphetamine (D_{11}, 98%)	100 µg/mL in methanol	1 mL
A-007	DL-Amphetamine (unlabeled)	1000 µg/mL in methanol	1 mL
CLM-10387-B*	DL-Amphetamine·HCl (ring-$^{13}C_6$, 98%) CP 95%	50 µg/mL in methanol	1 mL
A-049	*R*(-) Amphetamine (unlabeled)	1 mg/mL in methanol	1 mL
A-100	Anabasine·HCl (D_4, 98%)	100 µg/mL in methanol (as free base)	1 mL

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Drugs and Their Metabolites *(continued)*

Catalog No.	Description	Concentration	Unit Size
CLM-728*	Caffeine (3-methyl-^{13}C, 99%)	neat	0.5 g
C-082	Caffeine ($^{13}C_3$, 99%)	1 mg/mL in methanol	1 mL
CLM-514-1.2*	Caffeine (trimethyl-$^{13}C_3$, 99%)	100 µg/mL in methanol	1.2 mL
CLM-514*	Caffeine (trimethyl-$^{13}C_3$, 99%)	neat	1 g
NLM-332*	Caffeine (1,3-$^{15}N_2$, 99%)	neat	Please inquire
CNLM-333*	Caffeine (2-^{13}C, 99%; 1,3-$^{15}N_2$, 98%)	neat	0.1 g
C-051	Caffeine (unlabeled)	1000 µg/mL in methanol	1 mL
ULM-7653-1.2*	Caffeine (unlabeled)	100 µg/mL in methanol	1.2 mL
DLM-1819-1.2*	DL-Cotinine (methyl-D_3, 98%)	100 µg/mL in acetonitrile	1.2 mL
DLM-1819*	DL-Cotinine (methyl-D_3, 98%)	neat	0.01 g, 0.1 g, 0.5 g
D-141	(±)-*cis*-4,4′-Dimethylaminorex (unlabeled)	1 mg/mL in 1% 1 M HCl in methanol	1 mL
D-096	3,4-Dimethylmethcathinone (3,4-DMMC) norephedrine metabolite·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
E-026	(+)-Ephedrine·HCl (D_3, 98%)	1000 µg/mL in methanol (as free base)	1 mL
E-025	(+)-Ephedrine·HCl (D_3, 98%)	100 µg/mL in methanol (as free base)	1 mL
E-011	(+)-Ephedrine·HCl (unlabeled)	1000 µg/mL in methanol (as free base)	1 mL
E-023	(-)-Ephedrine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
E-130	*N*-Ethylpentylone·HCl (D_5, 98%)	100 µg/mL in methanol (as free base)	1 mL
E-129	*N*-Ethylpentylone·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
F-019	(±)-2-Fluoroamphetamine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
F-042	(±)-3-Fluorophenmetrazine·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
H-101	*trans*-3′-Hydroxycotinine (unlabeled)	1 mg/mL in methanol	1 mL
M-027	(±)-MDA (D_5, 98%)	1000 µg/mL in methanol	1 mL
M-068	(±)-MDEA (D_5, 98%)	1000 µg/mL in methanol	1 mL
M-082	(±)-MDEA (D_6, 98%)	1000 µg/mL in methanol	1 mL
M-081	(±)-MDEA (D_6, 98%)	100 µg/mL in methanol	1 mL
M-029	(±)-MDMA (D_5, 98%)	1000 µg/mL in methanol	1 mL
M-020	(+)-Methamphetamine (unlabeled)	1 mg/mL in methanol	1 mL
M-034	(±)-Methamphetamine (D_8, 98%)	1 mg/mL in methanol	1 mL
M-016	(±)-Methamphetamine (D_8, 98%)	100 µg/mL in methanol	1 mL
M-091	(±)-Methamphetamine (D_9, 98%)	1 mg/mL in methanol	1 mL
M-090	(±)-Methamphetamine (D_9, 98%)	100 µg/mL in methanol	1 mL
M-093	(±)-Methamphetamine (D_{14}, 98%)	1 mg/mL in methanol	1 mL
M-092	(±)-Methamphetamine (D_{14}, 98%)	100 µg/mL in methanol	1 mL
M-022	(±)-Methamphetamine (unlabeled)	100 µg/mL in methanol	1 mL
M-150	3,4-Methylenedioxypyrovalerone·HCl (MDPV) (D_8, 98%)	100 µg/mL in methanol (as free base)	1 mL
M-146	3,4-Methylenedioxypyrovalerone·HCl (MDPV) (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
N-074	4-(Methylnitrosamino)-1-(3-pyridyl)-1-butanol (NNAL) (unlabeled)	1 mg/mL in methanol	1 mL
N-076	4-(Methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK) (unlabeled)	1 mg/mL in methanol	1 mL
N-048	(±)-Nicotine (D_4, 98%)	100 µg/mL in acetonitrile	1 mL
CLM-3914-1.2*	DL-Nicotine (3′,4′,5′-$^{13}C_3$, 99%)	100 µg/mL in acetonitrile	1.2 mL
CLM-3914*	DL-Nicotine (3′,4′,5′-$^{13}C_3$, 99%)	neat	0.1 g
DLM-1818*	DL-Nicotine (methyl-D_3, 98%)	neat	0.1 g, 0.5 g
DLM-9017*	DL-Nornicotine (pyridine-D_4, 98%)	neat	Please inquire
N-008	*S*(-)-Nicotine (unlabeled)	1 mg/mL in methanol	1 mL
M-127	Methylphenidate·HCl (D_9, 98%)	100 µg/mL in methanol (as free base)	1 mL
M-083	Methylphenidate·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
M-084	Modafinil (unlabeled)	1 mg/mL in acetonitrile	1 mL
M-142	Modafinil acid (unlabeled)	1 mg/mL in acetonitrile	1 mL
N-067	Naphyrone·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL

**Products listed with an asterisk are available globally.*

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
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Catalog No.	Description	Concentration	Unit Size
N-032	Noroxycodone·HCl (D_3, 98%)	100 µg/mL in acetonitrile (as free base)	1 mL
N-011	Noroxycodone·HCl (unlabeled)	1000 µg/mL in methanol	1 mL
IMPC-051-03	Paraxanthine (unlabeled)	1 mg/mL in methanol	1 mL
P-023	Phentermine (unlabeled)	1 mg/mL in methanol	1 mL
P-034	Phentermine·HCl (D_5, 98%)	100 µg/mL in methanol (as free base)	1 mL
C-112	1-(3-chlorophenyl)Piperazine (MCPP)·HCl (D_8, 98%)	100 µg/mL in methanol (as free base)	1 mL
C-089	1-(3-chlorophenyl)Piperazine (MCPP)·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
P-081	Pyrovalerone·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
P-090	α-Pyrrolidinovalerophenone·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
R-011	Ritalinic acid·HCl (unlabeled)	1 mg/mL in methanol (as free base)	1 mL
R-014	(±)-*threo*-Ritalinic acid·HCl (D_{10}, 98%)	100 µg/mL in methanol (as free base)	1 mL
T-013	Theobromine (unlabeled)	100 µg/mL in methanol	1 mL
IMPC-051-01	Theophylline (unlabeled)	1 mg/mL in methanol	1 mL

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Fatty Acids and Lipids

Fatty acids and lipids are important biological compounds that are essential to the regulation and control of cellular functions and metabolic pathways. These biomolecules are also tied to the energetic balance of an organism. Their qualitative/quantitative analysis has emerged to better understand the underlying pathophysiology, as well as to identify new biomarkers or diagnose existing ones.

To aid such research initiatives, CIL is pleased to offer a multitude of stable isotope-labeled and unlabeled fatty acids and lipids. The fatty acids cover saturated and unsaturated classes, while the lipids include ceramides (e.g., *N*-palmitoyl-D-sphingosine, *N*-oleoyl-D-sphingosine), and phospholipids (e.g., dodecylphosphocholine, dipalmitoyl phosphatidylcholine), as well as triacylglycerides (e.g., tripalmitin, tristearin, triolein). These are available in various labeling patterns (i.e., uniform, partial), forms (i.e., free acid, salt, ester), and material grades (i.e., research, MPT – microbiological and pyrogen tested).

Catalog No.	Description	Unit Size
DLM-10481	Arachidic acid (2,2-D_2, 98%)	Please inquire
DLM-1234	Arachidic acid (methyl-D_3, 98%) CP 97%	0.1 g
DLM-10519	Arachidic acid (12,12,13,13-D_4, 98%)	0.1 g, 0.25 g
DLM-1233	Arachidic acid (D_{39}, 98%)	1 g
DLM-1661-N	Arachidonic acid (5,6,8,9,11,12,14,15-D_8, 98%)	5 mg
ULM-10272	Arachidonic acid (unlabeled)	Please inquire
CLM-9666	Butyric acid (1-^{13}C, 99%)	1 g
CLM-9215	Butyric acid ($^{13}C_4$, 99%)	0.1 g
DLM-1110	Butyric acid (3,3,4,4,4,-D_5, 97-98%)	Please inquire
DLM-1508	Buytric acid (D_7, 98%)	5 g
CLM-9768	Butyryl coenzyme A, lithium salt (butyryl-$^{13}C_4$, 99%) CP 95%	Please inquire
DNLM-10613	L-Carnitine (*N,N,N*-trimethyl-D_9, 98%; ^{15}N, 98%)	Please inquire
DLM-8272	L-Carnitine·ClO_4, 3-hydroxyisovaleryl (*N*-methyl-D_3, 98%)	1 mg
DLM-3975	L-Carnitine (mono)·ClO_4, *O*-glutaryl (*N*-methyl-D_3, 98%) CP 97%	0.1 mg
DLM-9189	L-Carnitine (mono)·ClO_4, *O*-3-DL-hydroxypalmitoyl (*N*-methyl-D_3, 98%)	0.1 mg
DLM-1871	L-Carnitine·HCL (methyl-D_3, 98%)	0.1 g
DLM-3820	L-Carnitine·HCL (dimethyl-D_6, 98%)	Please inquire
DLM-754	L-Carnitine·HCL, *O*-acetyl (*N*-methyl-D_3, 98%)	0.05 g
DLM-3861	L-Carnitine·HCl, *O*-butyryl (*N*-methyl-D_3, 98%)	10 mg
DLM-8746	L-Carnitine·HCl, *O*-dec-2-enoyl (95% E) (*N,N,N*-trimethyl-D_9, 98%)	Please inquire
DLM-8162	L-Carnitine·HCl, *O*-dodecanoyl (*N*-methyl-D_3, 98%)	0.1 mg
DLM-6718	L-Carnitine·HCl, *O*-hexacosanoyl (*N*-methyl-D_3, 98%) CP 95%	Please inquire
DLM-3974	L-Carnitine·HCl, *O*-isovaleryl (*N,N,N*-trimethyl-D_9, 98%)	5 mg
DLM-4425	L-Carnitine·HCl, *O*-myristoyl (*N,N,N*-trimethyl-D_9, 98%)	5 mg
DLM-10279	Coenzyme Q10 (dimethoxy-D_6, methyl-D_3, 98%) CP 97%	1 mg, 5 mg
DLM-2006	Decanoic acid (methyl-D_3, 98%)	0.5 g, 1 g
DLM-270	Decanoic acid (D_{19}, 98%)	1 g
DLM-1002	*N*-Decanol (D_{21}, 98%)	1 g
DLM-677-1.2	Dibenz[*A,H*]anthracene (D_{14}, 98%) (200 µg/mL in toluene-D_8)	1.2 mL
DLM-677	Dibenz[*A,H*]anthracene (D_{14}, 98%)	0.01 g, 0.1 g
CLM-8388	Docosahexaenoic acid (DHA) U-$^{13}C_{22}$, 99%) (may contain 5% docosapentaenoic acid or "DPA")	1 mg, 5 mg
DLM-10012	Docosahexaenoic acid (21,21,22,22,22-D_5, 98%)	1 mg, 5 mg
ULM-10013	Docosahexaenoic acid (unlabeled)	1 mg, 5 mg
DLM-10015	Docosahexaenoic acid, ethyl ester (21,21,22,22,22-D_5, 98%) CP 95%	Please inquire
ULM-10016	Docosahexaenoic acid, ethyl ester (unlabeled) CP 95%	Please inquire
CLM-8398	Docosahexaenoic acid, methyl ester (DHA U-$^{13}C_{22}$, 99%) (may contain 5% docosapentaenoic acid or "DPA")	1 mg, 5 mg
DLM-10014	Docosahexaenoic acid, methyl ester (21,21,22,22,22-D_5, 98%) CP 97%	1 mg
CLM-9909	Docosanoic acid (1,2,3,4,5,6-$^{13}C_6$, 99%) CP 95%	Please inquire
DLM-9180	Docosanoic acid (22,22,22-D_3, 98%)	Please inquire
DLM-9951	Docosanoic acid (3,3,5,5-D_4, 98%) CP 95%	Please inquire
DLM-10503	Docosanoic acid (12,12,13,13-D_4, 98%)	0.1 g, 0.25 g
DLM-4703	Docosanoic acid (D_{43}, 98%)	Please inquire
DLM-738	*N*-Dodecanol (D_{25}, 98%)	0.5 g, 1 g

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Catalog No.	Description	Unit Size
DLM-2274	Dodecylphosphocholine (D_{38}, 98%)	0.1 mg, 0.5 g
CLM-8389	Eicosapentaenoic acid (U-$^{13}C_{20}$, 98%)	Please inquire
DLM-9720	*cis*-5,8,11,14,17-Eicosapentaenoic acid (19,19,20,20,20-D_5, 98%)	1 mg, 5 mg
ULM-10024	*cis*-5,8,11,14,17-Eicosapentaenoic acid (unlabeled)	1 mg, 5 mg
DLM-10559	*cis*-5,8,11,14,17-Eicosapentaenoic acid, methyl ester (19,19,20,20,20-D_5, 98%) CP 95%	1 mg
DLM-10558	Eicosapentaenoic acid, ethyl ester (19,19,20,20,20-D_5, 98%) CP 95%	Please inquire
CLM-8399	Eicosapentaenoic acid, methyl ester (eicosapentaenoate-U-$^{13}C_{20}$, 90%)	Please inquire
DLM-10667	Ethyl hexacosanoate (hexacosanoyl-12,12,13,13-D_4, 98%)	Please inquire
CLM-8274	Ethyl hexanoate (hexanoate-$^{13}C_6$, 99%)	Please inquire
DLM-6013	Ethylmalonic acid (methyl-D_3, 98%)	0.1 g
DLM-6726	*n*-octyl-β-Glucoside (D_{24}, 98%)	0.1 g
DLM-1308	Heptadecanoic acid (methyl-D_3, 98%)	0.1 g
DLM-6905	Heptadecanoic acid (D_{33}, 98%)	0.25 g, 0.5 g
DLM-1820	Heptanoic acid (2,2,3,3-D_4, 98%)	Please inquire
DLM-2731	Heptanoic acid (D_{13}, 98%)	0.5 g
CLM-9790	Hexacosanoic acid (1,2,3,4,5,6-$^{13}C_6$, 99%)	Please inquire
DLM-9953	Hexacosanoic acid (3,3,5,5-D_4, 98%) CP 95%	Please inquire
DLM-8510	Hexacosanoic acid (12,12,13,13-D_4, 98%)	0.1 g
CLM-3519	Hexanoic acid (1-^{13}C, 99%)	0.5 g
DLM-3030	Hexanoic acid (2,2-D_2, 98%)	Please inquire
DLM-612	Hexanoic acid (methyl-D_3, 98%)	0.1 g, 0.5 g, 1 g
DLM-11023	Hexanoic acid (4,4,5,5,6,6,6-D_7, 98%)	Please inquire
DLM-277	Hexanoic acid (D_{11}, 98%)	0.1 g, 1 g
DLM-2922	DL-3-Hydroxymyristic acid (2,2,3,4,4-D_5, 96%)	Please inquire
CLM-2095	Isovaleric acid (1-^{13}C, 99%)	1 g
CLM-10348	Isovaleric acid (2,3,4-$^{13}C_3$, 3-methyl-^{13}C, 99%)	Please inquire
DLM-2938	Isovaleric acid (D_9, 98%)	Please inquire
CLM-1586	Lauric acid (1-^{13}C, 99%)	1 g, 5 g
DLM-3062	Lauric acid (methyl-D_3, 99%)	0.5 g, 1 g
DLM-563	Lauric acid (D_{23}, 98%)	1 g
CLM-9688	Linoleic acid (18:2) (1-^{13}C, 99%)	1 g
CLM-6855	Linoleic acid (18:2) (U-$^{13}C_{18}$, 98%) (<10% *cis/trans* isomer) CP 94%	0.1 mg, 0.1 g, 0.25 g, 1 g
CLM-2119	Linoleic acid (18:2), ethyl ester (1-^{13}C, 99%)	Please inquire
CLM-3960	Linoleic acid (18:2), ethyl ester (U-linoleate-$^{13}C_{18}$, 98%) CP 95%	0.5 g
DLM-1909	Linoleic acid (18:2), ethyl ester (9,10,12,13-D_4, 95%)	Please inquire
DLM-227	Linoleic acid (18:2), ethyl ester (17,17,18,18,18-D_5, 98%)	Please inquire
DLM-766	Linoleic acid (18:2), ethyl ester (D_{31}, 98%) CP 95%	Please inquire
CLM-8395	Linoleic acid (18:2), methyl ester (U-linoleate-$^{13}C_{18}$, 98%) CP 95%	0.1 g, 0.25 g, 1 g
DLM-9663	Linoleic acid (18:2), methyl ester (D_{31}, 98%) CP 95%	Please inquire
CLM-6229	Linoleic acid (18:2), potassium salt (1-^{13}C, 99%)	1 g
CLM-8835	Linoleic acid (18:2), potassium salt (U-$^{13}C_{18}$, 98%) (may have up to 5% isomers) CP 97%	Please inquire
CLM-10487	Linoleic acid (18:2), sodium salt (U-$^{13}C_{18}$, 98%) (may have up to 5% isomers) CP 94%	Please inquire
CLM-8386	Linolenic acid (18:3) (U-$^{13}C_{18}$, 98%) CP 95%	Please inquire
DLM-9348	Linolenic acid (18:3) (17,17,18,18,18-D_5, 98%) CP 90%	0.25 g
DLM-2351	Linolenic acid (18:3), ethyl ester (17,17,18,18,18-D_5, 98%) CP 95%	0.25 g
CLM-8396	Linolenic acid (18:3), methyl ester (linolenate-U-$^{13}C_{18}$, 98%) CP 95%	0.1 g
DLM-10520	Lysophosphatidylcholine 20:0 (eicosanoyl-12,12,13,13-D_4, 98%)	1 mg, 5 mg
ULM-10521	Lysophosphatidylcholine 20:0 (unlabeled)	5 mg, 10 mg
CLM-10499	Lysophosphatidylcholine 22:0 (docosanoyl-1,2,3,4,5,6-$^{13}C_6$, 99%)	1 mg, 5 mg
DLM-10500	Lysophosphatidylcholine 22:0 (docosanoyl-12,12,13,13-D_4, 98%)	1 mg, 5 mg
ULM-10498	Lysophosphatidylcholine 22:0 (unlabeled)	5 mg, 10 mg

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Fatty Acids and Lipids *(continued)*

Catalog No.	Description	Unit Size
CLM-10496	Lysophosphatidylcholine 24:0 (tetracosanoyl-1,2,3,4,5,6-$^{13}C_6$, 99%)	1 mg, 5 mg
DLM-10497	Lysophosphatidylcholine 24:0 (tetracosanoyl-12,12,13,13-D_4, 98%)	1 mg, 5 mg
ULM-10495	Lysophosphatidylcholine 24:0 (unlabeled)	5 mg, 10 mg
CLM-9792	Lysophosphatidylcholine 26:0 (hexacosanoyl-1,2,3,4,5,6-$^{13}C_6$, 99%)	1mg, 5mg
DLM-10501	Lysophosphatidylcholine 26:0 (hexacosanoyl-12,12,13,13-D_4, 98%)	1 mg, 5 mg
ULM-9791	Lysophosphatidylcholine 26:0 (unlabeled)	5 mg, 10 mg
DLM-2960	2-Methylsuccinic acid (D_6, 98%)	1 g
CLM-1844	Myristic acid (1-^{13}C, 99%)	1 g
CLM-3665	Myristic acid (1,2,3-$^{13}C_3$, 99%)	0.5 g
DLM-1039	Myristic acid (methyl-D_3, 98%)	0.1 g
DLM-7487	Myristic acid (13,13,14,14,14-D_5, 98%)	Please inquire
DLM-11024	Myristic acid (12,12,13,13,14,14,14-D_7, 98%)	Please inquire
DLM-208	Myristic acid (D_{27}, 98%)	1 g
CLM-6228	Myristic acid, potassium salt (1-^{13}C, 99%)	Please inquire
CLM-8695	Myristic acid, sodium salt (1,2,3-$^{13}C_3$, 99%)	0.5 g
DLM-10367	Nonadecanoic acid (D_{37}, 98%)	Please inquire
CLM-8724	Nonanoic acid (U-$^{13}C_9$, 98%)	Please inquire
DLM-7490	Nonanoic acid (9,9,9-D_3, 98%)	Please inquire
DLM-9501	Nonanoic acid (D_{17}, 98%)	0.5 g, 1 g
DLM-795	*N*-Octadecanol (D_{37}, 98%)	1 g
CLM-293	Octanoic acid (1-^{13}C, 99%)	1 g, 5 g
CLM-3827	Octanoic acid (1,2-$^{13}C_2$, 99%)	1 g
CLM-2721	Octanoic acid (1,2,3,4-$^{13}C_4$, 99%)	0.25 g
CLM-3981	Octanoic acid ($^{13}C_8$, 99%)	Please inquire
DLM-619	Octanoic acid (D_{15}, 98%)	1 g
CLM-3707	2-Octanoyl-1,3-distearin (octanoic-1-^{13}C, 99%)	1 g, 10 g
CLM-4258	2-Octanoyl-1,3-distearin (octanoyl-1,2-$^{13}C_2$, 99%)	1 g
CLM-149	Oleic acid (1-^{13}C, 99%)	0.5 g, 1 g
CLM-2492	Oleic acid (methyl-^{13}C, 99%)	0.25 g
CLM-460	Oleic acid (U-$^{13}C_{18}$, 98%)	0.1 mg, 0.1 g
DLM-689	Oleic acid (9,10-D_2, 97%)	0.1 g
DLM-1891	Oleic acid (D_{33}, 98%)	Please inquire
CLM-3959	Oleic acid, ethyl ester (oleate-U-$^{13}C_{18}$, 98%) CP 95%	1 g
DLM-8747	Oleic acid, ethyl ester (D_{33}, 98%) CP 95%	Please inquire
CLM-4337	Oleic acid, methyl ester (oleate-$^{13}C_{18}$, 98%)	Please inquire
CLM-4477	Oleic acid, potassium salt (1-^{13}C, 99%)	1 g
CLM-8856	Oleic acid, potassium salt (U-$^{13}C_{18}$, 98%) CP 95%	Please inquire
DLM-8837	Oleic acid, potassium salt (15,15,16,16,17,17,18,18,18-D_9, 98%)	Please inquire
CLM-6230	Oleic acid, sodium salt (1-^{13}C, 99%)	Please inquire
CLM-8763	Oleic acid, sodium salt (U-$^{13}C_{18}$, 98%)	Please inquire
NLM-10511	Oleylamine (^{15}N, 98%)	Please inquire
CLM-150	Palmitic acid (1-^{13}C, 99%)	1 g, 5 g, 10 g
CLM-2120	Palmitic acid (2-^{13}C, 99%)	1 g
CLM-214	Palmitic acid (1,2-$^{13}C_2$, 99%)	0.5 g
CLM-7896	Palmitic acid (1,2,3,4-$^{13}C_4$, 99%)	0.1 mg, 1 g
CLM-10926	Palmitic acid (1,2,3,4,5,6-$^{13}C_6$, 99%)	Please inquire
CLM-409	Palmitic acid (U-$^{13}C_{16}$, 98%)	0.5 g
DLM-8673	Palmitic acid (12-D, 98%)	Please inquire
DLM-1153	Palmitic acid (2,2-D_2, 98%)	1 g
DLM-2890	Palmitic acid (9,9-D_2, 98%)	Please inquire
DLM-2891	Palmitic acid (13,13-D_2, 98%)	0.5 g
DLM-611	Palmitic acid (methyl-D_3, 98%)	0.5 g
DLM-2893	Palmitic acid (7,7,8,8-D_4, 98%)	0.1 g, 0.5 g

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Catalog No.	Description	Unit Size
DLM-2894	Palmitic acid (11,11,12,12-D_4, 98%)	Please inquire
DLM-9424	Palmitic acid (13,13,14,14,15,15,16,16,16-D_9, 98%)	Please inquire
DLM-2895	Palmitic acid (9,9,10,10,11,11,12,12,13,13,14,14,15,15,16,16,16-D_{17}, 98%) CP 97%	0.1 g
DLM-215	Palmitic acid (D_{31}, 98%)	1 g
CLM-3957	Palmitic acid, ethyl ester (palmitate-$^{13}C_{16}$, 98%) CP 95%	1 g
DLM-8793	Palmitic acid, ethyl ester (D_{31}, 98%)	Please inquire
CLM-8390	Palmitic acid, methyl ester (palmitate-$^{13}C_{16}$, 98%)	0.25 g, 1 g
CLM-2241	Palmitoleic acid (U-$^{13}C_{16}$, 98%) CP 97%	5 mg, 10 mg
CLM-3958	Palmitoleic acid, ethyl ester (palmitoleate-U-$^{13}C_{16}$, 98%) CP 97%	Please inquire
CLM-8391	Palmitoleic acid, methyl ester (palmitoleate-U-$^{13}C_{16}$, 98%) CP 97%	Please inquire
DLM-1307	Pentadecanoic acid (methyl-D_3, 98%)	0.1 g
DLM-572	Pentanoic acid (D_9, 98%)	1 g, 5 g
CLM-10700	Pentanoic acid, pentyl ester ($^{13}C_{10}$, 99%) CP 95%	Please inquire
DLM-4341	DL-α-Phosphatidylcholine, dihexanoyl (DHPC) (D_{40}, 98%) CP 95%	0.1 g
CLM-9668	DL-α-Phosphatidylcholine, dipalmitoyl (DPPC) (U-$^{13}C_{40}$, 98%) CP 95%	0.05 g
DLM-8256	DL-α-Phosphatidylcholine, dipalmitoyl (DPPC) (D_{80}, 98%) CP 95%	Please inquire
DLM-605	L-α-Phosphatidylcholine, dimyristoyl (DMPC) (dimyristoyl-D_{54}, 97%) CP 95%	0.1 g
DLM-606	L-α-Phosphatidylcholine, dipalmitoyl (DPPC) (dipalmitoyl-D_{62}, 98%) CP 95%	0.1 g
CDLM-7572	L-α-Phosphatidylcholine, dipalmitoyl (DPPC) (palmitate-$^{13}C_{32}$, 98%; methyl-D_9, choline, 98%) CP 95%	Please inquire
DLM-7557	L-Phosphatidylglycerol, dipalmitoyl (DPPG) (dipalmitoyl-D_{62}, 98%)	Please inquire
DLM-6998	Phytanic acid (3-methyl-D_3, 98%) CP 95%	Please inquire
CLM-1889	Potassium palmitate (1-^{13}C, 99%)	1 g
CLM-6865	Potassium palmitate (1,2,3,4-$^{13}C_4$, 99%)	Please inquire
CLM-10942	Potassium palmitate (1,2,3,4,5,6-$^{13}C_6$, 99%)	Please inquire
CLM-3943	Potassium palmitate (U-$^{13}C_{16}$, 98%)	0.5 g
DLM-3773	Potassium palmitate (2,2-D_2, 97%)	1 g
DLM-6199	Potassium palmitate (methyl-D_3, 98%)	Please inquire
DLM-6033	Potassium palmitate (7,7,8,8-D_4, 98%)	0.5 g
DLM-8302	Pristanic acid (2-methyl-D_3, 98%) CP 95%	Please inquire
DLM-10241	Sebacic acid (2,2,9,9-D_4, 98%)	Please inquire
CLM-1256	Sodium butyrate (1-^{13}C, 99%)	1 g, 5 g
CLM-4780	Sodium butyrate (2-^{13}C, 99%)	Please inquire
CLM-10426	Sodium butyrate ($^{13}C_4$, 99%)	0.1 g
DLM-641	Sodium butyrate (3,3,4,4,4-D_5, 98%)	Please inquire
DLM-7616	Sodium butyrate (D_7, 98%)	Please inquire
DLM-197	Sodium dodecyl sulfate (D_{25}, 98%)	1 g
CLM-10897	Sodium isobutyrate ($^{13}C_4$, 99%)	Please inquire
CLM-1948	Sodium octanoate (1-^{13}C, 99%)	1 g, 5 g, 10 × 0.1 g
CLM-3876	Sodium octanoate (1,2,3,4-$^{13}C_4$, 99%)	0.1 g, 0.25 g
CLM-3980	Sodium octanoate (2,4,6,8-$^{13}C_4$, 99%)	Please inquire
CLM-9617	Sodium octanoate (U-$^{13}C_8$, 99%)	Please inquire
CLM-174	Sodium palmitate (1-^{13}C, 99%)	1 g
CLM-6059	Sodium palmitate (U-$^{13}C_{16}$, 98%)	1 g
ULM-9721	*N*-Decanoyl-D-sphingosine (ceramide d18:1/10:0) (unlabeled) CP 97%	Please inquire
ULM-9722	*N*-Octanoyl-D-sphingosine (ceramide d18:1/8:0) (unlabeled)	Please inquire
CLM-9583	*N*-Oleoyl-D-sphingosine (ceramide d18: 1/18:1 (9z) (oleoyl-U-$^{13}C_{18}$, 99%) CP 95%	0.1 mg, 1 mg
ULM-9581	*N*-Oleoyl-D-sphingosine (ceramide d18:1/18:1 (9z) (unlabeled) CP 95%	0.1 mg
CLM-9582	*N*-Palmitoyl-D-sphingosine (ceramide d18:1/16:0) (palmitoyl-U-$^{13}C_{16}$, 99%) CP 95%	0.1 mg, 1 mg
ULM-9580	*N*-Palmitoyl-D-sphingosine (ceramide d18:1/16:0) (unlabeled) CP 95%	0.1 mg
ULM-9579	Sphingosine (unlabeled) CP 95%	Please inquire
CLM-490	Stearic acid (methyl-^{13}C, 99%)	1 g
CLM-676	Stearic acid (1-^{13}C, 99%)	1 g, 5 g

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
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Fatty Acids and Lipids *(continued)*

Catalog No.	Description	Unit Size
CLM-6990	Stearic acid (U-$^{13}C_{18}$, 98%) CP 97%	0.25 g
DLM-1154	Stearic acid (methyl-D_3, 98%)	0.1 g, 0.25 g
DLM-2712	Stearic acid (17,17,18,18,18-D_5, 98%)	0.1 g, 0.5 g
DLM-379	Stearic acid (D_{35}, 98%)	1 g
CLM-8731	Stearic acid, ethyl ester (stearate-U-$^{13}C_{18}$, 98%)	Please inquire
CLM-8394	Stearic acid, methyl ester (stearate-U-$^{13}C_{18}$, 98%) CP 95%	0.25 g, 1 g
CLM-6227	Stearic acid, potassium salt (1-^{13}C, 99%)	Please inquire
CLM-10365	Stearic acid, sodium salt (U-$^{13}C_{18}$, 98%) CP 97%	Please inquire
DLM-6143	Suberic acid (2,2,7,7-D_4, 98%)	0.5 g, 1 g
CLM-9932	Tetracosanoic acid (1,2,3,4,5,6-$^{13}C_6$, 99%) CP 96%	Please inquire
DLM-9952	Tetracosanoic acid (3,3,5,5-D_4, 98%) CP 95%	Please inquire
DLM-9179	Tetracosanoic acid (9,9,10,10-D_4, 98%)	Please inquire
DLM-10502	Tetracosanoic acid (12,12,13,13-D_4, 98%)	0.1 g, 0.25 g
DLM-7302	Tetracosanoic acid (D_{47}, 98%)	Please inquire
DLM-1392	Tridecanoic acid (D_{25}, 98%)	0.5 g, 1 g
CLM-162	Trioctanoin (1,1,1-$^{13}C_3$, 99%)	0.25 g, 0.5 g, 1 g
CLM-163	Triolein (1,1,1-$^{13}C_3$, 99%)	0.1 g, 0.5 g
CLM-8445	Tripalmitin (glyceryl-$^{13}C_3$, 99%)	Please inquire
CLM-164	Tripalmitin (1,1,1-$^{13}C_3$, 99%)	0.25 g, 0.5 g, 1 g
CLM-350	Tripalmitin (2,2,2-$^{13}C_3$, 99%)	0.1 g
CLM-9468	Tripalmitin (1,1,1,2,2,2,3,3,3,4,4,4-$^{13}C_{12}$, 99%)	Please inquire
DLM-9986	Tripalmitin (glyceryl-D_5, 98-99%)	Please inquire
DLM-9462	Tripalmitin (trispalmitoyl-D_{93}, 98%)	0.5 g
DLM-9044	Tripalmitin (D_{98}, 98%)	Please inquire
DLM-7875	Tristearin (tristearoyl-D_{105}, 98%)	Please inquire
CLM-3399	Valproic acid (1,2,3,3′-$^{13}C_4$, 99%)	Please inquire
DLM-7876	Valproic acid (propyl-1,1-D_2, pentanoic-3,3-D_2, 98%)	Please inquire
DLM-4291	Valproic acid (4,4,4′,4′-D_4, 98%)	0.1 g
DLM-8875	Valproic acid (D_{15}, 98%)	Please inquire

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For research use only. Not for use in diagnostic procedures.

MS/MS Screening Mixtures and Standards

The utility of stable isotope-labeled standards for MS/MS screening is gaining traction worldwide. To support such research endeavors and enhance method adoption, CIL is pleased to offer a breadth of high-quality, stable isotope-labeled mixtures. These mixes contain a collection of stable isotope-labeled standards (e.g., 12 amino acids in NSK-A) and are class-specific (e.g., amino acids, carnitine/acylcarnitines, steroids). These are available in 10-vial sets or single vials and are suitable for metabolite quantification in isotope dilution MS (IDMS) experiments. Also listed here are example individual standards used in MS/MS screening research. Please refer to page 115 for CE-mark amino acid and acylcarnitine mixes.

Mixtures

Catalog No.	Description	Unit Size
NSK-A	Labeled Amino Acid Standards Set A	1 vial, 10 vials
NSK-A1	Labeled Amino Acid Standards Set A1	1 vial, 10 vials
NSK-A-US	Unlabeled Amino Acid Standards Set A	1 vial
NSK-B	Labeled Carnitine Standards Set B	1 vial, 10 vials
NSK-B-US	Unlabeled Carnitine Standards Set B	1 vial
NSK-B-G1	Labeled Carnitine Standards Supplement to NSK-B	1 vial, 10 vials
NSK-B-G1-US	Unlabeled Carnitine Standards Supplement to NSK-B	1 vial
NSK-AB	Labeled Standards Sets A & B	2 × 10 vials
NSK-S-CAH	Labeled Steroid CAH Set S	1 vial, 10 vials
NSK-T	Labeled Succinylacetone Standard Set T	1 vial, 10 vials
NSK-T-US	Unlabeled Succinylacetone Standard Set T	1 vial
NSK-NI-1	Acid Sphingomyelinase Substrate and Internal Standard	1 vial
NSK-KR-1	Galactocerebrosidase Substrate and Internal Standard	1 vial
NSK-FA-1	α-Galactosidase Substrate and Internal Standard	1 vial
NSK-GA-1	Glucocerebrosidase Substrate and Internal Standard	1 vial
NSK-MP-1	α-L-Iduronidase Substrate and Internal Standard	1 vial
NSK-PO-1	Lysosomal α-Glucosidase Substrate and Internal Standard	1 vial
NSK-LPC-1	Lyso-PC Mix (C20:0/22:0/24:0/26:0) (labeled)	1 vial
NSK-LPC-US-1	Lyso-PC Mix (C20:0/22:0/24:0/26:0) (unlabeled)	1 vial

Individual Standards (Examples)

Catalog No.	Description	Unit Size
CLM-3777	*N*-Acetylglycine (2-^{13}C, 99%)	Please inquire
CLM-3678	Adenosine (ribose-$^{13}C_5$, 98%) CP 97%	0.05 g, 0.1 g
CLM-8755	β-Alanine (3-^{13}C, 99%)	Please inquire
CLM-8756	β-Alanine ($^{13}C_3$, 99%)	Please inquire
NLM-1656	β-Alanine (^{15}N, 98%)	0.25 g
CNLM-3440	β-Alanine (3-^{13}C, 99%; ^{15}N, 98%)	Please inquire
CNLM-8457	β-Alanine (1,2-$^{13}C_2$, 99%; ^{15}N, 98%)	Please inquire
CNLM-3946	β-Alanine ($^{13}C_3$, 98%; ^{15}N, 96-99%)	0.25 g
CNLM-9007-CA	L-Argininosuccinic acid, barium salt·2H_2O (arginine-$^{13}C_6$, 99%; $^{15}N_4$, 99%) CP 90%	0.1 mg, 0.5 mg
ULM-9008-CA	L-Argininosuccinic acid, barium salt·3H_2O (unlabeled) CP 90%	0.1 mg
ULM-10431	DL-Carnitine·HCl, *O*-acetyl (unlabeled)	Please inquire
ULM-10703	DL-Carnitine·HCl, *O*-butyrl (unlabeled)	Please inquire
ULM-10704	DL-Carnitine·HCl, *O*-isovaleryl (unlabeled)	Please inquire
ULM-10705	DL-Carnitine·HCl, *O*-myristoyl (unlabeled)	Please inquire
ULM-10432	DL-Carnitine·HCl, *O*-octanoyl (unlabeled)	Please inquire
ULM-10433	DL-Carnitine·HCl, *O*-palmitoyl (unlabeled) CP 97%	Please inquire
ULM-10702	DL-Carnitine·HCl, *O*-propionyl (unlabeled)	Please inquire
DLM-11049	L-Carnitine·ClO_4, *O*-malonyl (*N*-methyl-D_3, 98%)	Please inquire
DLM-10962	L-Carnitine·HCl (trimethyl-D_9, 98%)	5 mg

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MS/MS Screening Mixtures and Standards *(continued)*

Catalog No.	Description	Unit Size
DLM-9067	L-Carnitine·HCl, *O*-decanoyl (*N*-methyl-D_3, 98%)	0.1 mg
DLM-8162	L-Carnitine·HCl, *O*-dodecanoyl (*N*-methyl-D_3, 98%)	0.1 mg
DLM-9276	L-Carnitine·HCl, *O*-hexanoyl (*N*-methyl-D_3, 98%)	0.1 mg
ULM-7198	L-Carnitine·HCl, *O*-hexanoyl (unlabeled)	Please inquire
DLM-6718	L-Carnitine·HCl, *O*-hexacosanoyl (*N*-methyl-D_3, 98%) CP 95%	Please inquire
CLM-7933	Creatine (guanidino-^{13}C, 99%)	0.1 g
DLM-1302	Creatine (methyl-D_3, 98%) CP 97%	0.25 g
DLM-3653	Creatinine (*N*-methyl-D_3, 98%)	0.1 g
CLM-4579	2′-Deoxyadenosine·H_2O (ribose-$^{13}C_5$, 99%)	Please inquire
CLM-7686	2′-Deoxyguanosine·H_2O (ribose-1-^{13}C, 98%)	Please inquire
DLM-7687	2′-Deoxyguanosine·H_2O (ribose-5,5-D_2, 98%)	Please inquire
NLM-3899-CA	2′-Deoxyguanosine·H_2O ($^{15}N_5$, 98%) CP 95%	5 mg, 10 mg, 25 mg
CNLM-3900-CA	2′-Deoxyguanosine·H_2O ($^{13}C_{10}$, 98%; $^{15}N_5$, 96-98%)	5 mg, 10 mg, 25 mg
DLM-6013	Ethylmalonic acid (methyl-D_3, 98%)	0.1 g
CLM-744	D-Galactose (1-^{13}C, 99%)	0.25 g, 0.5 g, 1 g
CLM-4217	D-Galactose (1,2-$^{13}C_2$, 99%)	Please inquire
CLM-1570	D-Galactose (U-$^{13}C_6$, 99%)	0.1 g
DLM-9308	D-Galactose (6,6'-D_2, 97%)	Please inquire
CLM-1822	L-Glutamine ($^{13}C_5$, 99%)	0.1 g, 0.25 g, 0.5 g
DLM-1826	L-Glutamine (2,3,3,4,4-D_5, 97%)	0.1 g
CNLM-1275	L-Glutamine ($^{13}C_5$, 99%; $^{15}N_2$, 99%)	0.1 g, 0.25 g, 0.5 g
CLM-1017	Glycine (1,2-$^{13}C_2$, 97- 99%)	0.5 g, 1 g, 5g
DLM-280	Glycine (D_5, 98%)	5 g
NLM-202	Glycine (^{15}N, 98%)	1 g, 5 g
CNLM-8111	*N*-(3-Methylcrotonyl)glycine (glycine-$^{13}C_2$, 98%; ^{15}N, 98%)	Please inquire
DLM-9715	*N*-(3-Phenylpropionyl)glycine (2,2,-D_2, 98%)	Please inquire
DLM-9998	Guanidinoacetic acid (2,2-D_2, 97%)	Please inquire
CLM-7688	Guanosine·H_2O (ribose-1-^{13}C, 98%)	0.05 g, 0.1 g
DLM-7689	Guanosine·H_2O, (ribose-5,5-D_2, 98%)	0.05 g, 0.1 g
CNLM-3808-CA	Guanosine·H_2O ($^{13}C_{10}$, 98%; $^{15}N_5$, 96-98%)	5 mg, 10 mg, 25 mg
CNLM-8448	*N*-Hexanoylglycine ($^{13}C_2$, 97-99%; ^{15}N, 97-99%) CP 95%	Please inquire
NLM-4649	L-Histidine (ring-ε-^{15}N, 98%) (<5% D)	Please inquire
NLM-4457	L-Histidine (ring-π-^{15}N, 98%) (<5% D)	Please inquire
NLM-9585	L-Histidine (ring-$^{15}N_2$, 98%)	Please inquire
DLM-3619	DL-Homocystine (3,3,3′,3′,4,4,4′,4′-D_8, 98%)	0.1 g, 0.5 g, 1 g
NLM-4264	Inosine ($^{15}N_4$, 95%)	0.01 g, 0.05 g
CLM-8742	L-allo-Isoleucine ($^{13}C_6$, 97-99%)	Please inquire
DLM-1505	L-allo-Isoleucine (D_{10}, 98%)	0.1 g
CNLM-9291	*N*-Isovalerylglycine (glycine-$^{13}C_2$, 99%; ^{15}N, 99%)	Please inquire
CLM-2247-H	L-Lysine·2HCl ($^{13}C_6$, 99%)	0.05 g, 0.1 g, 0.25 g, 0.5 g, 1 g
DLM-2640	L-Lysine·2HCl (4,4,5,5-D_4, 96-98%)	0.1 g, 0.25 g, 0.5g
NLM-143	L-Lysine·2HCl (α-^{15}N, 95-99%)	0.25 g, 1 g
DLM-10520	Lysophosphatidylcholine 20:0 (eicosanoyl-12,12,13,13-D_4, 98%)	1 mg, 5 mg
ULM-10521	Lysophosphatidylcholine 20:0 (unlabeled)	5 mg, 10 mg
CLM-10499	Lysophosphatidylcholine 22:0 (docosanoyl-1,2,3,4,5,6-$^{13}C_6$, 99%)	1 mg, 5 mg
DLM-10500	Lysophosphatidylcholine 22:0 (docosanoyl-12,12,13,13-D_4, 98%)	1 mg, 5 mg
ULM-10498	Lysophosphatidylcholine 22:0 (unlabeled)	5 mg, 10 mg
CLM-10496	Lysophosphatidylcholine 24:0 (tetracosanoyl-1,2,3,4,5,6-$^{13}C_6$, 99%)	1 mg, 5 mg
DLM-10497	Lysophosphatidylcholine 24:0 (tetracosanoyl-12,12,13,13-D_4, 98%)	1 mg, 5 mg
ULM-10495	Lysophosphatidylcholine 24:0 (unlabeled)	5 mg, 10 mg
CLM-9792	Lysophosphatidylcholine 26:0 (hexacosanoyl-1,2,3,4,5,6-$^{13}C_6$, 99%)	1 mg, 5 mg
DLM-10501	Lysophosphatidylcholine 26:0 (hexacosanoyl-12,12,13,13-D_4, 98%)	1 mg, 5 mg

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Catalog No.	Description	Unit Size
ULM-9791	Lysophosphatidylcholine 26:0 (unlabeled)	5 mg, 10 mg
CLM-10350	2-Methylbutyric acid (methyl-^{13}C, 99%)	Please inquire
DLM-2312	DL-2-Methylcitric acid (methyl-D_3, 98%) CP 90%	5 mg, 10 mg
CLM-9426	Methylmalonic acid ($^{13}C_4$, 99%)	0.1 g
DLM-387	Methylmalonic acid (methyl-D_3, 98%)	0.25 mg
ULM-10578	Methylmalonic acid, disodium salt (unlabeled) CP 95%	Please inquire
DLM-2960	2-Methylsuccinic acid (D_6, 98%)	1 g
NLM-1048	Orotic acid·H_2O (1,3-$^{15}N_2$, 98%)	0.25 mg
CLM-10604	Phenylpyruvic acid, sodium salt ($^{13}C_9$, 99%)	Please inquire
CLM-7944	3-(3-Methyl-1H-pyrazol-5-yl)propanoic acid (methyl-^{13}C, pyrazolyl-$^{13}C_3$, 3-^{13}C, 99%)	0.1 mg
CNLM-9292	*N*-Propionylglycine (glycine-$^{13}C_2$, 99%; ^{15}N, 99%)	Please inquire
CLM-510	L-Proline (1-^{13}C, 99%)	0.25 g
CLM-2260-H	L-Proline ($^{13}C_5$, 99%)	0.1 g, 0.25 g, 0.5 g
DLM-487	L-Proline (D_7, 97-98%)	0.1 g, 0.25 g
NLM-835	L-Proline (^{15}N, 98%)	0.25 g, 0.5 g
CNLM-7822	L-Proline (1-^{13}C, 99%; ^{15}N, 98%)	Please inquire
CNLM-436-H	L-Proline ($^{13}C_5$, 99%; ^{15}N, 99%)	0.1 g, 0.25 g, 0.5 g
DNLM-7562	L-Proline (D_7, 98%; ^{15}N, 98%)	0.25 g
CDNLM-6812	L-Proline ($^{13}C_5$, 97-99%; D_7, 97-99%; ^{15}N, 97-99%)	0.25 g
ULM-8333	L-Proline (unlabeled)	0.05 g, 0.1 g
CLM-646	Propionic acid (1-^{13}C, 99%)	1 g
CLM-647	Propionic acid ($^{13}C_3$, 99%)	1 g
DLM-2488	Propionic acid (2,2-D_2, 98%)	1 g, 5 g
DLM-1137	Propionic acid (methyl-D_3, 98%)	5 g
DLM-1919	Propionic acid (D_5, 98%)	5 g
DLM-599	Propionic acid (D_6, 98%)	Please inquire
CLM-1036	L-Ornithine·HCL (1,2-$^{13}C_2$, 99%)	0.1 g
CLM-4724	L-Ornithine·HCL ($^{13}C_5$, 98%)	0.1 g
DLM-2969	L-Ornithine·HCL (3,3,4,4,5,5-D_6, 98%)	0.1 g, 0.25 g
NLM-3610	L-Ornithine·HCL ($^{15}N_2$, 98%)	0.25 g
NLM-1072	Sarcosine (^{15}N, 98%)	Please inquire
CNLM-8183	Suberylglycine (glycine-$^{13}C_2$, 98%; ^{15}N, 98%) CP 95%	Please inquire
DLM-10502	Tetracosanoic acid (12,12,13,13-D_4, 98%)	0.1 g, 0.25 g
CLM-2261	L-Threonine ($^{13}C_4$, 97-99%)	0.1 g, 0.25 g, 0.5 g
DLM-1693	L-Threonine (D_5, 98%)	0.1 g
NLM-742	L-Threonine (^{15}N, 98%)	0.25 g, 0.5 g
CNLM-587	L-Threonine ($^{13}C_4$, 97-99%; ^{15}N, 97-99%)	0.1 g, 0.25 g, 0.5 g
CLM-6725	L-Thyroxine (tyrosine-ring-$^{13}C_6$, 99%) CP 90%	0.1 mg
CLM-8931	L-Thyroxine (ring-$^{13}C_{12}$, 99%) CP 97%	0.1 mg
ULM-8184	L-Thyroxine (unlabeled)	0.2 mg
DLM-10758	Trisodium 2-methylcitrate, racemic mixture of diastereomers (methyl-D_3, 98%) CP 90%	5 mg, 10 mg
ULM-10510	Trisodium 2-methylcitrate, racemic mixture of diastereomers (unlabeled) CP 90%	Please inquire
CLM-716	L-Tryptophan (indole-3-^{13}C, 95-99%)	0.25 g
CLM-4290-H	L-Tryptophan ($^{13}C_{11}$, 99%)	0.1 g
DLM-6903	L-Tryptophan (D_8, 97-98%)	0.25 g
NLM-800	L-Tryptophan ($^{15}N_2$, 98%)	0.25 g, 0.5 g

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Stable Isotopes and Mass Spectrometry: An Inseparable Duo

Researcher Perspective

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The importance of stable isotope-enriched compounds in accurate mass spectrometry (MS)-based quantification cannot be underestimated. For context, using ion counts without a reference to quantify a substance is like estimating the temperature based on the time of year. It is simply an inaccurate and imprecise strategy. Stable isotopes have therefore been an important tool throughout my entire career. This stems from the development of a novel MS approach for use in the discovery of drug metabolites to isotope dilution for the quantification of metabolites in neonatal blood spot screens. In both cases, the ability to choose compounds with variable labels (e.g., ^{13}C, ^{15}N, D) and positions that have been produced at high isotopic enrichment (>99%) and chemical purity (>98%) are vital to effective discovery and clinical-based applications. The following highlights this importance with a newborn screening example.

As one of the original developers of the tandem MS application of amino acid and acylcarnitines in dried blood spots of neonates,[1] it became clear early on that 3-4 standards would be insufficient to accurately measure metabolites in a profile of dozens of compounds from multiple chemical families (i.e., basic, acidic, neutral). As the compounds exhibit vast structural and chemical diversity (in terms of polarity, charge, and functional groups), it became imperative to develop an approach to measure multiple metabolite standards in a single analysis with each method, processing as many compounds or compound types as possible. Because flow injection MS/MS (without chromatography) is a feature of the screening method, having the ability to pick the right standard (with the correct number of labels and mass shifts from unlabeled) was extremely important. Also important in the standard selection process was the nature of quality control (QC). Only well-characterized standards would provide me with the confidence to utilize these on a routine basis in newborn screening analysis.

CIL was the first to develop a multiplexed standard approach back in the late 1990s. Since then, we have together been making improvements and expanding the metabolite list. Often, as the "real estate" for available mass values in a flow injection analysis becomes more narrow, we require custom synthesis to make the ideal standard and ultimately add to the set of standards in our multiplexed screening panel. Today, CIL still sets the standard by providing a resource to those in metabolic screening, as well as to the rapidly expanding, and clinically relevant, field of metabolomics.[2] Although there may not be a kit available immediately for all targets of interest, CIL remains a resource to obtain the candidate or validated biomarker standards for a proper quantitative reference.

References

1. Chace, D.H.; Kalas, T.A.; Naylor, E.W. **2003**. Use of tandem mass spectrometry for multianalyte screening of dried blood specimens from newborns. *Clin Chem, 49(11),* 1797-1817.

2. Ismail, I.T.; Showalter, M.R.; Fiehn, O. **2019**. Inborn errors of metabolism in the era of untargeted metabolomics and lipidomics. *Metabolites, 9(10).* pii: E242.

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Simultaneous Analysis of Amino Acids, Acylcarnitines, and Succinylacetone in Dried Blood Spots for Research Using Nonderivatized and Derivatized Methods

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Technical Note

Introduction

Flow injection tandem mass spectrometry (FIA-MS/MS) has been frequently used for analysis of amino acids (AA) and acylcarnitines (AC) in dried blood spots for inborn errors of metabolism research.[1-3] Established methods for detecting succinylacetone (SUAC) can be laborious because they require additional extraction due to its insolubility in the first extraction solution for AA and AC. In this technical note, a single extraction step was used to simultaneously analyze AA, AC, and SUAC in dried blood spots on the Thermo Scientific™ TSQ Endura™ triple quadrupole mass spectrometer.[4]

The original sample preparation techniques use butyl esterification (i.e., derivatized) of amino acids and acylcarnitines in dried blood spots (DBS) due to the increased sensitivity that derivatization provides. However, with the improved sensitivity of new mass spectrometry technologies, it is possible to detect both amino acids and acylcarnitines as their native free acids (i.e., nonderivatized). This technological improvement simplifies analytical operation and minimizes the use of corrosive chemicals. In this technical note, both nonderivatization and derivatization sample preparation methods were compared.

Many previous FIA-MS/MS studies on dried blood spots deployed neutral-loss scan mode (acylcarnitines) and precursor ion scan mode (some amino acids) for fast method development. In this technical note, selected reaction monitoring (SRM) was used for all AA, AC, and SUAC data acquisition. The advantage of SRM is that it accurately quantifies analytes and ensures both high selectivity and sensitivity, which especially benefited analysis of analytes that ionize poorly.

Method

Sample Preparation

Sets of isotope-labeled internal standards of amino acids (NSK-A), acylcarnitines (NSK-B and NSK-B-G), and succinylacetone (NSK-T) were purchased from Cambridge Isotope Laboratories, Inc. The daily working internal standard concentration is listed in **Table 1**. Hydrazine, 1-butanol, and acetyl chloride were purchased from Sigma-Aldrich®. The other reagents were from Thermo Fisher Scientific.

The DBS quality control (QC) samples were kindly provided by the United States Centers for Disease Control and Prevention (CDC) for research purposes. The QC samples contained enriched analytes at three concentrations: low, intermediate, and high.

Table 1. Daily working internal standard concentrations.

Standard	Concentrations (µM)
Alanine-d_4	2.50
Arginine-^{13}C-d_4	2.50
Aspartic acid-d_3	2.50
Citrulline-d_2	2.50
Glutamic acid-d_3	2.50
Glycine-^{13}C-^{15}N	12.50
Leucine-d_3	2.50
Methionine-d_3	2.50
Ornithine-d_2	2.50
Phenylalanine-$^{13}C_6$	2.50
Tyrosine-$^{13}C_6$	2.50
Valine-d_8	2.50
Succinylacetone-$^{13}C_5$	2.50
C0-Carnitine-d_9	0.76
C2-Carnitine-d_3	0.19
C3-Carnitine-d_3	0.04
C4-Carnitine-d_3	0.04
C5-Carnitine-d_9	0.04
C5DC-Carnitine-d_3	0.08
C5OH-Carnitine-d_3	0.04
C8-Carnitine-d_3	0.04
C12-Carnitine-d_9	0.04
C14-Carnitine-d_9	0.04
C16-Carnitine-d_3	0.08
C18-Carnitine-d_3	0.08

The following protocols were used to prepare the DBS samples:

Derivatized

1. Punch one 1/8" diameter disc from DBS sample into a 96-well plate.
2. Add 100 µL of working internal standard solution (containing internal standards of 12 amino acids, 12 acylcarnitines, and SUAC) to each well.
3. Shake the well plate for 45 min at 45°C.
4. Transfer the eluates to another well plate and evaporate at 50°C under nitrogen flow.
5. Pipet 50 µL of methanol into each sample well and evaporate under nitrogen flow.
6. Pipet 50 µL of 3 n-butanol HCl into each sample well and incubate at 65°C for 20 min. Then, evaporate under nitrogen flow.
7. Reconstitute each sample well with 100 µL of 50:50:0.02 acetonitrile/water/formic acid.

Continued ➤

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Simultaneous Analysis of Amino Acids, Acylcarnitines, and Succinylacetone in Dried Blood Spots for Research Using Nonderivatized and Derivatized Methods *(continued)*

Nonderivatized

1. Punch one 1/8" diameter disc from DBS sample into a 96-well plate.
2. Add 100 µL of working internal standard solution (containing internal standards of 12 amino acids, 12 acylcarnitines, and SUAC) to each well.
3. Shake the well plate for 45 min at 45°C.
4. Transfer the eluates to another well plate and evaporate at 50°C under nitrogen flow.
5. Pipet 50 µL of methanol into each sample well and evaporate under nitrogen flow.
6. Reconstitute each sample well with 100 µL of 50:50:0.02 acetonitrile/water/formic acid.

Liquid Chromatography

Pump	Thermo Scientific Dionex™ UltiMate™ HPG-3200 RS
Autosampler	Thermo Scientific UltiMate WPS-3000 TRS
HPLC column	None
Mobile phase	50:50:0.02 acetonitrile/water/formic acid
LC flow gradient	Refer to **Table 2**

Table 2. Flow gradient.

Time (min)	Flow Rate (mL/min)	Mobile Phase A (%)
0.00	0.09	100
1.23	0.09	100
1.25	0.30	100
1.50	0.09	100

Mass Spectrometry

Flow injection MS/MS analysis was performed on a TSQ Endura triple quadrupole mass spectrometer. The mass spectrometer conditions were as follows:

Ionization	Heated electrospray ionization (HESI)
Spray voltage	Positive, 3500 V
Sheath gas	50 Arb
Aux gas	7 Arb
Sweep gas	0 Arb
Ion transfer tube temperature	350°C
Vaporizer temperature	200°C
Data acquisition mode	SRM
Cycle time	1 s
Q1 resolution (FWHM)	0.7 Da
Q3 resolution (FWHM)	0.7 Da
CID gas	1.5 mTorr
Source fragmentation	0 V
Chrom filter	3 s
SRM parameters	Refer to **Table 3** (Derivatized) and **Table 4** (Nonderivatized)

Data Analysis

Tandem MS data were analyzed using a meta-calculation software, iRC PRO (2Next srl, Prato, Italy). This offline automated data analysis tool can process peaks and formulas, as well as quantify target analytes from the ion ratios (unlabeled:labeled) of SRM data (see **Figure 1**).[5]

The metacalculation software improves time effectiveness by eliminating the manual calculation process and removing transcription errors in the post-analytical phase. The processing time is reduced from hours to minutes.

Assay Validation

The intra-assay precision was determined at three concentrations by means of ten successive, independent measurements of DBS samples (n=10). The interassay precision was determined at three concentrations by means of ten independent measurements of DBS samples in seven different test series (n=70).

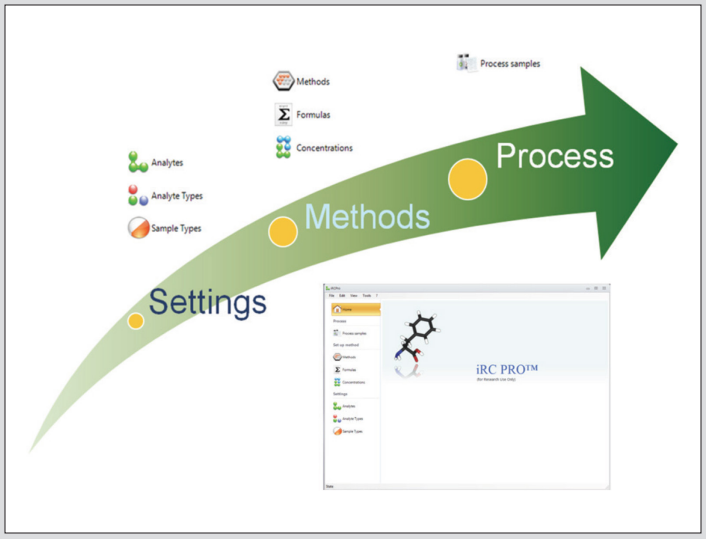

Figure 1. irC PRO intuitive workflow – icon-based interface.

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Table 3. SRM parameters (derivatized).

Analyte	Precursor Ion *m/z*	Product Ion *m/z*	Internal Standard	Precursor Ion *m/z*	Product Ion *m/z*	Collision Energy (V)	RF Lens (V)
Alanine	146.20	44.20	Alanine-d_4	150.20	48.18	17	62
Arginine	231.28	70.13	Arginine-^{13}C-d_4	236.28	75.13	30	87
Aspartic acid	246.18	144.13	Aspartic acid-d_3	249.25	147.13	15	103
Citrulline	232.28	113.13	Citrulline-d_2	234.28	115.18	20	85
Glutamic acid	260.28	157.93	Glutamic acid-d_3	263.33	161.13	16	94
Glycine	131.80	76.05	Glycine-^{13}C-^{15}N	134.20	78.10	8	55
Leucine	188.25	86.10	Leucine-d_3	191.25	89.18	15	75
Methionine	206.23	104.13	Methionine-d_3	209.20	107.23	16	81
Ornithine	189.25	70.10	Ornithine-d_2	191.18	72.13	24	79
Phenylalanine	222.25	120.13	Phenylalanine-$^{13}C_6$	228.33	126.18	19	105
Tyrosine	238.30	136.13	Tyrosine-$^{13}C_6$	244.28	142.15	18	93
Valine	174.25	72.13	Valine-d_8	182.23	80.18	16	73
SUAC	211.18	137.05	SUAC-$^{13}C_5$	216.18	142.05	12	91
C0-Carnitine	218.28	85.05	C0-Carnitine-d_9	227.33	85.05	28	104
C2-Carnitine	260.30	85.05	C2-Carnitine-d_3	263.30	85.05	25	113
C3-Carnitine	274.33	85.05	C3-Carnitine-d_3	277.33	85.05	25	121
C3DC-Carnitine	360.33	85.05					
C4-Carnitine	288.33	85.05	C4-Carnitine-d_3	291.33	85.05	27	117
C4OH-Carnitine	304.33	85.05					
C5-Carnitine	302.33	85.05	C5-Carnitine-d_9	311.38	85.05	30	113
C6-Carnitine	316.35	85.05					
C5DC-Carnitine	388.35	85.05	C5DC-Carnitine-d_3	391.35	85.05	31	138
C5OH-Carnitine	318.38	85.05	C5OH-Carnitine-d_3	321.38	85.05	31	138
C8-Carnitine	344.38	85.05	C8-Carnitine-d_3	347.38	85.05	32	141
C10-Carnitine	372.40	85.05					
C12-Carnitine	400.43	85.05	C12-Carnitine-d_9	409.43	85.05	36	184
C14-Carnitine	428.48	85.05	C14-Carnitine-d_9	437.48	85.05	35	193
C16-Carnitine	456.55	85.05	C16-Carnitine-d_3	459.55	85.05	37	183
C16OH-Carnitine	472.55	85.05					
C18-Carnitine	484.55	85.05	C18-Carnitine-d_3	487.55	85.05	38	215
C18OH-Carnitine	500.55	85.05					

Continued ➤

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Simultaneous Analysis of Amino Acids, Acylcarnitines, and Succinylacetone in Dried Blood Spots for Research Using Nonderivatized and Derivatized Methods *(continued)*

Table 4. SRM parameters (nonderivatized).

Analyte	Precursor Ion *m/z*	Product Ion *m/z*	Internal Standard	Precursor Ion *m/z*	Product Ion *m/z*	Collision Energy (V)	RF Lens (V)
Alanine	90.15	44.20	Alanine-d_4	94.15	48.20	13	45
Arginine	175.23	70.15	Arginine-^{13}C-d_4	180.23	75.15	24	92
Aspartic acid	134.20	116.13	Aspartic acid-d_3	137.20	119.13	6	54
Citrulline	176.20	113.13	Citrulline-d_2	178.20	115.13	18	59
Glutamic acid	148.15	130.08	Glutamic acid-d_3	151.15	133.08	9	62
Glycine	76.08	30.25	Glycine-^{13}C-^{15}N	78.08	32.25	13	43
Leucine	132.25	86.13	Leucine-d_3	135.25	89.13	11	56
Methionine	150.18	133.08	Methionine-d_3	153.18	136.08	9	60
Ornithine	133.15	70.15	Ornithine-d_2	135.15	72.15	19	63
Phenylalanine	166.20	120.15	Phenylalanine-$^{13}C_6$	172.20	126.15	16	69
Tyrosine	182.15	136.18	Tyrosine-$^{13}C_6$	188.15	142.18	15	71
Valine	118.23	72.15	Valine-d_8	126.23	80.15	13	53
SUAC	155.18	109.12	SUAC-$^{13}C_5$	160.18	114.12	22	63
C0-Carnitine	162.23	85.05	C0-Carnitine-d_9	171.23	85.05	23	69
C2-Carnitine	204.23	85.05	C2-Carnitine-d_3	207.23	85.05	21	96
C3-Carnitine	218.23	85.05	C3-Carnitine-d_3	221.23	85.05	23	91
C3DC-Carnitine	248.23	85.05					
C4-Carnitine	232.18	85.05	C4-Carnitine-d_3	235.18	85.05	21	78
C4OH-Carnitine	248.25	85.05					
C5-Carnitine	246.30	85.05	C5-Carnitine-d_9	255.30	85.05	25	96
C6-Carnitine	260.30	85.05					
C5DC-Carnitine	276.30	85.05	C5DC-Carnitine-d_3	279.30	85.05	25	96
C5OH-Carnitine	262.30	85.05	C5OH-Carnitine-d_3	265.30	85.05	25	96
C8-Carnitine	288.33	85.05	C8-Carnitine-d_3	291.33	85.05	26	108
C10-Carnitine	316.33	85.05					
C12-Carnitine	344.45	85.05	C12-Carnitine-d_9	353.45	85.05	39	152
C14-Carnitine	372.45	85.05	C14-Carnitine-d_9	381.45	85.05	39	152
C16-Carnitine	400.45	85.05	C16-Carnitine-d_3	403.45	85.05	36	185
C16OH-Carnitine	416.45	85.05					
C18-Carnitine	428.45	85.05	C18-Carnitine-d_3	431.45	85.05	36	185
C18OH-Carnitine	444.45	85.05					

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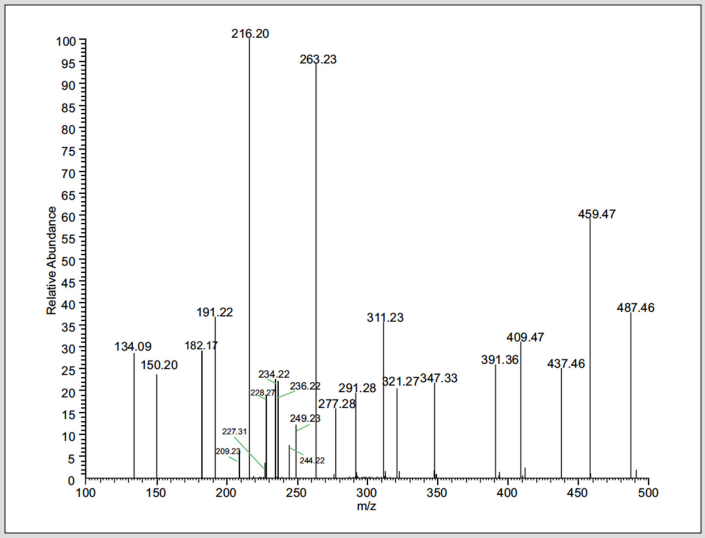
Results

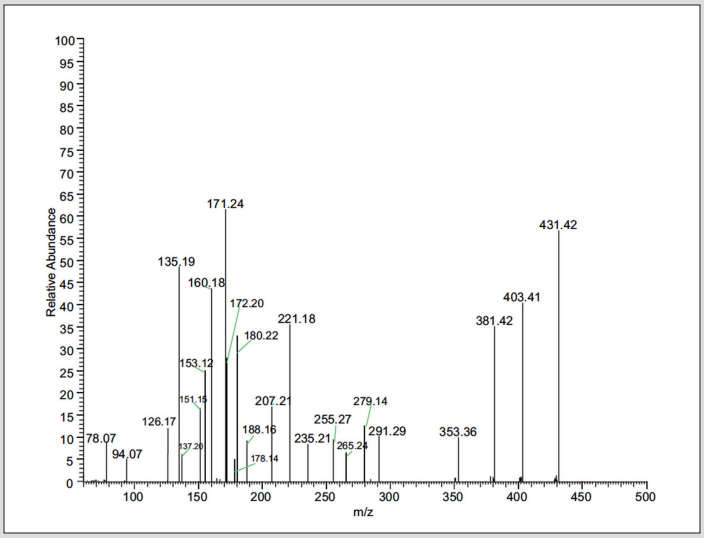
The derivatization process using butanol converted free amino acids and acylcarnitines into the butyric esters and added a mass of 56 (except for aspartic acid, glutamic acid, and C5DC, in which a mass of 112 was added). **Figures 2** and **3** show full-scan spectra of derivatized and nonderivatized internal standards, respectively.



Internal Standard	*m/z*
Alanine-d_4	150.20
Arginine-^{13}C-d_4	236.22
Aspartic acid-d_3	249.23
Citrulline-d_2	234.22
Glutamic acid-d_3	263.23
Glycine-^{13}C-^{15}N	134.09
Leucine-d_3	191.22
Methionine-d_3	209.23
Ornithine-d_2	191.22
Phenylalanine-$^{13}C_6$	228.27
Tyrosine-$^{13}C_6$	244.22
Valine-d_8	182.17
Succinylacetone-$^{13}C_5$	216.20

Internal Standard	*m/z*
C0-Carnitine-d_9	227.31
C2-Carnitine-d_3	263.23
C3-Carnitine-d_3	277.28
C4-Carnitine-d_3	291.28
C5-Carnitine-d_9	311.23
C5DC-Carnitine-d_3	391.36
C5OH-Carnitine-d_3	321.27
C8-Carnitine-d_3	347.33
C12-Carnitine-d_9	409.47
C14-Carnitine-d_9	437.46
C16-Carnitine-d_3	459.47
C18-Carnitine-d_3	487.46

Figure 2. Full-scan spectra of derivatized internal standards.



Internal Standard	*m/z*
Alanine-d_4	94.07
Arginine-^{13}C-d_4	180.22
Aspartic acid-d_3	137.20
Citrulline-d_2	178.14
Glutamic acid-d_3	151.15
Glycine-^{13}C-^{15}N	78.07
Leucine-d_3	135.19
Methionine-d_3	153.12
Ornithine-d_2	135.19
Phenylalanine-$^{13}C_6$	172.20
Tyrosine-$^{13}C_6$	188.16
Valine-d_8	126.17
Succinylacetone-$^{13}C_5$	160.18

Internal Standard	*m/z*
C0-Carnitine-d_9	171.24
C2-Carnitine-d_3	207.21
C3-Carnitine-d_3	221.18
C4-Carnitine-d_3	235.21
C5-Carnitine-d_9	255.27
C5DC-Carnitine-d_3	279.14
C5OH-Carnitine-d_3	265.24
C8-Carnitine-d_3	291.29
C12-Carnitine-d_9	353.36
C14-Carnitine-d_9	381.42
C16-Carnitine-d_3	403.41
C18-Carnitine-d_3	431.42

Figure 3. Full-scan spectra of nonderivatized internal standards.

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Simultaneous Analysis of Amino Acids, Acylcarnitines, and Succinylacetone in Dried Blood Spots for Research Using Nonderivatized and Derivatized Methods *(continued)*

SRM was used to acquire MS/MS data for all the analytes. Collision energy and RF lens parameters were optimized for each target and internal standard to ensure maximum selectivity and sensitivity.

SRM allowed acquisition of peaks with good signal-to-noise ratios even for analytes with poor ionization such as SUAC and C5DC regardless of whether derivatization was used (see **Figures 4** and **5**).

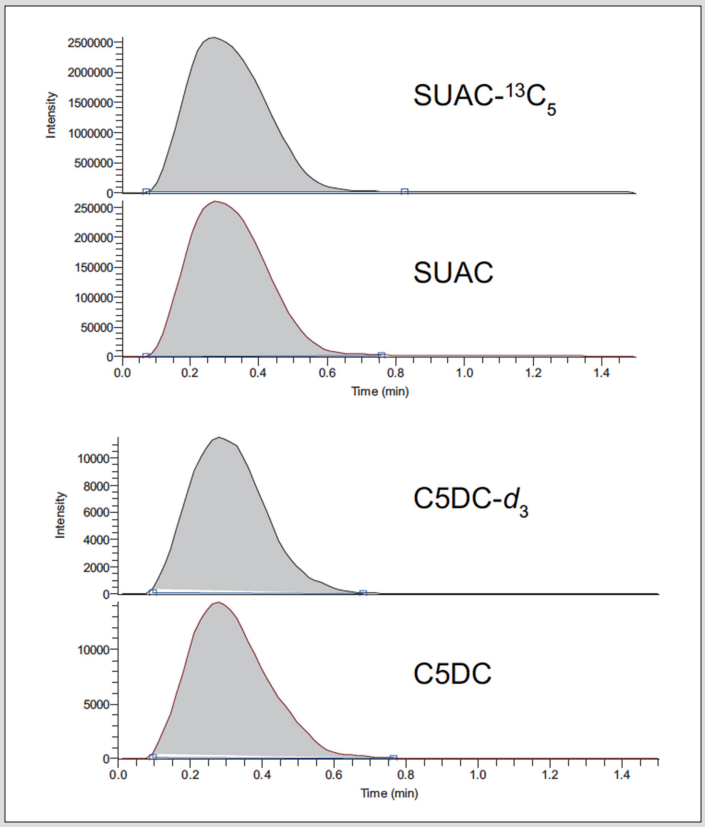

Figure 4. Flow injection analysis (FIA) profiles of SUAC-$^{13}C_5$, SUAC and C5DC-d_3, C5DC using derivatized method.

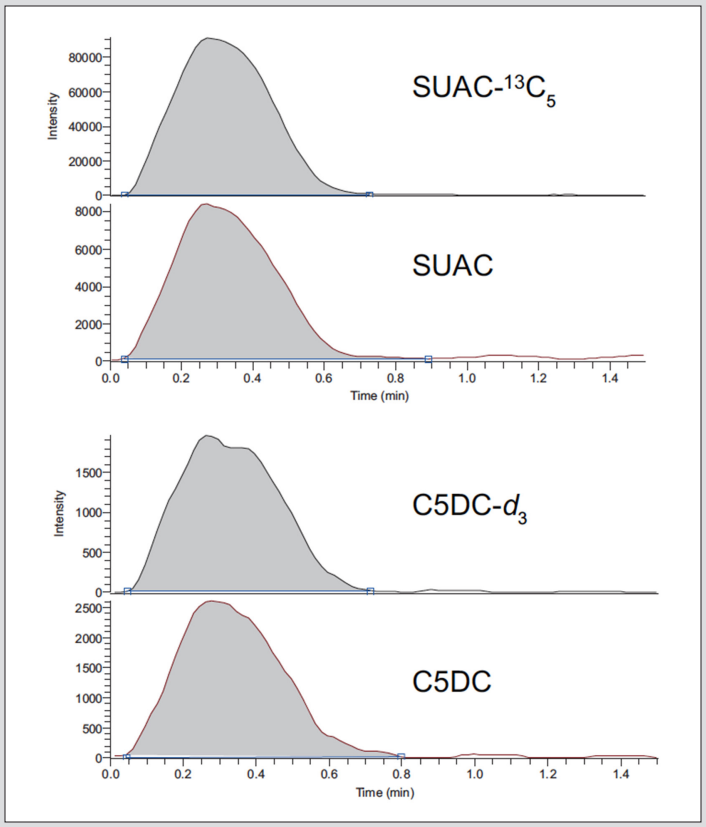

Figure 5. Flow injection analysis (FIA) profiles of SUAC-$^{13}C_5$, SUAC and C5DC-d_3, C5DC using nonderivatized method.

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
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Intra-assay Precision

For the derivatized method, the average intra-assay precisions (n=10) for 12 AA and SUAC at three concentrations were 7.9% (low), 8.0% (intermediate), and 8.0% (high). The average intra-assay precisions for 18 AC at three concentrations were 8.9% (low), 8.3% (intermediate), and 9.0% (high) (see **Table 5**).

Table 5. Derivatized method intra-assay precision at three concentrations (low, intermediate, and high). n=10

Analyte	Coefficient of Variation (%)			Concentrations (µmol/L)		
	Low	Intermediate	High	Low	Intermediate	High
Alanine	9.5	8.9	11.5	552.3	710.2	890.3
Arginine	5.4	9.6	7.6	111.2	211.4	317.8
Aspartic acid	9.0	6.5	8.0	N/A	N/A	N/A
Citrulline	6.8	4.0	5.6	55.8	131.6	277.4
Glutamic acid	10.1	5.9	4.7	N/A	N/A	N/A
Glycine	8.8	8.2	6.8	N/A	N/A	N/A
Leucine	8.5	8.4	6.8	225.1	378.8	633.0
Methionine	7.7	6.4	8.7	65.1	154.6	257.5
Ornithine	8.4	12.3	8.4	N/A	N/A	N/A
Phenylalanine	7.5	8.5	5.5	169.8	274.9	369.7
Tyrosine	7.8	10.8	8.6	236.6	416.5	605.0
Valine	9.6	8.3	8.1	289.5	410.0	547.8
SUAC	8.2	7.2	9.4	1.9	4.6	9.9
C0-Carnitine	12.2	5.0	6.8	35.3	54.4	70.6
C2-Carnitine	10.8	8.6	7.6	24.6	37.6	47.9
C3-Carnitine	11.6	12.7	11.7	4.9	10.1	14.6
C3DC-Carnitine	7.4	6.9	9.0	0.2	0.6	1.1
C4-Carnitine	6.7	6.5	10.6	1.1	2.8	5.0
C4OH-Carnitine	7.1	6.1	8.6	0.3	0.6	1.4
C5-Carnitine	6.9	5.4	10.6	0.6	1.7	3.2
C6-Carnitine	8.1	5.7	5.9	0.7	1.3	3.3
C5DC-Carnitine	4.7	8.6	8.3	1.0	2.2	3.1
C5OH-Carnitine	8.4	7.3	9.1	0.6	1.2	2.8
C8-Carnitine	9.0	9.5	4.0	0.6	1.2	2.7
C10-Carnitine	7.4	6.8	6.9	0.6	1.2	3.1
C12-Carnitine	6.1	6.7	8.8	0.7	1.3	2.8
C14-Carnitine	8.9	10.8	8.7	0.6	1.5	2.9
C16-Carnitine	10.7	10.9	10.8	3.5	7.8	11.8
C16OH-Carnitine	12.6	13.0	12.6	0.1	0.4	0.7
C18-Carnitine	10.2	7.4	13.6	1.6	2.6	5.6
C18OH-Carnitine	10.9	11.1	8.8	0.4	0.7	1.1

N/A, the analytes were not enriched in QC samples.

Continued ➤

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Simultaneous Analysis of Amino Acids, Acylcarnitines, and Succinylacetone in Dried Blood Spots for Research Using Nonderivatized and Derivatized Methods *(continued)*

For the nonderivatized method, the average intra-assay precisions (n=10) for AA and SUAC at three concentrations were 6.1% (low), 7.2% (intermediate), and 9.8% (high). The average intra-assay precisions for AC at three concentrations were 7.6% (low), 6.2% (intermediate), and 8.2% (high) (see **Table 6**).

Table 6. Nonderivatized method intra-assay precision at three concentrations (low, intermediate, and high). n=10

Analyte	Coefficient of Variation (%)			Concentrations (µmol/L)		
	Low	Intermediate	High	Low	Intermediate	High
Alanine	4.7	7.2	11.7	531.2	749.2	894.0
Arginine	6.1	7.2	9.7	104.8	206.2	303.3
Aspartic acid	13.0	13.7	15.1	N/A	N/A	N/A
Citrulline	4.4	7.8	8.0	54.0	127.3	269.0
Glutamic acid	8.0	3.8	7.3	N/A	N/A	N/A
Glycine	8.6	9.7	10.6	N/A	N/A	N/A
Leucine	5.5	6.3	9.2	252.9	416.0	637.4
Methionine	8.1	4.8	9.7	65.0	155.7	253.7
Ornithine	5.4	7.7	9.4	N/A	N/A	N/A
Phenylalanine	4.9	5.7	9.4	164.1	266.2	347.7
Tyrosine	5.2	5.9	7.5	240.4	431.7	623.5
Valine	5.1	6.3	10.1	295.9	439.5	547.3
SUAC	10.5	14.1	13.0	1.9	4.2	9.1
C0-Carnitine	5.6	6.0	6.6	30.8	43.4	56.9
C2-Carnitine	6.7	5.4	6.8	24.1	38.3	48.5
C3-Carnitine	8.7	3.9	8.9	4.6	10.1	14.6
C3DC-Carnitine	6.9	6.5	5.9	0.3	0.6	1.4
C4-Carnitine	9.6	5.2	8.5	1.1	2.8	5.3
C4OH-Carnitine	5.2	5.5	7.3	0.3	0.7	1.4
C5-Carnitine	7.8	7.3	9.0	0.6	1.7	3.2
C6-Carnitine	6.3	6.8	10.8	0.7	1.4	3.3
C5DC-Carnitine	8.7	7.1	10.3	1.1	1.9	2.7
C5OH-Carnitine	10.1	7.8	10.3	0.5	1.0	2.3
C8-Carnitine	8.3	5.2	7.8	0.6	1.1	2.7
C10-Carnitine	9.6	6.8	9.2	0.8	1.6	3.9
C12-Carnitine	6.7	4.6	6.5	0.4	0.9	2.1
C14-Carnitine	5.8	8.2	5.9	0.5	1.4	2.6
C16-Carnitine	7.8	4.0	5.5	3.7	8.9	12.2
C16OH-Carnitine	5.9	8.3	8.7	0.1	0.4	0.7
C18-Carnitine	7.1	3.4	9.5	1.7	2.7	5.6
C18OH-Carnitine	9.6	10.1	10.4	0.4	0.8	1.4

N/A, the analytes were not enriched in QC samples.

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
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Inter-assay Precision

For the derivatized method, the average inter-assay precisions (n=70) for 12 AA and SUAC at three concentrations were 13.5% (low), 12.9% (intermediate), and 12.5% (high). The average inter-assay precisions for 18 AC at three concentrations were 15.0% (low), 15.6% (intermediate), and 16.1% (high) (see **Table 7**).

Table 7. Derivatized method intra-assay precision at three concentrations (low, intermediate, and high). n=70

Analyte	Coefficient of Variation (%)			Concentrations (µmol/L)		
	Low	Intermediate	High	Low	Intermediate	High
Alanine	12.2	9.6	10.3	538.1	711.4	882.2
Arginine	17.1	16.6	18.6	123.8	222.5	326.0
Aspartic acid	11.2	10.7	7.9	N/A	N/A	N/A
Citrulline	17.0	14.8	12.5	58.9	132.6	285.3
Glutamic acid	13.0	10.8	10.4	N/A	N/A	N/A
Glycine	10.3	12.2	10.4	N/A	N/A	N/A
Leucine	12.2	12.2	12.1	224.2	381.2	640.3
Methionine	13.2	11.6	11.5	66.2	154.5	246.3
Ornithine	17.2	15.4	17.5	N/A	N/A	N/A
Phenylalanine	11.8	12.8	12.5	172.1	271.6	362.2
Tyrosine	13.6	12.5	14.0	232.9	400.9	604.1
Valine	11.4	12.8	11.5	290.4	409.3	539.3
SUAC	13.0	13.4	9.4	2.0	4.7	9.9
C0-Carnitine	15.7	15.1	13.4	36.4	51.7	71.8
C2-Carnitine	13.8	14.1	15.1	24.2	37.1	49.4
C3-Carnitine	16.3	15.3	16.6	4.8	9.5	14.2
C3DC-Carnitine	13.8	14.1	16.1	0.2	0.5	1
C4-Carnitine	16.3	13.4	17.5	1.0	2.5	4.7
C4OH-Carnitine	16.2	18.4	15.5	0.3	0.6	1.3
C5-Carnitine	15.1	14.6	16.6	0.6	1.5	2.9
C6-Carnitine	14.9	12.3	14.2	0.7	1.3	3.1
C5DC-Carnitine	13.7	15.6	15.2	1.1	2.1	3.1
C5OH-Carnitine	13.4	16.2	14.7	0.6	1.1	2.7
C8-Carnitine	15.4	13.8	16.6	0.6	1.1	2.6
C10-Carnitine	17.4	16.9	18.0	0.6	1.1	2.8
C12-Carnitine	15.4	17.1	17.3	0.7	1.2	2.6
C14-Carnitine	14.5	14.9	17.1	0.6	1.4	2.7
C16-Carnitine	14.7	16.1	16.2	3.7	7.9	11.5
C16OH-Carnitine	13.0	17.6	18.3	0.1	0.4	0.7
C18-Carnitine	14.7	18.2	15.5	1.7	2.5	5.1
C18OH-Carnitine	15.2	17.1	16.5	0.4	0.7	1.1

N/A, the analytes were not enriched in QC samples.

Continued ➤

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
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Simultaneous Analysis of Amino Acids, Acylcarnitines, and Succinylacetone in Dried Blood Spots for Research Using Nonderivatized and Derivatized Methods *(continued)*

For the nonderivatized method, the average inter-assay precisions (n=70) for AA and SUAC at three concentrations were 12.8% (low), 12.8% (intermediate), and 12.6% (high). The average inter-assay precisions for AC at three concentrations were 12.7% (low), 10.5% (intermediate), and 11.8% (high) (see **Table 8**).

Table 8. Nonderivatized method intra-assay precision at three concentrations (low, intermediate, and high). n=70

Analyte	Coefficient of Variation (%)			Concentrations (µmol/L)		
	Low	Intermediate	High	Low	Intermediate	High
Alanine	20.0	16.1	15.6	632.1	863.2	1002.4
Arginine	12.0	11.3	12.2	103.3	204.2	303.2
Aspartic acid	13.4	17.5	18.1	N/A	N/A	N/A
Citrulline	10.7	11.4	9.7	54.3	129.0	263.3
Glutamic acid	10.4	9.1	10.6	N/A	N/A	N/A
Glycine	13.4	13.7	14.8	N/A	N/A	N/A
Leucine	10.8	9.7	10.2	260.6	414.2	646.0
Methionine	18.8	17.5	20.2	53.8	129.2	200.1
Ornithine	8.6	8.8	8.8	N/A	N/A	N/A
Phenylalanine	7.7	8.7	11.2	162.9	268.8	351.3
Tyrosine	8.1	10.0	10.8	239.7	435.9	615.8
Valine	9.1	9.3	10.1	300.1	432.9	539.5
SUAC	18.1	21.0	13.7	2.7	4.9	9.3
C0-Carnitine	12.5	11.3	12.0	29.4	40.3	51.9
C2-Carnitine	10.3	10.0	10.9	24.1	38.1	47.8
C3-Carnitine	9.8	9.7	11.8	4.5	9.9	14.3
C3DC-Carnitine	12.4	11.8	9.1	0.3	0.6	1.3
C4-Carnitine	10.3	10.8	11.6	1.1	2.7	5.2
C4OH-Carnitine	11.3	10.5	10.6	0.3	0.6	1.4
C5-Carnitine	11.2	11.6	11.6	0.6	1.7	3.2
C6-Carnitine	16.9	16.5	12.7	0.7	1.4	3.2
C5DC-Carnitine	11.3	9.1	10.1	1.0	1.9	2.6
C5OH-Carnitine	12.8	11.3	12.3	0.5	1.0	2.4
C8-Carnitine	9.9	8.6	10.7	0.6	1.1	2.6
C10-Carnitine	18.4	13.5	13.2	0.8	1.6	4.0
C12-Carnitine	12.2	8.7	9.8	0.4	0.9	2.1
C14-Carnitine	11.3	8.0	10.0	0.5	1.4	2.7
C16-Carnitine	10.9	8.4	12.2	3.6	8.7	12.2
C16OH-Carnitine	14.3	9.6	13.9	0.1	0.4	0.7
C18-Carnitine	12.1	7.8	11.6	1.7	2.7	5.7
C18OH-Carnitine	21.3	11.2	17.8	0.4	0.9	1.5

N/A, the analytes were not enriched in QC samples.

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
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Method Comparison

The concentration of analytes obtained from nonderivatized and derivatized methods were compared. The average method differences of 12 AA and SUAC between quantitative values resulting from derivatization and nonderivatization methods at three concentrations were 3.8% (low), 4.8% (intermediate), and 3.2% (high). The average method differences of 18 AC at three concentrations were 14.2% (low), 11.4% (intermediate), and 10.5% (high) (see **Figure 6**). Therefore the two methods were highly correlated. Our data are consistent with the reported results from a comprehensive empirical analysis.[6]

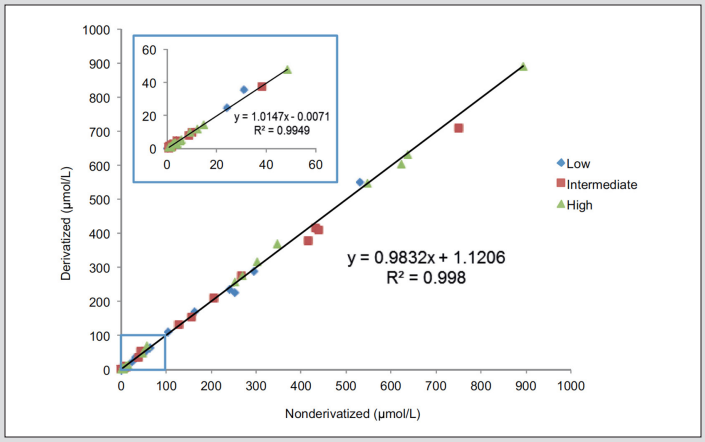

Figure 6. Comparisons between quantitative values of 12 AA, SUAC, and 18 AC resulting from nonderivatized and derivatized methods.

Conclusions

- Flow injection-tandem mass spectrometry methods were developed to simultaneously detect and quantify amino acids, acylcarnitines, and succinylacetone in a single extraction process in dried blood spots for research. Rapid data processing was performed using iRC Pro metacalculation software.
- Both derivatization and nonderivatization sample preparation methods were capable of accurately quantifying AA/AC/SUAC on TSQ Endura triple quadrupole MS with a run time of 1.5 min.
- SRM data acquisition mode optimized for each analyte and internal standard guarantees both high sensitivity and high selectivity.
- The TSQ Endura MS system can provide average intra-assay precision (n=10) at three enriched concentrations of less than 10% and average inter-assay precision (n=70) of less than 15% for both nonderivatized and derivatized methods.
- The method difference between quantitative values resulting from nonderivatized and derivatized methods was minor and both methods are highly correlated.

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Neurotransmitters and Their Metabolites

Neurotransmitters are small chemicals in the central nervous system that modulate and regulate brain function. Signals are relayed from neuron to neuron by release, upon stimulation, from a synaptic vesicle into a space where it can bind to a receptor. These molecules can be grouped into several classes, such as amino acids and their derivatives (e.g., γ-aminobutyric acid, glutamate) and biogenic amines (e.g., dopamine, epinephrine, serotonin). MS analysis of neurotransmitters in human biosamples, such as urine, is a clinically relevant area as they mediate homeostatic function, modulate neural activity, and have been correlated to the pathogenesis of neurodegenerative diseases (e.g., Alzheimer's).

CIL offers an array of stable isotope-labeled neurotransmitters. These research grade materials are available in their solution and/or neat form.

Catalog No.	Description	Unit Size
DLM-11029	*N*-Acetyl-5-hydroxytryptamine (acetyl-D_3, 98%)	Please inquire
CLM-8666	4-Aminobutyric acid ($^{13}C_4$, 97-99%)	0.05 g, 0.1 g
CLM-548	Choline chloride (1,2-$^{13}C_2$, 99%)	0.1 g
DLM-549	Choline chloride (trimethyl-D_9, 98%)	1 g
DLM-2499	3,4-Dihydroxyphenylacetic acid (ring-D_3, 2,2-D_2, 98%)	0.01 g, 0.1 g
COLM-386	3,4-Dihydroxyphenylacetic acid (ring-$^{13}C_6$, 99%; 4-hydroxy-^{18}O, 95%)	10 mg
CLM-3368	Dopamine·HCl (2-(3,4-dihydroxyphenyl)- ethylamine·HCl) (1-^{13}C, 99%)	0.01 g, 0.05 g
CLM-3369	Dopamine·HCl (2-(3,4-dihydroxyphenyl)- ethylamine·HCl) (ring-$^{13}C_6$, 99%)	Please inquire
DLM-2833	Dopamine·HCl (2-(3,4-dihydroxyphenyl)- ethylamine·HCl) (1,1-D_2, 93%) CP 96-98%	Please inquire
DLM-2834	Dopamine·HCl (2-(3,4-dihydroxyphenyl)- ethylamine·HCl) (2,2-D_2, 97-98%)	0.01 g, 0.1 g
DLM-2181	Dopamine·HCl (2-(3,4-dihydroxyphenyl)- ethylamine·HCl) (ring-D_3, 98%)	0.1 g
DLM-2498	Dopamine·HCl (2-(3,4-dihydroxyphenyl)- ethylamine·HCl) (1,1,2,2-D_4, 97-98%)	0.01 g, 0.1 g
DLM-2290	Dopamine·HCl (2-(3,4-dihydroxyphenyl)- ethylamine·HCl) (ring-D_3, 95%; 2,2-D_2, 95%) CP 95%	0.05 g, 0.1 g
CNLM-3445	Dopamine·HCl (2-(3,4-dihydroxyphenyl)- ethylamine·HCl) (1-^{13}C, 99%; ^{15}N, 99%)	Please inquire
DLM-9088	DL-Epinephrine (ring-D_3, 1,2,2-D_3, 98%)	Please inquire
CNLM-7889	DL-Epinephrine (1,2-$^{13}C_2$, 99%; ^{15}N, 98%)	10 mg
CLM-3632	DL-Glutamic acid (3-^{13}C, 99%)	Please inquire
DLM-335	DL-Glutamic acid (2,4,4-D_3, 98%)	1 g
DLM-357	DL-Glutamic acid (2,3,3,4,4-D_5, 97%)	0.25 g
CLM-3721	DL-Glutamic acid·H_2O (1-^{13}C, 99%)	1 g
CLM-674	L-Glutamic acid (1-^{13}C, 99%)	1 g
CLM-2474	L-Glutamic acid (2-^{13}C, 99%)	Please inquire
CLM-4742	L-Glutamic acid (3-^{13}C, 99%)	Please inquire
CLM-2431	L-Glutamic acid (4-^{13}C, 98-99%)	Please inquire
CLM-613	L-Glutamic acid (5-^{13}C, 99%)	0.1 g
CLM-2024	L-Glutamic acid (1,2-$^{13}C_2$, 99%)	0.25 g
CLM-3646	L-Glutamic acid (3,4-$^{13}C_2$, 99%)	0.25 g
CLM-1800-H	L-Glutamic acid ($^{13}C_5$, 99%)	0.1 mg, 0.25 g, 0.5 g, 1 g
DLM-3725	L-Glutamic acid (2,4,4-D_3, 97-98%)	0.5 g
DLM-556	L-Glutamic acid (2,3,3,4,4-D_5, 98%)	0.05 g, 0.1 g
NLM-135	L-Glutamic acid (^{15}N, 98%)	0.5 g, 1 g
CNLM-7812	L-Glutamic acid (1-^{13}C, 99%; ^{15}N, 98%)	0.25 g
CNLM-554-H	L-Glutamic acid ($^{13}C_5$, 99%; ^{15}N, 99%)	0.25 g, 0.5 g, 1 g
DNLM-6996	L-Glutamic acid (2,3,3,4,4-D_5, 98%; ^{15}N, 98%)	0.25 g, 0.5 g
CDNLM-6804	L-Glutamic acid ($^{13}C_5$, 97-99%; D_5, 97-99%; ^{15}N, 97-99%)	0.25 g
ULM-8675	L-Glutamic acid (unlabeled)	0.1 mg
CLM-6664	L-Glutamic acid, *N*-acetyl (glutamate-$^{13}C_5$, 97-99%)	Please inquire
OLM-8028	L-Glutamic acid·HCl ($^{17}O_4$, ~30%)	Please inquire
DLM-2911	Histamine·2HCl (α,α,β,β-D_4, 98%)	10 mg
CLM-373	Homovanillic acid (1,2-$^{13}C_2$, 98-99%)	0.1 g
DLM-2738	Homovanillic acid (phenyl-D_3, 2,2-D_2, 96-98%)	0.1 g
COLM-376	Homovanillic acid (ring-$^{13}C_6$, 99%; 4-hydroxy-^{18}O, 90-95%)	0.01 g

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
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Catalog No.	Description	Unit Size
CLM-10900	Homovanillic acid, sodium salt (1,2-$^{13}C_2$, 98-99%)	Please inquire
ULM-10577	Homovanillic acid, sodium salt (unlabeled)	Please inquire
CLM-9936-C	5-Hydroxyindole-3-acetic acid (3α,4,5,6,7,7α-$^{13}C_6$, 98%) 100 µg/mL in methanol	1 mL
CLM-9936	5-Hydroxyindole 3-acetic acid (3α,4,5,6,7,7α-$^{13}C_6$, 98%)	Please inquire
DLM-11029	*N*-acetyl-5-Hydroxytryptamine (*N*-acetylserotonin) (acetyl-D_3, 98%)	Please inquire
DLM-7101	Melatonin (acetyl-D_3, 98%)	5 mg, 10 mg
DLM-3560	DL-Metanephrine·HCl (α,β,β-D_3, 98%)	5 mg, 10 mg
DLM-2950	*N*-τ-Methylhistamine·2HCl (*N*-methyl-D_3, 98%)	0.1 g
DLM-8820	DL-Norepinephrine·HCl (ring-D_3,1,2,2-D_3, 99%)	5 mg, 10 mg
DLM-8609	DL-Normetanephrine·HCl (α,β,β-D_3, 98%)	5 mg, 10 mg
DLM-2993	2-Phenylethylamine (2,2-D_2, 95%)	Please inquire
DLM-11030	Serotonin·HCl (α,α,β,β-D_4, 98%) CP 96%	Please inquire
CLM-6622	Taurine (1,2-$^{13}C_2$, 98%)	0.25 g, 0.5 g
DLM-8057	Taurine (D_4, 98%) CP 95%	0.1 g, 0.25 g
NLM-4472	Taurine (^{15}N, 98%)	Please inquire
CNLM-10253	Taurine ($^{13}C_2$, 99%; ^{15}N, 98%)	0.01 g
DLM-8075	Tyramine·HCl (1,1,2,2-D_4, 98%)	Please inquire
DLM-4794	DL-Vanilmandelic acid (VMA) (ring-D_3, 98%)	0.1 g

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Nucleic Acids

Nucleic acids are necessary biomolecules of living systems being fundamentally important to a multitude of cellular processes. Its basic building blocks are nucleobases (e.g., adenine, cytosine, xanthine), nucleosides (e.g., adenosine, guanosine, inosine), and nucleotides (e.g., ATP, CDP, dGTP). The qualification/quantification of these compounds, and their synthetic analogues (e.g., 5-fluorouracil), in biosamples is performed preclinically and clinically to address a number of purposes. This includes the screening of metabolic errors and the efficacy evaluation of drug treatments (be it anticancer, antiviral, or immunosuppressive), among other target areas.

CIL offers an array of stable isotope-labeled nucleic acid building blocks for MS- or NMR-based research. These standards are available in a variety of labeling patterns and quantities.

Catalog No.	Description	Unit Size
CLM-1654	Adenine (8-^{13}C, 95%)	0.5 g
NLM-6924	Adenine·HCl·½ H_2O ($^{15}N_5$, 98%)	10 mg
CLM-3698	Adenosine (ribose-2-^{13}C, 99%)	Please inquire
CLM-3678	Adenosine (ribose-$^{13}C_5$, 98%) CP 97%	0.05 g, 0.1 g
DLM-7676	Adenosine (ribose-1-D, 98%)	Please inquire
DLM-7677	Adenosine (ribose-2-D, 97%)	Please inquire
DLM-7678	Adenosine (ribose-5,5-D_2, 98%)	Please inquire
NLM-9750-SL	Adenosine (U-$^{15}N_5$, 96-98%)	10 mg, 50 mg
CNLM-3806-CA	Adenosine ($^{13}C_{10}$, 98%; $^{15}N_5$, 96-98%)	10 mg, 50 mg
CLM-3605	Adenosine·H_2O (ribose-1-^{13}C, 99%) CP 95%	0.1 g, 0.25 g
CLM-7674	Adenosine·H_2O (3′-^{13}C, 98%)	0.05 g, 0.1 g
NLM-3792-SL	Adenosine 5′-monophosphate, lithium salt (U-$^{15}N_5$, 96-98%)	10 mg, 50 mg
CNLM-3802-SL	Adenosine 5′-monophosphate (U-$^{13}C_{10}$, 98%; U-$^{15}N_5$, 96-98%)	10 mg, 50 mg
CLM-8426-CA	Adenosine 5′-triphosphate (ATP), ammonium salt ($^{13}C_{10}$, 99%) (in solution) CP 95%	100 µmol
DLM-7514-CA	Adenosine 5′-triphosphate (ATP), ammonium salt (D, 97%) (in solution) CP 90%	20 µmol, 50 µmol, 100 µmol
DLM-8815-CA	Adenosine 5′-triphosphate (ATP), ammonium salt (2-D, 97%) (in solution) CP 90%	100 µmol
DLM-8922-CA	Adenosine 5′-triphosphate (ATP), ammonium salt (ribose-3′,4′,5′,5′-D_4, 98%) (in solution) CP 90%	20 µmol, 50 µmol, 100 µmol
NLM-3987-CA	Adenosine 5′-triphosphate (ATP), ammonium salt ($^{15}N_5$, 98-99%) (in solution) CP 90%	20 µmol, 100 µmol
CNLM-4265-CA	Adenosine 5′-triphosphate (ATP), ammonium salt ($^{13}C_{10}$, 98-99%; $^{15}N_5$, 98-99%) (in solution) CP 90%	20 µmol, 50 µmol, 100 µmol
DNLM-10985-CA	Adenosine 5′-triphosphate (ATP), ammonium salt ($^{15}N_5$, 98%; ribose-D_6, 98%) (in solution) CP 90%	100 µmol
CLM-3611	Cytidine (ribose-1-^{13}C, 99%)	Please inquire
CLM-3699	Cytidine (ribose-2-^{13}C, 99%)	Please inquire
CLM-3679	Cytidine (ribose-$^{13}C_5$, 98%)	0.05 g, 0.1 g
DLM-7681	Cytidine (ribose-5,5-D_2, 98%)	Please inquire
NLM-3797	Cytidine ($^{15}N_3$, 96-98%)	50 mg
CNLM-3807	Cytidine ($^{13}C_9$, 98%; $^{15}N_3$, 96-98%)	50 mg
DLM-9101-CA	Cytidine·H_2O (5,6-D_2, 98%) (as dry powder) CP 95%	Please inquire
NLM-3793-SL	Cytidine 5′-monophosphate, lithium salt (U-$^{15}N_3$, 96-98%) CP 90%	10 mg, 50 mg
CNLM-3803-SL	Cytidine 5′-monophosphate, lithium salt (U-$^{13}C_9$, 98%; U-$^{15}N_3$, 96-98%) (in solution) CP 90%	10 mg, 50 mg
CLM-10987-CA	Cytidine 5′-triphosphate (CTP), ammonium salt ($^{13}C_9$, 99%) (in solution) CP 95%	100 µmol
DLM-9267-CA	Cytidine 5′-triphosphate (CTP), ammonium salt (5,6-D_2, 97%) (in solution) CP 90%	100 µmol
DLM-8924-CA	Cytidine 5′-triphosphate (CTP), ammonium salt (5-D, ribose-3′,4′,5′,5′-D_4, 97%) (in solution) CP 90%	20 µmol, 50 µmol, 100 µmol
DLM-8594-CA	Cytidine 5′-triphosphate (CTP), ammonium salt (cytosine-5-D, 6-H; ribose-1,2,3,4,5,5-D_6, 96-97%)	100 µmol
DLM-7515-CA	Cytidine 5′-triphosphate (CTP), ammonium salt (D_8, 97%) (in solution) CP 90%	20 µmol, 50 µmol, 100 µmol
NLM-4266-CA	Cytidine 5′-triphosphate (CTP), ammonium salt ($^{15}N_3$, 96%) (in solution) CP 90%	20 µmol, 100 µmol
CNLM-4267-CA	Cytidine 5′-triphosphate (CTP), ammonium salt ($^{13}C_9$, 99%; $^{15}N_3$, 96-98%) (in solution) CP 90%	20 µmol, 50 µmol, 100 µmol
CLM-1001	Cytosine (2-^{13}C, 99%)	Please inquire
CNLM-4424	Cytosine (2-^{13}C, 99%; 1,3-$^{15}N_2$, 98%)	0.05 g
DLM-4750	2-Deoxy-D-ribose (5,5-D_2, 98%)	Please inquire
CLM-3700	2′-Deoxyadenosine·H_2O (deoxyribose-1-^{13}C, 99%)	Please inquire
CLM-3701	2′-Deoxyadenosine·H_2O (deoxyribose-2-^{13}C, 99%)	Please inquire
CLM-7682	2′-Deoxyadenosine·H_2O (ribose-5-^{13}C, 98%)	0.05 g, 0.1 g
CLM-4579	2′-Deoxyadenosine·H_2O (ribose-$^{13}C_5$, 99%)	Please inquire

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Catalog No.	Description	Unit Size
DLM-7683	2′-Deoxyadenosine·H_2O (ribose-5,5-D_2, 98%)	Please inquire
NLM-3895	2′-Deoxyadenosine·H_2O ($^{15}N_5$, 96-98%)	25 mg
CNLM-3896-CA	2′-Deoxyadenosine monohydrate ($^{13}C_{10}$, 98%; $^{15}N_5$, 96-98%)	5 mg, 10 mg, 25 mg
NLM-3919-SL	2′-Deoxyadenosine 5′-monophosphate (U-$^{15}N_5$, 98%)	10 mg, 50 mg
CNLM-3918-SL	2′-Deoxyadenosine 5′-monophosphate, lithium salt (U-$^{13}C_{10}$, 98%; U-$^{15}N_5$, 98%)	10 mg, 50 mg
NLM-6829	2′-Deoxyadenosine phosphoramidite ($^{15}N_5$, 98%) CP 95%	10 mg, 25 mg, 50 mg
CNLM-6828	2′-Deoxyadenosine phosphoramidite ($^{13}C_{10}$, 98%; $^{15}N_5$, 98%) CP 95%	10 mg, 25 mg, 50 mg
CNLM-6219-CA	2′-Deoxyadenosine 5′-triphosphate, ammonium salt ($^{13}C_{10}$, 98%; $^{15}N_5$, 96-98%) (in solution) CP 90%	20 µmol, 100 µmol
DLM-7507-SL	2′-Deoxyadenosine 5′-triphosphate, lithium salt (U-D, 97%) (in solution) CP 90%	10 mg, 50 mg
NLM-6215-SL	2′-Deoxyadenosine 5′-triphosphate, lithium salt (U-$^{15}N_5$, 98%) (in solution) CP 90%	10 mg, 50 mg
NLM-3897	2′-Deoxycytidine ($^{15}N_3$, 96-98%)	25 mg
CLM-7684	2′-Deoxycytidine·H_2O (ribose-1-^{13}C, 98%)	Please inquire
CLM-3702	2′-Deoxycytidine·H_2O (deoxyribose-2-^{13}C, 99%)	Please inquire
DLM-7685	2′-Deoxycytidine·H_2O (ribose-5,5-D_2, 98%)	Please inquire
NLM-3921	2′-Deoxycytidine 5′-monophosphate ($^{15}N_3$, 96%)	10 mg
NLM-6827	2′-Deoxycytidine phosphoramidite ($^{15}N_3$, 97-98%) CP 95%	10 mg, 25 mg, 50 mg
CNLM-6830	2′-Deoxycytidine phosphoramidite ($^{13}C_9$, 98%; $^{15}N_3$, 98%) CP 95%	10 mg, 25 mg, 50 mg
DLM-7508-SL	2′-Deoxycytidine 5′-triphosphate, dilithium salt (U-D, 97%) (in solution) CP 90%	10 mg, 50 mg
NLM-6216-SL	2′-Deoxycytidine 5′-triphosphate, lithium salt (U-$^{15}N_3$, 98%) (in solution) CP 90%	10 mg, 50 mg
CNLM-6220-SL	2′-Deoxycytidine 5′-triphosphate, lithium salt (U-$^{13}C_9$, 98%; U-$^{15}N_3$, 98%) (in solution) CP 90%	10 mg, 50 mg
CLM-7686	2′-Deoxyguanosine·H_2O (ribose-1-^{13}C, 98%)	Please inquire
DLM-7687	2′-Deoxyguanosine·H_2O (ribose-5,5-D_2, 98%)	Please inquire
NLM-3899-CA	2'-Deoxyguanosine·H_2O ($^{15}N_5$, 98%) CP 95%	Please inquire
CNLM-3900-CA	2′-Deoxyguanosine·H_2O ($^{13}C_{10}$, 98%; $^{15}N_5$, 96-98%)	5 mg, 10 mg, 25 mg
NLM-6826	2′-Deoxyguanosine phosphoramidite ($^{15}N_5$, 98%) CP 95%	10 mg, 25 mg, 50 mg
CNLM-6825	2′-Deoxyguanosine phosphoramidite ($^{13}C_{10}$, 98%; $^{15}N_5$, 98%) CP 95%	10 mg, 25 mg, 50 mg
NLM-6835-SL	2′-Deoxyguanosine 5′-monophosphate (U-$^{15}N_5$, 98%) (in solution) CP 90%	10 mg
CNLM-6836-SL	2′-Deoxyguanosine 5′-monophosphate (U-^{13}C, 98%; U-^{15}N, 98%)	10 mg, 50 mg
NLM-6217-CA	2′-Deoxyguanosine 5′-triphosphate, ammonium salt ($^{15}N_5$, 98-99%) (in solution) CP 90%	100 µmol
CNLM-6221-CA	2′-Deoxyguanosine 5′-triphosphate, ammonium salt ($^{13}C_{10}$, 98%; $^{15}N_5$, 96-98%) CP 90%	100 µmol
DLM-7509-SL	2′-Deoxyguanosine 5′-triphosphate, dilithium salt (U-D, 97%) (in solution) CP 90%	10 mg, 50 mg
CNLM-7871-SL	Set of 4: 2′-Deoxyribonucleoside 5′-monophosphates (U-^{13}C, 98%; U-^{15}N, 98%) (in solution) CP 90%	4 × 10 mg
NLM-7512-SL	Set of 4: 2′-Deoxyribonucleoside 5′-triphosphates, lithium salt (U-^{15}N, 98%) (in solution) CP 90%	4 × 10 mg, 4 × 50 mg
CNLM-7513-SL	Set of 4: 2′-Deoxyribonucleoside 5′-triphosphates (U-^{13}C, 98%; U-^{15}N, 98%) (in solution) CP 90%	4 × 10 mg, 4 × 50 mg
DLM-7511-SL	Set of 4: 2′-Deoxyribonucleoside 5′-triphosphates, lithium salt (U-D, 98%) (in solution) CP 90%	4 × 10 mg, 4 × 50 mg
CNLM-8771-CA	2′-Deoxyuridine·ammonium salt ($^{13}C_9$, 98-99%; $^{15}N_2$, 98-99%) (in solution) CP 90%	25 µmol, 50 µmol, 100 µmol
DLM-4391	5,6-Dihydrothymine (5,6,6-D_3, methyl-D_3, 95%)	50 mg
CNLM-4510	5,6-Dihydrouracil ($^{13}C_4$, 99%; $^{15}N_2$, 98%)	25 mg
DLM-7862	Equimolar mix: ATP, GTP (ribose-3′,4′,5′,5″-D_4, 98%), CTP, UTP (5-D, ribose-3′,4′,5′,5″"-D_4, 98%) NH_4^+ salt	100 mg
CNLM-3752	Fapyadenine (formyl-^{13}C, 98%; diamino-$^{15}N_2$, 98%)	25 mg
CNLM-3858	Fapyguanine (formyl-^{13}C, 99%; 4-amino-5-amido-$^{15}N_2$, 98%)	Please inquire
NLM-798	5-Fluorouracil (1,3-$^{15}N_2$, 99%)	Please inquire
CNLM-3916	5-Fluorouracil ($^{13}C_4$, 99%; $^{15}N_2$, 98%)	10 mg
DLM-1846	Guanidine·DCl (D_6, 98%)	1 g
NLM-6723	Guanidine·HBr ($^{15}N_3$, 98%)	Please inquire
CLM-1019	Guanine (8-^{13}C, 98%)	0.5 g
NLM-6925	Guanine ($^{15}N_5$, 98%)	10 mg
CNLM-3990	Guanine (8-^{13}C, 98%; 7,9-$^{15}N_2$, 98%)	25 mg
CLM-7688	Guanosine·H_2O (ribose-1-^{13}C, 98%)	Please inquire
DLM-7689	Guanosine·H_2O (ribose-5,5-D_2, 98%)	Please inquire
CNLM-3808-CA	Guanosine·H_2O ($^{13}C_{10}$, 98%; $^{15}N_5$, 96-98%)	5 mg, 10 mg, 25 mg

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
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Nucleic Acids *(continued)*

Catalog No.	Description	Unit Size
NLM-3798	Guanosine·$2H_2O$ ($^{15}N_5$, 96-98%)	50 mg
CNLM-3804-SL	Guanosine 5′-monophosphate, lithium salt (U-$^{13}C_{10}$, 98%; U-$^{15}N_5$, 98%) (in solution) CP 90%	10 mg, 50 mg
NLM-3794-SL	Guanosine 5′-monophosphate, lyophilized powder (U-$^{15}N_5$, 98%) CP 90%	10 mg, 50 mg
CLM-10988-CA	Guanosine 5′-triphosphate (GTP), ammonium salt ($^{13}C_{10}$, 99%) (in solution) CP 90%	100 µmol
DLM-7516-CA	Guanosine 5′-triphosphate (GTP), ammonium salt (D, 97%) (in solution) CP 90%	20 µmol, 50 µmol,100 µmol
DLM-8923-CA	Guanosine 5′-triphosphate (GTP), ammonium salt (ribose-3′,4′,5′,5′-D_4, 98%) (in solution) CP 90%	20 µmol, 50 µmol,100 µmol
NLM-4268-CA	Guanosine 5′-triphosphate (GTP), ammonium salt ($^{15}N_5$, 98-99%) (in solution) CP 90%	20 µmol, 100 µmol
CNLM-4269-CA	Guanosine 5′-triphosphate (GTP), ammonium salt ($^{13}C_{10}$, 99%; $^{15}N_5$, 98%) (in solution) CP 90%	20 µmol, 50 µmol,100 µmol
DNLM-10913-CA	Guanosine 5′-triphosphate (GTP), ammonium salt (ribose-1′,2′,3′,4′,5′,5″-D_6, 98%; $^{15}N_5$, 98%) (in solution) CP 90%	100 µmol
NLM-6715	8-Hydroxy-2′-deoxyguanosine ($^{15}N_5$, 98%) CP 95%	0.1 mg, 1 mg
CNLM-4392	5-Hydroxycytosine (2-^{13}C, 99%; 1,3-$^{15}N_2$, 98%)	25 mg, 50 mg
DLM-10484	5-Hydroxymethyl-2'-deoxycytidine (hydroxymethyl-D_2, 6-D, 98%)	Please inquire
CLM-8042	Hypoxanthine ($^{13}C_5$, 99%)	0.1 mg, 10 mg
DLM-8658	Hypoxanthine (2,8-D_2, 98%)	0.1 g
DLM-2923	Hypoxanthine (2,8,9-D_3, OD, 98%)	0.1 g
NLM-8500	Hypoxanthine ($^{15}N_4$, 98%)	Please inquire
CNLM-7894	Hypoxanthine ($^{13}C_5$, 99%; $^{15}N_4$, 98%)	10 mg
NLM-4264	Inosine ($^{15}N_4$, 95%)	0.01 g, 0.05 g
NLM-8712-CA	Inosine 5′-monophosphate, ammonium salt ($^{15}N_4$, 98-99%) (in solution) CP 90%	100 µmol
DLM-7471	3-Methyladenine (methyl-D_3, 98%)	50 mg
DLM-7472	7-Methylguanine (methyl-D_3, 98%)	10 mg
DLM-7473	6-*O*-Methylguanine (methyl-D_3, 98%)	10 mg
CLM-10671	Nicotinamide adenine dinucleotide (NAD^+), NH_4 salt (ribose-$^{13}C_5$, 98%) CP 96%	0.5 mg, 1 mg
CLM-9427-CA	1-(5′-Phosphoribosyl)-5-amino-4-imidazole-carboxamide salt ($2NH_4^+$) (ribose-$^{13}C_5$, 99%) CP 90%	100 µmol
DLM-7518-CA	Set of 4: Ribonucleoside 5′-triphosphates, ammonium salt (U-D, 98%) (in solution) CP 90%	4 × 20 µmol, 4 × 50 µmol, 4 × 100 µmol
NLM-7519-CA	Set of 4: 2′-Ribonucleoside 5′-triphosphates, ammonium salt (U-^{15}N, 98%) (in solution) CP 90%	4 × 100 µmol
CNLM-7503-CA	Set of 4: 2′-Ribonucleoside 5′-triphosphates, ammonium salt (U-^{13}C, U-^{15}N; 98-99%) (in solution) CP 90%	4 × 20 µmol, 4 × 50 µmol, 4 × 100 µmol
CLM-3629	Ribothymidine (ribose-1-^{13}C, 99%)	Please inquire
NLM-7565-SL	RNA standard (^{15}N, 98%)	1 mg
DLM-10436	Theobromine (3,7-dimethylxanthine) (7-methyl-D_3, 98%)	Please inquire
CLM-3647	Thymidine (methyl-^{13}C, 98%)	0.25 g, 0.5 g
CLM-4289	Thymidine (deoxyribose-1-^{13}C, 99%)	Please inquire
CLM-3703	Thymidine (deoxyribose-2-^{13}C, 99%)	Please inquire
CLM-7692	Thymidine (deoxyribose-3-^{13}C, 99%)	Please inquire
DLM-7691	Thymidine (ribose-5,5-D_2, 98%)	Please inquire
DLM-3327	Thymidine (methyl-D_3, ring-6-D, 97%) CP 95%	Please inquire
NLM-3901	Thymidine ($^{15}N_2$, 96-98%)	25 mg
CNLM-3902	Thymidine ($^{13}C_{10}$, 98%; $^{15}N_2$, 96-98%)	25 mg
NLM-10691	α-Thymidine ($^{15}N_2$, 98%)	Please inquire
NLM-6823	Thymidine phosphoramidite ($^{15}N_2$, 96-98%) CP 95%	10 mg, 25 mg, 50 mg
CNLM-6824	Thymidine phosphoramidite ($^{13}C_{10}$, 98%; $^{15}N_2$, 98%) CP 95%	10 mg, 25 mg, 50 mg
NLM-3925	Thymidine 5′-monophosphate ($^{15}N_2$, 98%)	10 mg
CNLM-3924-SL	Thymidine 5′-monophosphate (U-$^{13}C_{10}$, 98%; U-$^{15}N_2$, 98%)	10 mg, 50 mg
DLM-7510-SL	Thymidine 5′-triphosphate, lithium salt (U-D, 97%) (in solution) CP 90%	10 mg, 50 mg
NLM-6218-SL	Thymidine 5′-triphosphate, lithium salt (U-$^{15}N_2$, 98%) (in solution) CP 90%	10 mg, 50 mg
CNLM-6222-SL	Thymidine 5′-triphosphate, lithium salt (U-$^{13}C_{10}$, 98%; U-$^{15}N_2$, 98%) (in solution) CP 90%	10 mg, 50 mg
CLM-3764	Thymine (6-^{13}C, 99%)	0.25 g
DLM-1089	Thymine (α,α,α,6-D_4, 98%)	1 g
NLM-3995	Thymine (1,3-$^{15}N_2$, 98%)	0.1 g
CNLM-6945	Thymine ($^{13}C_5$, 98%; $^{15}N_2$, 98%)	Please inquire

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Catalog No.	Description	Unit Size
CLM-10507	Uracil ($^{13}C_4$, 99%)	Please inquire
NLM-637	Uracil (1,3-$^{15}N_2$, 98%)	0.25 g, 0.5 g
NLM-1697	Uric acid (1,3-$^{15}N_2$, 98%)	0.1 g, 0.5 g
CNLM-10617	Uric acid (2-^{13}C, 98%; 1,3,7-$^{15}N_3$, 98%) CP 95%	1 mg
CLM-3276	Uracil (2-^{13}C, 99%)	0.1 g
CLM-692	Uracil (4,5-$^{13}C_2$, 99%)	0.25 g
DLM-8633	Uracil (5-D, 98%)	0.1 g, 0.25 g
DLM-8502	Uracil (5,6-D_2, 98%)	0.1 g, 0.25 g
CNLM-3917	Uracil ($^{13}C_4$, 99%; $^{15}N_2$, 98%)	0.1 g
NLM-10910	Uric acid, sodium salt ($^{15}N_2$, 98%) CP 95%	Please inquire
CLM-3630	Uridine (ribose-1-^{13}C, 99%)	0.05 g, 0.1 g
CLM-3680	Uridine (ribose-$^{13}C_5$, 98%)	Please inquire
DLM-7693	Uridine (ribose-5,5-D_2, 98%)	Please inquire
NLM-812	Uridine ($^{15}N_2$, 98%)	25 mg
CNLM-3809	Uridine ($^{13}C_9$, 98%; $^{15}N_2$, 96-98%)	Please inquire
CLM-10513	Uridine diphosphate-α-D-glucose, disodium salt (glucose-$^{13}C_6$, 99%)	Please inquire
NLM-3795	Uridine 5′-monophosphate ($^{15}N_2$, 96-98%)	10 mg
NLM-3795-SL	Uridine 5′-monophosphate, lithium salt (U-$^{15}N_2$, 96-98%)	10 mg
CNLM-3805-SL	Uridine 5′-monophosphate, lithium salt (U-$^{13}C_9$, 98%; U-$^{15}N_2$, 96-98%) (in solution) CP 90%	10 mg, 50 mg
CLM-10914-CA	Uridine 5′-triphosphate (UTP), ammonium salt ($^{13}C_9$, 99%) (in solution) CP 90%	100 µmol
DLM-9365-CA	Uridine 5′-triphosphate (UTP), ammonium salt (uracil-5-D, 98%) (in solution) CP 90%	100 µmol
DLM-9100-CA	Uridine 5′-triphosphate (UTP), ammonium salt (5,6-D_2, 98%) (in solution) CP 90%	100 µmol
DLM-8925-CA	Uridine 5′-triphosphate (UTP), ammonium salt (5-D, ribose-3′,4′,5′,5′-D_4, 98%) (in solution) CP 90%	20 µmol, 50 µmol, 100 µmol
DLM-8637-CA	Uridine 5′-triphosphate (UTP), ammonium salt (uracil-5-D, 6-H; ribose-1,2,3,4,5,5-D_6, 96-97%)	100 µmol
DLM-7517-CA	Uridine 5′-triphosphate (UTP), ammonium salt (D_8, 97%) (in solution) CP 90%	20 µmol, 50 µmol, 100 µmol
NLM-4270-CA	Uridine 5′-triphosphate (UTP), ammonium salt ($^{15}N_2$, 98-99%) (in solution) CP 90%	20 µmol, 100 µmol
CNLM-4271-CA	Uridine 5′-triphosphate (UTP), ammonium salt ($^{13}C_9$, 99%; $^{15}N_2$, 98%) (in solution) CP 90%	20 µmol, 50 µmol, 100 µmol
DNLM-10986-CA	Uridine 5′-triphosphate (UTP), ammonium salt (uracil-$^{15}N_2$, 98%; ribose-D_6, 98%) (in solution) CP 90%	100 µmol
NLM-1698	Xanthine (1,3-$^{15}N_2$, 98%) CP 90%	0.1 g
CLM-10530	Xanthosine ($^{13}C_5$, 98%) CP 95%	Please inquire
CLM-8700-CA	Xanthosine-5′-monophosphate, ammonium salt ($^{13}C_{10}$, 98%) (in solution) CP 90%	20 µmol, 100 µmol

“I have been extremely happy with all products and services that we’ve obtained from CIL. All stable isotope reagents have exceeded our expectations. We’ve also obtained custom services from CIL to complete some very challenging studies, and have found CIL flexible and willing to work with us to achieve our goals. In short, I have nothing but positive things to say about our experience with CIL and their products.”

Matthew Steinhauser, MD
Principle Investigator, Department of Medicine
Brigham and Women’s Hospital

“When my lab makes labeled RNA, we count on high yields and purity. We have been using $^{13}C/^{15}N$ ribonucleotide triphosphates (rNTPs) and selectively deuterated rNTPs from CIL for the past 10 years. We have always been very happy with the performance and quality of the CIL rNTPs. They are the gold standard.”

Samuel Butcher, PhD
Professor, Department of Chemistry
University of Wisconsin-Madison

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Organic Acids, Their Derivatives, and Their Conjugate Salts

Organic acids (OAs) play essential roles in energy metabolism pathways (e.g., glycolysis, tricarboxylic acid cycle), with the short-chained OAs emerging as important regulators of host immune response and transcriptional regulation.

To aid quantitative research in preclinical and clinical studies, CIL is pleased to offer a collection of stable isotope-labeled and unlabeled OAs and their conjugate salts. These encompass monocarboxylic (e.g., acetic, lactic), dicarboxylic (e.g., malic, succinic), and tricarboxylic (e.g., *cis*-aconitic, citric) acids.

Catalog No.	Description	Concentration	Unit Size
CLM-317	Acetic acid (1-^{13}C, 99%)	neat	1 g, 5 g
CLM-318	Acetic acid (2-^{13}C, 99%)	neat	1 g
CLM-113	Acetic acid (1,2-$^{13}C_2$, 99%)	neat	0.5 g, 1 g
CLM-9878	*trans*-Aconitic acid (2,4,4'-$^{13}C_3$, 99%) CP 95%	neat	Please inquire
CLM-11066	*cis*-Aconitic acid, tripotassium salt ($^{13}C_6$, 95%) CP 95%	neat	Please inquire
CLM-4723	Adipic acid ($^{13}C_6$, 99%)	neat	0.1 g
DLM-2905	Adipic acid (2,2,5,5-D_4, 98%)	neat	Please inquire
DLM-2632	Adipic acid (3,3,4,4-D_4, 98%)	neat	0.5 g, 1 g
DLM-2115	Adipic acid (D_{10}, 98%)	neat	Please inquire
CLM-10894	Adipic acid, disodium salt ($^{13}C_6$, 99%)	neat	0.1 mg
ULM-10893	Adipic acid, disodium salt (unlabeled) CP 95%	neat	0.1 mg
CLM-535	5-Aminolevulinic acid:HCl (4-^{13}C, 99%)	neat	0.05 g
CLM-1371	5-Aminolevulinic acid·HCl (5-^{13}C, 99%) CP 96%	neat	0.05 g, 0.1 g
CLM-7337	Citric acid (1,5-$^{13}C_2$, 98%)	neat	Please inquire
CLM-148	Citric acid (2,4-$^{13}C_2$, 99%)	neat	Please inquire
CLM-9876	Citric acid (1,5,6-carboxyl-$^{13}C_3$, 99%)	neat	0.1 mg, 0.1 g
CLM-9021	Citric acid ($^{13}C_6$, 99%) CP 97%	neat	Please inquire
DLM-3487	Citric acid (2,2,4,4-D_4, 98%)	neat	0.5 g
CLM-7933	Creatine (guanidino-^{13}C, 99%)	neat	0.1 g
DLM-1302	Creatine (methyl-D_3, 98%) CP 97%	neat	0.25 g
CLM-681	Ethyl acetoacetate (3-^{13}C, 99%)	neat	0.5 g, 1 g
CLM-1284	Formic acid (^{13}C, 99%) (<5% H_2O)	neat	0.5 g, 1 g, 5 g
DLM-743	Formic acid (formyl-D, 98%) (<5% H_2O)	neat	5 g
DLM-285	Formic acid (OD, 98%) (<5% D_2O)	neat	5 g
DLM-286	Formic acid (D_2, 98%) <5% D_2O	neat	5 g
CLM-1529	Fumaric acid ($^{13}C_4$, 99%)	neat	0.1 mg, 0.1 g
DLM-1539	Fumaric acid (2,3-D_2, 98%)	neat	5 g
DLM-7654	Fumaric acid (D_4, 98%)	neat	1 g
CDLM-6062	Fumaric acid (1-^{13}C, 99%; 2,3-D_2, 98%)	neat	Please inquire
CDLM-8473	Fumaric acid (1,4-$^{13}C_2$, 99%; 2,3-D_2, 98%)	neat	0.1 g
CLM-10890	Fumaric acid, disodium salt ($^{13}C_4$, 99%)	neat	Please inquire
DLM-3106	Glutaric acid (2,2,4,4-D_4, 98%)	neat	5 g
CLM-10351	DL-2-Hydroxyglutaric acid, disodium salt ($^{13}C_5$, 99%)	neat	1 mg, 10 mg
ULM-10479	DL-2-Hydroxyglutaric acid, disodium salt (unlabeled)	neat	0.01 g, 0.1 g
DLM-9104	(*RS*)-2-Hydroxyglutaric acid, disodium salt (2,3,3-D_3; OD, 98%) CP 95%	neat	0.1 g
CLM-6820	α-Ketobutyric acid, sodium salt (methyl-^{13}C, 99%)	neat	0.5 g
CLM-6164	α-Ketobutyric acid, sodium salt ($^{13}C_4$, 98%)	neat	0.5 g
CDLM-7318	α-Ketobutyric acid, sodium salt (methyl-^{13}C, 99%; 3,3-D_2, 98%)	neat	0.5 g, 1 g
CDLM-7353	α-Ketobutyric acid, sodium salt (4-^{13}C, 99%; 3,3,4,4-D_4, 98%)	neat	0.25 g
CDLM-4611	α-Ketobutyric acid, sodium salt ($^{13}C_4$, 98%; 3,3-D_2, 98%)	neat	0.1 g, 0.25 g
CLM-2411	α-Ketoglutaric acid ($^{13}C_5$, 99%) CP 90%	neat	10 mg, 0.1 g
DLM-9476	α-Ketoglutaric acid (D_6, 98%)	neat	0.01 g, 0.1 g
CLM-4442	α-Ketoglutaric acid, disodium salt (1,2,3,4-$^{13}C_4$, 99%) CP 97%	neat	0.1 mg, 10 mg, 0.1 g, 0.5 g
ULM-10648	α-Ketoglutaric acid, disodium salt hydrate (unlabeled) CP 90%	neat	0.1 mg
CLM-2093	α-Ketoisocaproic acid, sodium salt (1-^{13}C, 99%)	neat	1 g, 10 g
CLM-4826	α-Ketoisocaproic acid, sodium salt (1,2-$^{13}C_2$, 99%)	neat	0.1 g

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Catalog No.	Description	Concentration	Unit Size
DLM-4214	α-Ketoisocaproic acid, sodium salt (isopropyl-D_7, 98%)	neat	0.1 g, 0.25 g
CLM-4785	α-Ketoisocaproic acid, sodium salt ($^{13}C_6$, 99%)	neat	0.1 g
DLM-1944	α-Ketoisocaproic acid, sodium salt (methyl-D_3, 98%)	neat	0.5 g
CLM-6821	α-Ketoisovaleric acid, sodium salt (dimethyl-$^{13}C_2$, 99%)	neat	0.5 g
CLM-4418	α-Ketoisovaleric acid, sodium salt ($^{13}C_5$, 98%)	neat	0.25 g, 1 g
DLM-4646	α-Ketoisovaleric acid, sodium salt (D_7, 98%)	neat	Please inquire
CDLM-10647	α-Ketoisovaleric acid, sodium salt (dimethyl-$^{13}C_2$, 99%; 3-D, 98%)	neat	0.1 g, 0.5 g
CDLM-4418	α-Ketoisovaleric acid, sodium salt ($^{13}C_5$, 98%; 3-D, 98%)	neat	0.25 g
CDLM-7317	α-Ketoisovaleric acid, sodium salt (3-methyl-^{13}C, 99%; 3,4,4,4-D_4, 98%)	neat	0.5 g, 1 g
CDLM-7354	α-Ketoisovaleric acid, sodium salt (3-methyl-^{13}C, 99%; 3-methyl-D_2, 3,4,4,4-D_4, 98%)	neat	0.25 g
CDLM-8446	α-Ketoisovaleric acid, sodium salt (dimethyl-$^{13}C_2$, 98%; 3-methyl-D_2, 4,4-D_2, 98%)	neat	0.25 g
CDLM-8100	α-Ketoisovaleric acid, sodium salt (1,2,3,4-$^{13}C_4$, 99%; 3,4′,4′,4′-D_4, 97-98%)	neat	0.25 g
DLM-1129	Maleic acid (2,3-D_2, 98%)	neat	5 g
CLM-10892	Maleic acid, disodium salt monohydrate ($^{13}C_4$, 99%)	neat	Please inquire
CLM-310	Maleic anhydride (1,4-$^{13}C_2$, 99%)	neat	0.25 g
CLM-312	Maleic anhydride (2,3-$^{13}C_2$, 99%)	neat	0.1 g
CLM-6019	Maleic anhydride ($^{13}C_4$, 99%)	neat	Please inquire
DLM-1853	Maleic anhydride (D_2, 98%)	neat	1 g, 5 g
DLM-9045	DL-Malic acid (2,3,3-D_3, 98%)	neat	0.1 g
CLM-8065	L-Malic acid ($^{13}C_4$, 99%)	neat	0.1 mg
ULM-10964	L-Malic acid (unlabeled)	neat	0.1 mg
CLM-10826	Malic acid, disodium salt monohydrate ($^{13}C_4$, 99%)	neat	Please inquire
CLM-751	Malonic acid (2-^{13}C, 99%)	neat	0.5 g, 1 g
CLM-1248	Malonic acid (1,3-$^{13}C_2$, 99%)	neat	0.25, 0.5 g, 1 g
CLM-6123	Malonic acid ($^{13}C_3$, 99%)	neat	0.25 g
DLM-205	Malonic acid (D_4, 98%)	neat	50 g
CLM-10887	Malonic acid, disodium salt ($^{13}C_3$, 99%)	neat	Please inquire
DLM-2312	DL-2-Methylcitric acid (methyl-D_3, 98%) CP 90%	neat	5 mg, 10 mg
CLM-4285	3-Methylglutaconic acid (2,4-$^{13}C_2$, 3-methyl-^{13}C, 99%) (*cis*/*trans* mix)	neat	5 mg
CLM-10398-D	2-Methylglutaric acid (4,5-$^{13}C_2$, 98%) CP 95%	1 mg/mL in methanol	1 mL
CLM-10398	2-Methylglutaric acid (4,5-$^{13}C_2$, 98%) CP 95%	neat	Please inquire
CLM-9426	Methylmalonic acid ($^{13}C_4$, 99%)	neat	0.1 g
DLM-387	Methylmalonic acid (methyl-D_3, 98%)	neat	0.25 g
CLM-10895	Methylmalonic acid, disodium salt ($^{13}C_4$, 99%)	neat	Please inquire
ULM-10578	Methylmalonic acid, disodium salt (unlabeled) CP 95%	neat	Please inquire
NLM-10907	Orotic acid, sodium salt ($^{15}N_2$, 98%)	neat	Please inquire
NLM-1048	Orotic acid·H_2O (1,3-$^{15}N_2$, 98%)	neat	0.1 mg, 0.25 g
CNLM-10662	Orotic acid·H_2O (2-^{13}C, 99%; 1,3-$^{15}N_2$, 98%)	neat	Please inquire
CLM-4449	Oxalic acid, disodium salt (1,2-$^{13}C_2$, 99%)	neat	1 g
CLM-10902	Phthalic acid, disodium salt ($^{13}C_4$, 99%)	neat	Please inquire
CLM-3551	Potassium phosphoenol pyruvate (2-^{13}C, 99%)	neat	Please inquire
CLM-2723	Potassium phosphoenol pyruvate (3-^{13}C, 99%)	neat	Please inquire
CLM-3398	Potassium phosphoenol pyruvate (2,3-$^{13}C_2$, 99%)	neat	0.05 g
CLM-646	Propionic acid (1-^{13}C, 99%)	neat	1 g
CLM-647	Propionic acid ($^{13}C_3$, 99%)	neat	1 g
DLM-2488	Propionic acid (2,2-D_2, 98%)	neat	1 g, 5 g
DLM-1137	Propionic acid (methyl-D_3, 98%)	neat	5 g
DLM-1919	Propionic acid (D_5, 98%)	neat	5 g
DLM-599	Propionic acid (D_6, 98%)	neat	Please inquire
CLM-8077	Pyruvic acid (1-^{13}C, 99%)	neat	1 g, 5 g
CLM-8849	Pyruvic acid (2-^{13}C, 99%)	neat	1 g, 5 g
CLM-9505	Pyruvic acid (1,2-$^{13}C_2$, 99%)	neat	1 g, 5 g
DLM-10675	Pyruvic acid (D_4, 98%)	neat	Please inquire

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Organic Acids, Their Derivatives, and Their Conjugate Salts *(continued)*

Catalog No.	Description	Concentration	Unit Size
CDLM-10674	Pyruvic acid (1-^{13}C, 99%; D_4, 98%)	neat	Please inquire
CLM-2471	Sodium acetate – ^{13}C depleted (1,2-$^{12}C_2$, 99.95%)	neat	Please inquire
CLM-156	Sodium acetate (1-^{13}C, 99%)	neat	1 g, 5 g, 10 g
CLM-381	Sodium acetate (2-^{13}C, 99%)	neat	1 g, 5 g, 10 g
CLM-440	Sodium acetate (1,2-$^{13}C_2$, 99%)	neat	1 g, 5 g
DLM-3126	Sodium acetate (D_3, 99%)	neat	25 g
OLM-1077	Sodium acetate ($^{18}O_2$, 95%)	neat	1 g
CDLM-611	Sodium acetate (1-^{13}C, 99%; D_3, 98%)	neat	1 g
CDLM-3457	Sodium acetate (1,2-$^{13}C_2$, 99%; D_3, 98%)	neat	1 g
CDLM-1240	Sodium acetate (2-^{13}C, 99%; D_3, 98%)	neat	1 g
COLM-1230	Sodium acetate (1-^{13}C, 99%; $^{18}O_2$, 96%)	neat	Please inquire
CLM-1256	Sodium butyrate (1-^{13}C, 99%)	neat	1 g, 5 g
CLM-10426	Sodium butyrate ($^{13}C_4$, 99%)	neat	0.1 g
DLM-641	Sodium butyrate (3,3,4,4,4-D_5, 98%)	neat	Please inquire
DLM-7616	Sodium butyrate (D_7, 98%)	neat	Please inquire
CLM-3780	Sodium dichloroacetate ($^{13}C_2$, 99%)	neat	Please inquire
CLM-583	Sodium formate (^{13}C, 99%)	neat	1 g, 5 g
OLM-8123	Sodium formate ($^{18}O_2$, 95%)	neat	0.5 g
CLM-3706	Sodium D-3-hydroxybutyrate (2,4-$^{13}C_2$, 99%)	neat	1 g
CLM-3853	Sodium D-3-hydroxybutyrate ($^{13}C_4$, 99%) CP 97%	neat	0.5 g
DLM-10415-D	Sodium DL-3-hydroxybutyrate (3,4,4,4-D_4, 98%) CP 95%	1 mg/mL in water	1 mL
CLM-10768	Sodium D-lactate ($^{13}C_3$, 98%)	20% w/w in water	Please inquire
CLM-1577	Sodium L-lactate (1-^{13}C, 99%)	20% w/w in water	1 g/compound
CLM-1578	Sodium L-lactate (3-^{13}C, 98%)	20% w/w in water	0.25 g/compound, 0.5 g/compound, 1 g/compound
CLM-1579	Sodium L-lactate ($^{13}C_3$, 98%)	20% w/w in water	0.5 g/compound
CLM-1579-N	Sodium L-lactate ($^{13}C_3$, 98%)	neat	0.1 mg
DLM-9071	Sodium L-lactate (3,3,3-D_3, 98%)	20% w/w in water	0.1 g/compound, 0.25 g/compound
CLM-771	Sodium propionate (1-^{13}C, 99%)	neat	1 g
CLM-1506	Sodium propionate (2-^{13}C, 99%)	neat	0.5 g, 1 g
CLM-4573	Sodium propionate (3-^{13}C, 99%)	neat	Please inquire
CLM-3042	Sodium propionate (2,3-$^{13}C_2$, 99%)	neat	Please inquire
CLM-1865	Sodium propionate ($^{13}C_3$, 99%)	neat	0.1 g
DLM-1601	Sodium propionate (D_5, 98%)	neat	1 g
CLM-1082	Sodium pyruvate (1-^{13}C, 99%)	neat	0.25 g, 0.5 g, 1 g
CLM-1580	Sodium pyruvate (2-^{13}C, 99%)	neat	0.5 g, 1 g
CLM-1575	Sodium pyruvate (3-^{13}C, 99%)	neat	0.25 g, 0.5 g, 1 g
CLM-3507	Sodium pyruvate (2,3-$^{13}C_2$, 99%)	neat	0.5 g, 1 g
CLM-2440	Sodium pyruvate ($^{13}C_3$, 99%)	neat	0.5 g, 1 g
DLM-6068	Sodium pyruvate (D_3, 97-98%)	neat	0.5 g, 1 g
CLM-1084	Succinic acid (1,4-$^{13}C_2$, 99%)	neat	0.25 g, 0.5 g, 1 g
CLM-1199	Succinic acid (2,3-$^{13}C_2$, 99%)	neat	1 g
CLM-1571	Succinic acid ($^{13}C_4$, 99%)	neat	0.1 g, 0.25 g, 0.1 mg
DLM-584	Succinic acid (D_4, 98%)	neat	5 g, 10 g
DLM-831	Succinic acid (D_6, 98%)	neat	5 g
CDLM-7754	Succinic acid ($^{13}C_4$, 99%; 2,2,3,3-D_4, 98%)	neat	Please inquire
CLM-9371	Succinic acid, disodium salt (2,3-$^{13}C_2$, 99%)	neat	1 g
DLM-2307	Succinic acid, disodium salt (D_4, 80%) CP 95%	neat	10 g, 25 g
CLM-6755	Succinylacetone (3,4,5,6,7-$^{13}C_5$, 99%)	neat	10 mg
NLM-1697	Uric acid (1,3-$^{15}N_2$, 98%)	neat	0.1 g, 0.5 g

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Other Compounds and Mixtures

CIL offers a breadth of other compounds and multicomponent mixtures that could find utility in clinical MS-based analyses. For additional compounds/mixes and product details, please refer to isotope.com.

Individual Standards (Examples)

Catalog No.	Description	Concentration	Unit Size
CLM-173	Acetaldehyde (1,2-$^{13}C_2$, 99%)	neat	0.5 g, 1 g
DLM-112	Acetaldehyde (D_4, 99%)	neat	1 g, 5 g
NLM-467	Ammonium chloride (^{15}N, 99%)	neat	1 g, 5 g, 10 g, 25 g, 50 g
NLM-711	Ammonium nitrate (ammonium-^{15}N, 98%)	neat	1 g
NLM-711-10	Ammonium nitrate (ammonium-^{15}N, 10%)	neat	Please inquire
NLM-712	Ammonium nitrate (nitrate-^{15}N, 98%)	neat	1 g
NLM-712-10	Ammonium nitrate (nitrate-^{15}N, 10%)	neat	Please inquire
NLM-390	Ammonium nitrate ($^{15}N_2$, 98%)	neat	1 g
NLM-390-10	Ammonium nitrate ($^{15}N_2$, 10%)	neat	Please inquire
NLM-390-5	Ammonium nitrate ($^{15}N_2$, 5%)	neat	Please inquire
NLM-713	Ammonium sulfate ($^{15}N_2$, 99%)	neat	1 g, 5 g, 10 g, 25 g, 50 g
NLM-713-10	Ammonium sulfate ($^{15}N_2$, 10%)	neat	50 g
NLM-713-5	Ammonium sulfate ($^{15}N_2$, 5%)	neat	Please inquire
DLM-1100	Ammonium sulfate (D_8, 98%)	neat	5 g, 10 g
CLM-8141	Arsenobetaine bromide (carboxymethyl-$^{13}C_2$, 99%) CP 90%	neat	Please inquire
CNLM-9695	5-Azacytosine (4,6-$^{13}C_2$, 98%; $^{15}N_4$, 98%)	neat	Please inquire
CLM-9435	*N*-(3-aminopropyl) Butane-1,4-diamine·3HCl (spermidine·3HCl) ($^{13}C_4$, 99%) CP 95%	neat	5 mg
ULM-10264	*N*-(3-aminopropyl) Butane-1,4-diamine (unlabeled) CP 95%	neat	1 mg, 5 mg, 10 mg
DLM-9262	*N,N′-bis*(3-aminopropyl)-1,4-Butanediamine·4HCl (1,1,2,2,3,3,4,4-D_8, 97%) CP 95%	neat	5 mg, 10 mg
ULM-10265	*N,N′*-bis(3-aminopropyl)-1,4-Butanediamine·4HCl (unlabeled) CP 95%	neat	1 mg, 5 mg, 10 mg
DLM-1109	*tert*-Butanol (anhydrous) (OD, 99%)	neat	25 g, 100 g
DLM-4862	Cacodylic acid (D_7, 98%)	neat	0.5 g
NLM-499	Calcium nitrate ($^{15}N_2$, 98%)	neat	1 g
NLM-499-10	Calcium nitrate ($^{15}N_2$, 10%)	neat	Please inquire
CLM-9256	(±)-Catechin (2,3,4-$^{13}C_3$, 99%)	neat	1 mg
CLM-10554	(±)-Catechin gallate (2,3,4-$^{13}C_3$, 99%) CP 97%	neat	1 mg
DLM-2816	Clozapine (4-methylpiperazinyl-D_4, 97%)	neat	5 mg, 10 mg
DLM-9786	*p*-Cresol sulfate, potassium salt (D_7, 98%) CP 95%	neat	10 mg
CNLM-4661-10X-1.2	Cyanuric acid ($^{13}C_3$, 99%; $^{15}N_3$, 98%) CP 90%	1000 µg/mL in water	1.2 mL
CNLM-4661-1.2	Cyanuric acid ($^{13}C_3$, 99%; $^{15}N_3$, 98%) CP 90%	100 µg/mL in water	1.2 mL
CLM-9255	1,3-Diaminobenzene ($^{13}C_6$, 99%) CP 95%	neat	Please inquire
CLM-10563	1,4-Diaminobenzene ($^{13}C_6$, 99%)	neat	Please inquire
DLM-10544	Desethylamodiaquine (ethyl-D_5, 97%)	neat	2 mg, 5 mg
DLM-2744	Enalaprilat·H_2O (phenyl-D_5, 98%)	neat	Please inquire
CLM-9257	(±)-Epicatechin (2,3,4-$^{13}C_3$,99%) CP 97%	neat	1 mg
ULM-10550	(±)-Epicatechin (unlabeled) CP 97%	neat	1 mg, 5 mg
CLM-10553	(±)-Epicatechin gallate (2,3,4-$^{13}C_3$, 99%) CP 97%	neat	1 mg
CLM-10555	(±)-Epigallocatechin (2,3,4-$^{13}C_3$, 99%) CP 97%	neat	1 mg
CLM-10551	(±)-Epigallocatechin gallate (2,3,4-$^{13}C_3$, 99%) CP 97%	neat	1 mg
CLM-344	Ethanol (1-^{13}C, 99%) <6% H_2O	neat	0.5 g, 1 g
CLM-130	Ethanol (2-^{13}C, 99%) <6% H_2O	neat	0.5 g, 1 g
CLM-551	Ethanol (1,2-$^{13}C_2$, 99%) <6% H_2O	neat	0.5 g, 1 g
DLM-552	Ethanolamine (1,1,2,2-D_4, 98%)	neat	0.1 g, 1 g
NLM-8722	Ethanolamine (^{15}N, 98%)	Please inquire	Please inquire
CLM-3911	Ethanolamine·HCl (1-^{13}C, 99%)	neat	1 g
CLM-274	Ethanolamine·HCl (1,2-$^{13}C_2$, 99%)	neat	0.1 g, 0.25 g

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Other Compounds and Mixtures *(continued)*

Catalog No.	Description	Concentration	Unit Size
CNLM-3446	Ethylenediamine·2HCl ($^{13}C_2$, 99%; $^{15}N_2$, 99%)	neat	Please inquire
CLM-9756	Galangin (2,3,4-$^{13}C_3$, 99%) CP 95%	neat	1 mg
ULM-10281	Galangin (unlabeled)	neat	1 mg
CLM-10556	(±)-Gallocatechin (2,3,4-$^{13}C_3$, 99%) CP 97%	neat	1 mg
CLM-10552	(±)-Gallocatechin gallate (2,3,4-$^{13}C_3$, 99%) CP 97%	neat	1 mg
CNLM-6245	Glutathione (glycine-$^{13}C_2$, 98%; ^{15}N, 96-99%) (65-70% net peptide) peptide purity 85-90%	neat	10 mg, 50 mg
CNLM-6245-HP	Glutathione (glycine-$^{13}C_2$, 98%; ^{15}N, 96-99%) (90% net peptide) peptide purity 95%	neat	10 mg
CNLM-8782	Glutathione disulfide (glycines-$^{13}C_2$, 98%; ^{15}N, 96-99%) (65-70% net peptide 90%) peptide purity 90%	neat	Please inquire
DLM-558	Glycerol (D_8, 99%)	neat	1 g, 5 g
DLM-1326	Glycerol [$(OD)_3$, 98%]	neat	5 g, 10 g
NLM-6723	Guanidine·HBr ($^{15}N_3$, 98%)	neat	0.1 g
CLM-10368	Hydrocinnamic acid (1-^{13}C, 99%)	neat	Please inquire
CLM-8877	Hydrocinnamic acid (1,2,3-$^{13}C_3$, 99%)	neat	0.1 g
CNLM-10399	DL-3-Hydroxykynurenine (1,2,3-$^{13}C_3$, 98%; α-amino-^{15}N, 98%) CP 95%	neat	1 mg
CLM-9260	4-Hydroxy-3-methoxycinnamic acid (1′,2′,3′-$^{13}C_3$, 99%)	neat	1 mg, 5 mg
DLM-3033	Imidazole (D_4, 98%)	neat	1 g, 5 g
CLM-11040	Kaempferol (U-^{13}C, 98%)	neat	Please inquire
NLM-10806	Lactose ureide·$2H_2O$ ($^{15}N_2$, 95%)	neat	Please inquire
CLM-7613	*trans*-Lycopene (8,8′,9,9′,10,10′,11,11′,19,19′-$^{13}C_{10}$, 99%)	neat	Please inquire
CNLM-8150-10X-1.2	Melamine ($^{13}C_3$, 99%; amino-$^{15}N_3$, 98%)	1000 µg/mL in water	1.2 mL
CNLM-8150-1.2	Melamine ($^{13}C_3$, 99%; amino-$^{15}N_3$, 98%)	100 µg/mL in water	1.2 mL
DLM-7101	Melatonin (acetyl-D_3, 98%)	neat	5 mg, 10 mg
CLM-359	Methanol (^{13}C, 99%)	neat	1 g, 5 g
DLM-1211	Methanol (D, 98%)	neat	5 g
DLM-1209	Methanol (D_2, 98%)	neat	5 g
CDLM-1035	Methanol (^{13}C, 99%; D_3, 98%)	Please inquire	Please inquire
DLM-651	Methyl formate (formyl-D, 99%)	neat	5 g, 10 g
CLM-10408	*N*-Phenyl-1-napthylamine (phenyl-$^{13}C_6$, 98%)	neat	1 mg
CLM-10409	*N*-Phenyl-2-napthylamine (phenyl-$^{13}C_6$, 98%)	neat	1 mg
CLM-7831	(±)-Pantoprazole, sodium salt sesquihydrate (pyridyl-4-methoxy-^{13}C, 98%)	neat	Please inquire
NLM-765	Potassium nitrate (^{15}N, 99%)	neat	1 g
NLM-765-10	Potassium nitrate (^{15}N, 10%)	neat	Please inquire
CLM-222	Potassium thiocyanate (^{13}C, 95-99%) CP 95%	neat	0.5 g, 1 g
CNLM-3952	Potassium thiocyanate (^{13}C, 99%; ^{15}N, 98%)	neat	0.5 g
DLM-10542	Resorufin (D_6, 98%) CP 96%	neat	10 mg, 50 mg
CLM-9259	Resveratrol (4-hydroxyphenyl-$^{13}C_6$, 99%)	neat	1 mg, 5 mg, 10 mg
DLM-3579	Serotonin creatinine sulfate complex (α,α,β,β-D_4, 98%)	neat	Please inquire
CLM-441	Sodium bicarbonate (^{13}C, 99%)	neat	1 g, 5 g
CLM-3780	Sodium dichloroacetate ($^{13}C_2$, 99%)	neat	Please inquire
CLM-9676	Sodium isopropyl carbonate (carbonyl-^{13}C, 99%)	neat	Please inquire
NLM-157	Sodium nitrate (^{15}N, 98%)	neat	1 g, 5 g
CLM-796	Vanillic acid (carboxyl-^{13}C, 99%)	neat	0.1 g
CLM-1867	Vanillic acid (ring-$^{13}C_6$, 99%)	neat	0.1 g
CLM-10417	Toxoflavin (3,4α,5,8α-$^{13}C_4$, 98%) CP 95%	neat	1 mg
DLM-4779	Trimethylamine *N*-oxide (D_9, 98%)	neat	1 g

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Metabolomics Mixtures and Kits

Catalog No.	Description	Unit Size
IROA-100-50	IROA 100 for Yeast/Fungi Metabolic Profiling ^{13}C Biochemical Quantitation Kit	1 kit
IROA-200-50	IROA 200 for Bacterial Metabolic Profiling ^{13}C Biochemical Quantitation Kit	1 kit
IROA-300-250	IROA 300 for Mammalian Metabolic Profiling ^{13}C Biochemical Quantitation Kit	1 kit
IROA-PHENO-95-300	IROA 300 for Phenotypic Metabolic Profiling ^{13}C Biochemical Quantitation Kit	1 kit
IROA-FLUX-05-300	IROA 300 for Fluxomic Metabolic Profiling ^{13}C Biochemical Quantitation Kit	1 kit
ISO1	Metabolite Yeast Extract (U-^{13}C, 98%)	1 kit
MSK-A2-1.2	Metabolomics Amino Acid Mix Standard	1.2 mL
MSK-CAA	Canonical Amino Acid Mix	1 vial
MSK-NCAA	Noncanonical Amino Acid Mix	1 vial
MSK-CRED-DD-KIT	Credentialed *E. coli* Cell Extract Kit (dried down)	1 kit
MSK-CRED-KIT	Credentialed *E. coli* Cell Extract Kit (solution)	1 kit
MSK-OA	Organic Acid Mix	1 vial
MSK-OA1	Keto Acid Mix	1 vial
MSK-OA2	Diacid Mix	1 vial
MSK-OA3	Monoacid Mix	1 vial
MSK-OA4	Hydroxy Acid Mix	1 vial
MSK-OA5	Aromatic Acid Mix	1 vial
MSK-OA6	Other Acid Mix	1 vial
MSK-OA7	Other Organic Acid Mix	1 vial
MSK-QC-KIT	Metabolomics QC Kit	1 kit
MSK-QC1	Metabolomics QC Standard 1	1 vial
MSK-QC2	Metabolomics QC Standard 2	1 vial
MSK-QReSS-KIT	Metabolomics QReSS Kit	1 kit
MSK-QReSS1-1	Metabolomics QReSS Standard 1	1 vial
MSK-QReSS2-1	Metabolomics QReSS Standard 2	1 vial

Companion unlabeled standard mixes and kits are also available; please inquire.

“CIL has greatly facilitated our clinical research by supplying specially designed labeled compounds. We have made great progress in our neonatal antioxidant research program by the provision of labeled glutathione by CIL.”

Frans W.J. te Braake, PhD
Erasmus MC, Sophia Children’s Hospital

“Much like electrons, those extra neutrons make my world go ‘round.”

Andy Hoofnagle, MD, PhD
Professor of Lab Medicine at University of Washington

“I have used products from Cambridge Isotope Laboratories (CIL) for well over 15 years because of the high-quality provided. Recently, I have collaborated with CIL to develop a new product that would enable improved quality control in MS metabolomics. This process was exciting and engaging. Through collaboration, I found CIL to be a cutting-edge vendor that seeks opportunities to enable scientific discovery and data quality. They seek advice from clients to learn how to better serve them. I always look forward to talking with CIL at conferences and often seek out their booth to visit, not just to talk science, but to also see how their team is doing.”

Timothy J. Garrett, PhD
Associate Professor in Department of Pathology, Immunology, and Laboratory Medicine
University of Florida

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PeptiQuant™ Plus Assay Kits

Researchers in academia and life science industries continue to adopt a targeted, bottom-up MS-based workflow for protein biomarker evaluation. Biomarker verification/validation requires absolute quantification of surrogate peptides in the sample matrix, a requirement that is best achieved using well-characterized standards. To ensure robust quantitative measurement, quality control (QC) checks should be routinely performed.

CIL is pleased to offer a collection of PeptiQuant™ Assay Kits (from MRM Proteomics Inc.) for QC and biomarker assessment using bottom-up LC-MS/MS methodologies. The QC kits are designed to evaluate the performance of an LC-MS platform, either alone or in combination with a human or mouse plasma proteomic workflow. The biomarker assessment kits (BAKs) are intended to help researchers screen target panels of candidate protein disease biomarkers in human or mouse plasma samples. Current platform-specific kit offerings are listed below.

Quality Control (QC) Kits

Catalog No.	Description	Unit Size
LCMSP-QC-6490-INJ	PeptiQuant Plus Human Plasma Daily QC Kit for Agilent 6490 QqQ and 1290 UPLC	10, 20, or 50 injections
LCMSP-QC-6495-INJ	PeptiQuant Plus Human Plasma Daily QC Kit for Agilent 6495 QqQ and 1290 UPLC	10, 20, or 50 injections
LCMSP-QC-6500-INJ	PeptiQuant Plus Human Plasma Daily QC Kit for Sciex QTRAP® 6500 and 1290 UPLC	10, 20, or 50 injections
LCMSP-QC-QE-INJ	PeptiQuant Plus Human Plasma Daily QC Kit for Thermo Scientific™ Q Exactive™ Plus and 1290 UPLC	10, 20, or 50 injections
WFPK-A6490-P	PeptiQuant Plus Human Plasma Workflow QC Kit for Agilent 6490 QqQ and 1290 UPLC	1 or 2 runs
WFPK-A6495-P	PeptiQuant Plus Human Plasma Workflow QC Kit for Agilent 6495 QqQ and 1290 UPLC	1 or 2 runs
WFPK-SC6500-P	PeptiQuant Plus Human Plasma Workflow QC Kit for Sciex QTRAP 6500 and 1290 UPLC	1 or 2 runs
WFPK-QE-P	PeptiQuant Plus Human Plasma Workflow QC Kit for Thermo Scientific Q Exactive Plus and 1290 UPLC	1 or 2 runs

“The PeptiQuant Plus Platform Performance Kit has proven to be a vital component of our everyday quality assurance that enables us to deliver high-quality targeted proteomics data in an accurate and timely manner. This kit has a ‘dilute and shoot’ operation and comes with vendor-specific LC-MRM/MS parameters and a Skyline analysis file for quick input and results output. Altogether, the performance kit is an excellent means to rapidly assess LC-MS performance that should become a routine staple in a proteomic user’s toolbox.”

Tasso Miliotis, PhD
Associate Principal Scientist at AstraZeneca Gothenburg

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Biomarker Assessment Kits (BAKs)

Catalog No.	Description	Unit Size
BAK-A6490-125	PeptiQuant Plus Human Plasma Proteomics Kit for Agilent 6490 QqQ and 1290 UPLC	20, 50, or 100 samples
BAK-A6495-125	PeptiQuant Plus Human Plasma Proteomics Kit for Agilent 6495 QqQ and 1290 UPLC	20, 50, or 100 samples
BAK-SC6500-125	PeptiQuant Plus Human Plasma Proteomics Kit for Sciex QTRAP 6500 and 1290 UPLC	20, 50, or 100 samples
BAK-QE-125	PeptiQuant Plus Human Plasma Proteomics Kit for Thermo Scientific Q Exactive Plus and 1290 UPLC	20, 50, or 100 samples
M-BAK-A6490-125	PeptiQuant Plus Mouse Plasma Proteomics Kit for Agilent 6490 QqQ and 1290 UPLC	20, 50, or 100 samples
M-BAK-A6490-125-2*	PeptiQuant Plus Mouse Plasma Proteomics Kit for Agilent 6490 QqQ and 1290 UPLC	20, 50, or 100 samples
M-BAK-A6490-125-3*	PeptiQuant Plus Mouse Plasma Proteomics Kit for Agilent 6490 QqQ and 1290 UPLC	20, 50, or 100 samples
M-BAK-A6495-125	PeptiQuant Plus Mouse Plasma Proteomics Kit for Agilent 6495 QqQ and 1290 UPLC	20, 50, or 100 samples
M-BAK-A6495-125-2*	PeptiQuant Plus Mouse Plasma Proteomics Kit for Agilent 6495 QqQ and 1290 UPLC	20, 50, or 100 samples
M-BAK-A6495-125-3*	PeptiQuant Plus Mouse Plasma Proteomics Kit for Agilent 6495 QqQ and 1290 UPLC	20, 50, or 100 samples
M-BAK-SC6500-125	PeptiQuant Plus Mouse Plasma Proteomics Kit for Sciex QTRAP 6500 and 1290 UPLC	20, 50, or 100 samples
M-BAK-6545-125-2*	PeptiQuant Plus Mouse Plasma Proteomics Kit for Agilent 6545 Q-tof and 1290 UPLC	20, 50, or 100 samples
M-BAK-QE-125	PeptiQuant Plus Mouse Plasma Proteomics Kit for Thermo Scientific Q Exactive Plus and 1290 UPLC	20, 50, or 100 samples
M-BAK-QE-125-2*	PeptiQuant Plus Mouse Plasma Proteomics Kit for Thermo Scientific Q Exactive Plus and 1290 UPLC	20, 50, or 100 samples
M-BAK-QE-125-3*	PeptiQuant Plus Mouse Plasma Proteomics Kit for Thermo Scientific Q Exactive Plus and 1290 UPLC	20, 50, or 100 samples

*The -2 and -3 demarcations refer to an alternate set of 125 target proteins.

PeptiQuant is a trademark of MRM Proteomics Inc.

“PeptiQuant Plus Assay Kits contain all the essential materials, including the standards and methods, for performing absolute protein quantification by LC-MRM/MS in a standardized way. The standard protocol helped us reduce the assay development time, while improve the reproducibility and precision of multiplex protein quantification. In addition to the biomarker assessment kits, the quality control kits enable the instrument performance and assay reproducibility to be monitored and assessed, which ultimately provided us confidence in the reliability of the quantification results.”

Elaine Wong, PhD
Scientific Officer at Queen Mary Hospital, Fu Lam, Hong Kong

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Protein Expression Reagents and Kits

The use of stable isotope-labeled proteins in MS- or NMR-based proteomics are useful standards as they exhibit similar physicochemical behavior as their endogenous (or natural) counterparts. Adding a labeled protein, either as an individual standard or as a mixture, at the beginning of a workflow can therefore help normalize for any variation that may occur throughout an analytical run. When used as quantitative standards, as is the case in preclinical and clinical MS applications, validated biomarkers can be screened for diagnostic or prognostic purposes.

To help facilitate the production of isotope-enriched recombinant proteins, CIL offers a diverse array of isotopically labeled prokaryotic and eukaryotic cell growth media. CIL also offers various wheat germ cell-free kits, such as the Premium Plus Expression Kit for MS, for protein expression. The listing below outlines our current offerings. The researcher perspective that follows discusses the different approaches to quantifying proteins using stable isotope-labeled proteins or peptides as internal standards.

Bacterial Cell Growth Media

Catalog No.	Description	Unit Size
CGM-1030P-C	Celtone Base Powder (^{13}C, 98%)	0.5 g, 1 g
CGM-1030P-N	Celtone Base Powder (^{15}N, 98%)	0.5 g, 1 g
CGM-1030P-D	Celtone Base Powder (D, 97%)	0.5 g, 1 g
CGM-1030P-CN	Celtone Base Powder (^{13}C, 98%; ^{15}N, 98%)	0.5 g, 1 g
CGM-1030P-DN	Celtone Base Powder (D, 97%; ^{15}N, 98%)	0.5 g, 1 g
CGM-1030P-CDN	Celtone Base Powder (^{13}C, 98%; D, 97%; ^{15}N, 98%)	0.5 g, 1 g
CGM-1030P-U	Celtone Base Powder (unlabeled)	1 g
CGM-1050P-C	Celtone Plus Base Powder (U-^{13}C, 97-99%)	1 g, 10 g
CGM-1050P-N	Celtone Plus Base Powder (U-^{15}N, 97-99%)	1 g
CGM-1050P-D	Celtone Plus Base Powder (U-D, 97%)	1 g
CGM-1050P-DN	Celtone Plus Base Powder (U-D, 97-99%; U-^{15}N, 97-99%)	1 g
CGM-1050P-CDN	Celtone Plus Base Powder (U-^{13}C, 97-99%; U-D, 97-99%; U-^{15}N, 97-99%)	1 g
CGM-1050P-U	Celtone Plus Base Powder (unlabeled)	1 g
CGM-1040-C	Celtone Complete Medium (^{13}C, 98%)	0.1 L, 1 L
CGM-1040-N	Celtone Complete Medium (^{15}N, 98%)	0.1 L, 1 L
CGM-1040-D	Celtone Complete Medium (D, 97%)	0.1 L, 1 L
CGM-1040-CN	Celtone Complete Medium (^{13}C, 98%; ^{15}N, 98%)	0.1 L, 1 L
CGM-1040-DN	Celtone Complete Medium (D, 97%; ^{15}N, 98%)	0.1 L, 1 L
CGM-1040-CDN	Celtone Complete Medium (^{13}C, 98%; D, 97%; ^{15}N, 98%)	0.1 L, 1 L
CGM-1040-U	Celtone Complete Medium (unlabeled)	0.1 L, 1 L
CGM-1000-C	BioExpress Cell Growth Media (U-^{13}C, 98%) 10x concentrate	100 mL kit
CGM-1000-N	BioExpress Cell Growth Media (U-^{15}N, 98%) 10x concentrate	100 mL kit
CGM-1000-D	BioExpress Cell Growth Media (U-D, 98%) 10x concentrate	100 mL kit
CGM-1000-CN	BioExpress Cell Growth Media (U-^{13}C, 98%; U-^{15}N, 98%) 10x concentrate	100 mL kit
CGM-1000-CD	BioExpress Cell Growth Media (U-^{13}C, 98%; U-D, 98%) 10x concentrate	100 mL kit
CGM-1000-DN	BioExpress Cell Growth Media (U-D, 98%; U-^{15}N, 98%) 10x concentrate	100 mL kit
CGM-1000-CDN	BioExpress Cell Growth Media (U-^{13}C, 98%; U-D, 98%, U-^{15}N, 98%) 10x concentrate	100 mL kit
CGM-1000-U	BioExpress Cell Growth Media (unlabeled) 10x concentrate	100 mL kit
CGM-1020-SL-C	E. coli-OD2 (^{13}C, 98%)	1 L
CGM-1020-SL-N	E. coli-OD2 (^{15}N, 98%)	1 L
CGM-1020-SL-D	E. coli-OD2 (D, 98%)	1 L
CGM-1020-SL-CN	E. coli-OD2 (^{13}C, 98%; ^{15}N, 98%)	1 L
CGM-1020-SL-CDN	E. coli-OD2 (^{13}C, 98%; D, 98%; ^{15}N, 98%)	1 L
CGM-1020-SL-U-S	E. coli-OD2 (unlabeled)	200 mL
CGM-3030-C	Spectra 9 (^{13}C, 98%)	0.5 L, 1 L
CGM-3030-N	Spectra 9 (^{15}N, 98%)	0.5 L, 1 L
CGM-3030-D	Spectra 9 (D, 97%)	0.5 L, 1 L
CGM-3030-CN	Spectra 9 (^{13}C, 98%; ^{15}N, 98%)	0.5 L, 1 L
CGM-3030-DN	Spectra 9 (D, 97%; ^{15}N, 98%)	0.5 L, 1 L
CGM-3030-CDN	Spectra 9 (^{13}C, 98%; D, 97%; ^{15}N, 98%)	0.5 L, 1 L
CGM-3030-U	Spectra 9 (unlabeled)	0.1 L, 1 L

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Minimal Media Reagents

Catalog No.	Description	Unit Size
NLM-467	Ammonium chloride (^{15}N, 99%)	1 g, 5 g, 10 g, 25 g, 50 g
NLM-713	Ammonium sulfate ($^{15}N_2$, 99%)	1 g, 5 g, 10 g, 25 g, 50 g
DLM-4-99	Deuterium oxide (D, 99%)	1000 g, 5000 g
DLM-4-99.8	Deuterium oxide (D, 99.8%)	1000 g
DLM-4	Deuterium oxide (D, 99.9%)	10 g, 100 g, 1000 g
CLM-1396	D-Glucose ($^{13}C_6$, 99%)	0.1 mg, 0.25 g, 0.5 g, 1 g, 2 g, 5 g, 10 g, 25 g, 50 g
DLM-2062	D-Glucose (1,2,3,4,5,6,6-D_7, 97-98%)	0.5 g, 1 g, 5 g, 10 g, 20 g
CDLM-3813	D-Glucose (U-$^{13}C_6$, 99%; 1,2,3,4,5,6,6-D_7, 97-98%)	1 g, 2 g, 10 g
CLM-1510	Glycerol ($^{13}C_3$, 99%)	1 g, 5 g
DLM-558	Glycerol (D_8, 99%)	1 g, 5 g

Insect Cell Growth Media

CGM-2000-CN	BioExpress® 2000 (U-^{13}C, 98%; U-^{15}N, 98%)	1 kit
CGM-2000-N	BioExpress® 2000 (U-^{15}N, 98%)	1 kit
CGM-2000-U	BioExpress® 2000 (unlabeled)	1 kit

Yeast Cell Growth Media

CGM-4020-SL-C	Yeast-OD2 (^{13}C, 98%)	1 L
CGM-4020-SL-N	Yeast-OD2 (^{15}N, 98%)	1 L
CGM-4020-SL-CN	Yeast-OD2 (^{13}C, 98%; ^{15}N, 98%)	1 L
CGM-4020-SL-U	Yeast-OD2 (unlabeled)	1 L

Mammalian Cell Growth Media

CGM-6000-N	BioExpress® 6000 (U-^{15}N, 98%)	1 L
CGM-6000-CN	BioExpress® 6000 (U-^{13}C, 98%; U-^{15}N, 98%)	1 L
CGM-6000-U	BioExpress® 6000 (unlabeled)	1 L

Kits for Cell-Free Protein Expression

Catalog No.	Description	Contents	Specifications
CFS-PRK-G24	Protein Research Kit (G)	Premixed transcription and translation reagents for GST-fusion protein expression. Reaction scale is 226 µL.	24 reactions
CFS-PRK-H24	Protein Research Kit (H)	Premixed transcription and translation reagents for His-fusion protein expression. Reaction scale is 226 µL.	24 reactions
CFS-PRK-S24	Protein Research Kit (S)	Premixed transcription and translation reagents for protein expression. Reaction scale is 226 µL.	24 reactions
CFS-TRI-PLE-BD	Proteoliposome BD Expression Kit	WEPRO 7240, transcription buffer LM, NTP mix, SP6 RNA polymerase, RNase inhibitor, creatine kinase, pEU-E01-T1R1 plasmid, SUB-AMIX SGC S1-S4, and asolectin liposome. Reaction scale is 2.5 mL.	6 reactions
CFS-TRI-PLE	Proteoliposome Expression Kit	WEPRO 7240, transcription buffer LM, NTP mix, SP6 RNA polymerase, RNase inhibitor, creatine kinase, pEU-E01-T1R1 plasmid, SUB-AMIX SGC S1-S4, and asolectin liposome. Reaction scale is 4 mL.	6 reactions
CFS-EDX-PLUS	Premium PLUS Expression Kit	Expression vector (pEU-E01-MCS), PCR primer for transcription and translation, positive control, and reaction cups. Reaction scale is 227 µL.	8 reactions
CFS-EDX-PLUS-MS	Premium PLUS Expression Kit for MS	Expression vector (pEU-E01-MCS), PCR primer set (SPU, deSP6E01), transcription premix LM, WEPRO9240 and SUB-AMIX SGC for MS, positive control, and reaction cups. Reaction scale is 227 µL.	16 reactions
CFS-EDX-PLE-PLUS	Proteoliposome Premium PLUS Expression Kit	Expression vector, primers for DNA preparation by PCR, prepared apolection-liposomes, positive control, and reaction cups. Reaction scale is 226 µL.	8 reactions

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Mass Spectrometry Signal Calibration for Protein Quantitation

Researcher Perspective

Michael J. MacCoss, PhD, Associate Professor of Genome Sciences
University of Washington, School of Medicine, Seattle, Washington USA

Introduction

Quantitative analysis of proteins and peptides by mass spectrometry is an important and growing area of biomedical research. Immunoassays have been the primary tool for protein quantitation. However, immunoassays are far from a perfect solution and may no longer meet the basic research needs in protein detection and quantitation. Recent efforts to overcome the limitations of immunoassays have shown that mass spectrometry assays, when combined with stable isotope-labeled internal standards, careful analyte calibration, quality control, and in some cases enrichment, can overcome the limitations of immunoassays. This is promising because it suggests that protein biochemists may no longer need to rely on the slow and expensive development of immunoassays for their target protein of interest. Instead, we can rely on mass spectrometry to deliver the sensitivity and specificity needed for the next generation of quantitative protein measurements at a greatly reduced cost. While the strengths of mass spectrometry are clear, these are still complicated measurements to perform.

Mass spectrometry has a long history of making quantitative measurements and has even been used for the quantitation of peptides for greater than three decades. However, in the proteomics field, we tend to use the term "quantitation" broadly. Frequently, methods described in papers that measure a signal intensity for peptides between two or more samples or conditions tend to be be labeled as quantitative. Are these data quantitative? Maybe, but not necessarily.

Here we will review some of the fundamentals of quantitative analysis and revisit what types of validation are required to assess whether a measurement is quantitative. We will review a few common strategies for the use of stable isotope-labeled internal standards in proteomics and how these data are used to calibrate the mass spectrometer response. We will approach this from a purely theoretical basis and enable the reader to assess whether the respective strengths and caveats should alter their chosen methodology depending on the intended application. Finally, we hope to correct a couple of misconceptions in the community about the use of stable isotope-labeled internal standards and what makes a mass spectrometry assay quantitative.

What Is the Difference Between Quantitative and Differential Analysis?

What makes any assay quantitative? To make a measurement quantitative, there must be a change in signal that reflects the change in quantity. To assess whether we get an expected change in signal with a change in quantity, we use standards of "known" quantity. We place quotations around known because the accuracy of any quantitative measurement is only going to be as good as the accuracy of the standards.

An illustration of a quantitative calibration curve can be seen in **Figure 1**. In this figure, the X-axis is the known quantity of standard samples and the Y-axis is the measured signal intensity. All measurements when plotted in this manner should have a range where there is a linear response between the measured signal intensity and the quantity of the target analyte. There will be a point at the lower end of this curve where the response in signal is not reflective of the quantity. This point is known as the lower limit of quantitation (LLOQ). There is also a similar point at the upper end of the linear dynamic range where the detector begins to saturate and no longer respond linearly (upper limit of quantitation or ULOQ). Quantitation should be performed in the linear dynamic range or at least in a range where there is a change in signal that reflects the change in quantity.

While it may be possible to obtain relative quantities without the use of a standard curve, it is impossible to assess whether all points are within the linear dynamic range of the instrument without

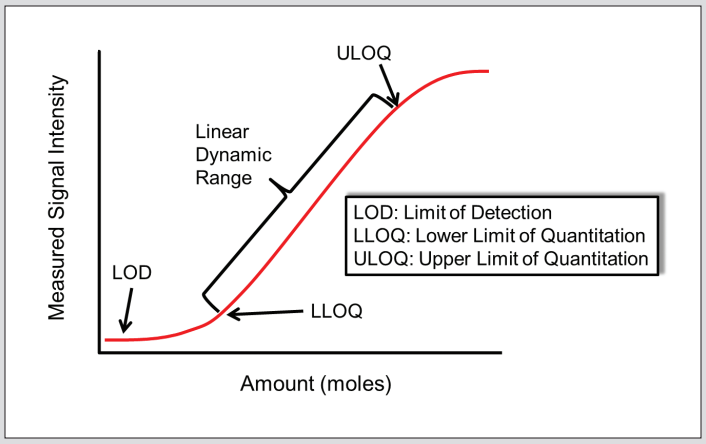

Figure 1. Illustration of a simplistic calibration curve.

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standards. Imagine two measurements, one below the LLOQ and one above. While there could be a statistically significant difference in intensity between the two measurements, the magnitude of the differences will not necessarily reflect a quantitative difference. Thus, without validation that the intensities are within the quantitative range, the measurements are limited to being differential and should not be considered quantitative.

Why Use a Stable Isotope-Labeled Internal Standard?

For the quantitation of compounds in complex matrices the use of internal standards minimizes errors associated with sample isolation and preparation because the compound of interest is measured relative to the added internal standard. A standard is chosen that will mimic the measured compound during the sample isolation and preparation, therefore will account for any possible losses.

The measurement of the ion-current ratio between the target peptide and an internal standard with a mass spectrometer significantly reduces errors associated with the ion source and inlet systems because "like molecules" will experience similar biases during the sample preparation and measurement. The use of stable isotopically labeled internal standards and isotope ratios further minimizes these errors and reduces the effect of long term drifts by using a standard, which is structurally identical to the peptide of interest. Therefore, when used with mass spectrometric detection, stable isotopically labeled proteins or peptides are a nearly ideal internal standard.

When performing quantitation with a stable isotope-labeled internal standard, the basic rules of quantitative analysis remain the same. The one difference is that instead of measuring a raw measured signal intensity, the intensity reported is a intensity normalized to the internal standard – essentially an ion current ratio. Thus, one divides the target signal by the intensity of the signal from the respective stable isotope-labeled internal standard (**Figure 2**). The use of the internal standard will not necessarily alter the quantitative accuracy or dynamic range but it should almost certainly improve the quantitative precision by minimizing sample preparation "noise."

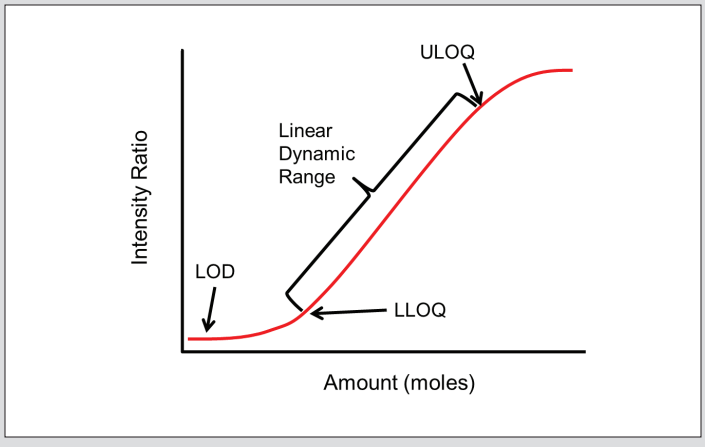

Figure 2. Illustration of a calibration curve using a stable isotope-labeled internal standard. The curve is identical to the one shown in Figure 1 except the Y-axis has been changed from a RAW signal intensity to a normalized intensity ratio.

In the example shown in **Figure 2**, the internal standard is used to normalize the signal intensity and improve the precision of the measurement. We want to make it clear that the stable isotope-labeled internal standard is not necessarily what makes the assay quantitative. The quantitation is still made relative to unlabeled standards. We do not need to know the amount of the stable isotope labeled internal standard particularly well – we just need to make sure that the same amount of the internal standard is added to every sample and standard.

Single-Point Calibration

Arguably the most common method used in proteomics for calibrating the instrument response is the use of a single-point calibration. In these experiments, a known quantity of a stable isotope-labeled peptide is added to a sample and then the signal of the target analyte is measured relative to the internal standard. The measured ratio *(R)* between the unlabeled peptide and internal standard is assumed to be proportional to the mole ratio between the two respective isotopomers

Equation 1 $R \approx n_a / n_b$

where n_a and n_b are the moles of the unlabeled and stable isotope-labeled internal standard respectively. Assuming this relationship is linear, we can write a simple linear equation describing the relationship between the isotopomer mole ratio and the measured signal ratio in the mass spectrometer.

Equation 2 $R = k \cdot n_a / n_b + R_b$

In this case, k is a response factor that can be used as a factor to correct differences in the response between the labeled and unlabeled peptide. Likewise, R_b is the measured background ratio during the injection of a blank that contains only the stable isotope-labeled internal standard and no endogenous peptide.

In these experiments it is assumed that $k = 1$ and $R_b = 0$ and standards are not necessarily run to confirm these assumptions over the range of the quantitative measurement. Given these assumptions and the "known" quantity of the stable isotope-labeled internal standard, then Equation 2 is rearranged to

Equation 3 $n_a = R \cdot n_b$

to solve for the absolute quantity of endogenous peptide.

This approach is used throughout the proteomics literature for "absolute" quantitation. However, is the assumption valid that $k = 1$ and $R_b = 0$? Should we expect equal quantities of unlabeled and stable isotope-enriched peptides to respond similarly in the mass spectrometer? The answer is, of course, it depends.

One main challenge that needs to be accounted for in the use of a simple single-point calibration using ^{13}C-labeled peptides is the effect on the isotope distribution (**Figure 3**). Consider the peptide

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Mass Spectrometry Signal Calibration for Protein Quantitation *(continued)*

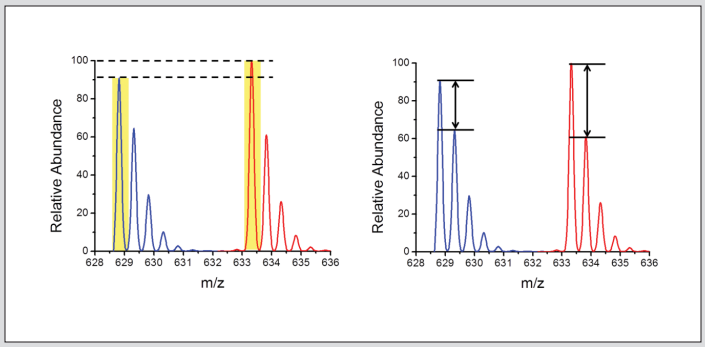

Figure 3. Theoretical effect of the measured mass spectrometer signal intensity between a peptide that contains only natural abundance isotopes and the identical peptide sequence that is enriched with 8 x ^{13}C atoms at 99.9 atom percent excess (APE).

sequence YAGILDC$_{ICAT}$FK where the cysteine residue is labeled with either an isotope-coded affinity tag (ICAT) reagent that contains natural abundance isotopes (light version) or nine of the carbons replaced with ^{13}C-enriched atoms at 99.9 APE (heavy version). If the two peptides are mixed at a perfect 1-to-1 mole ratio and the monoisotopic isotope peak is used for each of the two isotopomers the expected signal would not be 1-to-1 (**Figure 3**). In fact, assuming perfect and equal ionization between these two isotopomers, we would expect that the ^{13}C-labeled version of the peptide would actually be more intense by almost 10%. The signal intensity of the monoisotopic mass of a stable isotope-labeled peptide should always be more intense than the unlabeled equivalent and the magnitude of the difference will depend on the elemental composition of the molecule, the number of labeled atoms, the type of labeled atom and the enrichment of the isotope-labeled starting material.

So what is the cause of this difference in signal intensity? This difference is caused because the monoisotopic peak is now a greater portion of the total isotope distribution in the heavy peptide relative to the light peptide. In the right side of **Figure 3**, it is obvious that the difference in intensity between the M+0 and the M+1 isotope is very different between the light and the heavy isotopomer. Interestingly, this effect is worse with ^{13}C labeling than ^{15}N, ^{18}O, or D. This effect is because we are in essence removing nine carbons from the contribution to the M+1 isotope peak. At low resolution this is less of a problem because without resolution of the individual isotope peaks, the entire distribution is used and, in that case, the sum of the distributions are equal. Thus, in using high resolution mass spectrometry, Equation 3 cannot be used for absolute quantitation without applying a correction factor for the difference in the fraction of the monoisotopic peak of the total isotope distribution between the light and the heavy peptide. This correction factor can be computed theoretically for each light and heavy peptide or can be bypassed using a standard curve of known unlabeled peptide quantities (see **Figure 4**).

There are other limitations in the use of a single-point calibration with a stable isotope-labeled peptide standard. One is the lack of day-to-day reproducibility in the quantitative measurement.[1] However, another major limitation is that with a single point, it is impossible to determine whether the signal intensities from both the light and the heavy peptide are both within the linear quantitative range of the mass spectrometer (**Figure 1**). As mentioned previously, the inability to confirm the measurements are within the linear range generally means the measurement should simply be considered differential and not quantitative. This being said, the simplicity of a single-point calibration still makes it an extremely popular and powerful strategy. However, it is important for users to be aware of the potential limitations in the method and/or data reported using this approach.

Using a Peptide Standard Curve

An improvement to the use of a single-point calibration is to use a peptide standard curve. In this case, a constant amount of a stable isotope-labeled internal standard peptide is added to several unlabeled peptide standards of known quantity that span the range of quantities that need to be quantified. The ratio of the target peptide signal is measured relative to the stable isotope-labeled internal standard *(R)* and plotted relative to the moles from the unlabeled peptide standards *(n_a)*. An example of a theoretical standard curve is shown in Figure 4. The linear portion of the curve follows the equation:

Equation 4 $R=k\cdot n_a+R_b$

Where *k* is the slope of the standard curve and R_b is the background ratio from the injection of a blank containing only internal standard peptide. Unlike the single point calibration described above, the use of a peptide standard curve confirms that the measurement is within a linear range of quantitation.

A key advantage of the use of a peptide standard curve is that there is less demand on the chemical purity and isotope enrichment of the standards. As long as the same amount of internal standard is added to each standard and sample, the *k* in Equation 4 will correct for this appropriately. While it is helpful to know the absolute quantity of the stable isotope-labeled internal standard added to each sample, it is not necessary. Thus, it is more important to have peptide standards at high purity and absolute known quantities for the unlabeled peptide than it is for the stable isotope-labeled peptides. While the use of a peptide standard curve offers advantages over a single point calibration, it still has limitations. The main thing that the user needs to consider is that the instrument response is calibrated relative to *peptide* standards and, therefore, it is important to be careful about making claims about *protein* quantities. While the quantitation of peptides can be made very accurate and precise, these measurements do not account for incomplete recovery of peptides during the sample preparation and digestion of the protein sample.

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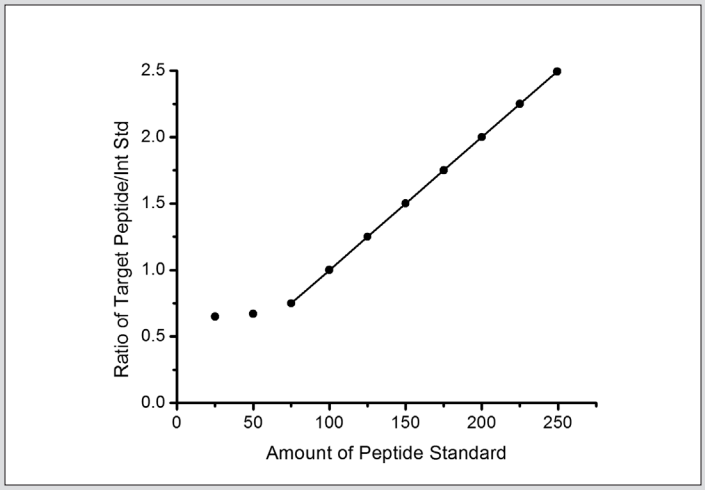

Figure 4. Theoretical calibration curve using known peptide standards. In this example, the amount of the peptide standard is plotted on the x-axis and the ratio of the unlabeled peptide relative to the respective stable isotope-labeled internal standard is used as the signal intensity. It is important that the amount of the stable isotope-labeled internal standard is the same across all samples but knowing the exact quantity of the internal standard is not essential. The two lowest abundance standards are not above the lower limit of quantitation.

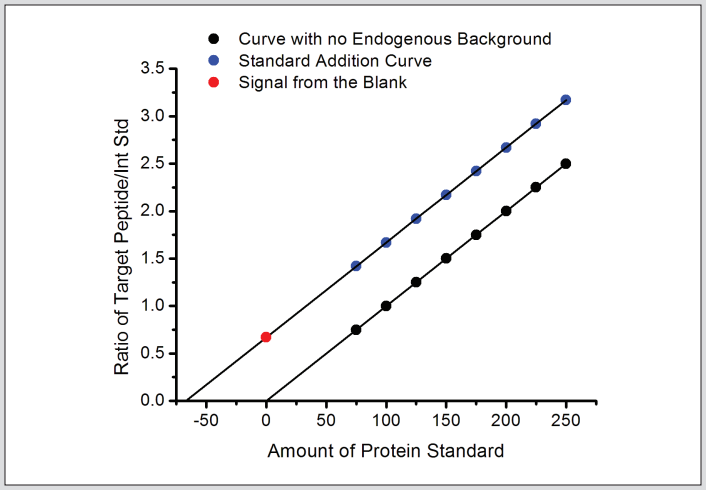

Figure 5. Theoretical calibration curves using known *protein* standards. In these examples, the amount of the standard is plotted on the x-axis and the ratio of the unlabeled peptide relative to the respective stable isotope-labeled internal standard is used as the signal intensity. In the black example, the protein standards are in a sample matrix without any endogenous protein. The blue example is a standard curve that adds the standards to the sample matrix where there is an endogenous amount of the target protein. The red point is the signal measured from the endogenous matrix when no additional protein standard is spiked into the sample. The slope of the two lines should be indistinguishable.

Using a Protein Standard Curve

If the goal is to quantify proteins then it is best to use actual protein standards with known quantity to calibrate the signal response. We recently described an inexpensive way to generate protein standards and determine their quantity using *in vitro* transcription/translation.[2] By using an actual protein standard, the sample is then calibrated relative to the protein and not the peptide (**Figure 5**). The use of a protein standard is better than the use of a peptide standard because it has to undergo digestion to produce the peptide that is measured just like the endogenous protein.

While a recombinant protein is a better standard than a peptide, the measured peptides from the protein standard still might not represent what is measured from the endogenous protein. One complication is that a protein standard will likely be prepared from a sample matrix that is different from the endogenous sample matrix. In this case, a protein might experience different digestion efficiency in the sample relative to a standard buffer. A way to minimize this sample preparation difference is to spike the standards of varying concentration into the same background sample (see **Figure 5**, blue curve). This approach is known as the method of standard addition and the standard curve should now reflect differences in sample preparation and measurement that are reflective of the sample matrix. The curve from the standard addition in the sample matrix will often have the same slope as the curve with no endogenous background, but the intercept will be higher because of endogenous amount of the protein. If the endogenous quantity is within the linear quantitative range of the measurement, the line from the spiked standards will go through the signal measured from the sample with only the endogenous quantity of protein (**Figure 5**, red point). The absolute amount of the endogenous peptide in the background matrix can be estimated using the negative X-intercept.

Conclusions

There are many different ways to calibrate the instrument response in quantitative mass spectrometry. Here we described three common ways of performing signal calibration for proteomics. Each of the methods has different positive and negative attributes. The user should be aware of the limitations of the method that they choose and, thus, interpret their data appropriately. Depending on the scale of the experiment, the required accuracy and precision, and the reagent budget, the user can choose the best approach for the project.

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1. Hoofnagle, A.N. **2010**. Peptide lost and found: internal standards and the mass spectrometric quantification of peptides *Clin Chem, 56(10),* 1515-1517.

2. Stergachis, A.B.; MacLean, B.; Lee, K.; et al. **2011**. Rapid empirical discovery of optimal peptides for targeted proteomics. *Nat Methods, 8,* 1041-1043.

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Skyline – skyline.maccosslab.org

Skyline is a freely available and open-source Windows client application for Selected Reaction Monitoring (SRM)/ Multiple Reaction Monitoring (MRM) and Full-Scan (MS1 and MS/MS) quantitative methods and analyzing the resulting mass spectrometer data. It makes use of cutting-edge technologies for creating and iteratively refining targeted methods for large-scale proteomics studies.

Panorama – panoramaweb.org

Panorama is a freely available, open-source repository server application for targeted proteomics assays that integrates into a Skyline proteomics workflow. PanoramaWeb is a public Panorama server hosted at the University of Washington where laboratories and organizations can own free projects. You can request a project on this server to find out what Panorama has to offer, without having to set up and maintain your own server. You will be able to explore all the available features in Panorama, and be given administrative rights to your project so that you can set up folders and configure permissions. Panorama can also be installed by laboratories and organizations on their own servers.

Topograph – topograph.maccosslab.org

Topograph is a Windows application designed to analyze data in protein turnover experiments. Protein turnover experiments involve modifying an organism's diet or growth media to include a stable isotope-labeled amino acid, and then measuring the rate at which the label appears in peptides.

CHORUS – chorusproject.org

CHORUS is an effort to provide a free, professionally developed community solution for the storage, sharing and analysis of mass spectrometry data. This is currently a collaborative partnership between the University of Pittsburgh, University of Washington, Infoclinika, and Amazon Web Services. The application provides a Google Docs-type interface optimized for mass spectrometry data. Data can be uploaded and kept private, shared with a group of collaborators, or made entirely public. Tools are available to visualize and analyze the data directly on the cloud.

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
For research use only. Not for use in diagnostic procedures.

Steroids and Hormones

Steroids and hormones play vital roles in the regulation of a diverse array of cellular functions and physiological processes. These pertain to development, reproduction, homeostasis, and metabolism, among others. Accurate quantification of this compound class is essential for basic and clinical translation research. This can be achieved by spiking an isotopically labeled steroid standard(s) into a sample of interest, such as plasma or urine, with measurement performed by an MS- or NMR-based approach.

CIL offers a variety of stable isotope-labeled and unlabeled steroids and hormones. These are available in different labeling patterns in their neat and/or solution forms.

Catalog No.	Description	Concentration	Unit Size
DLM-10472-C	Aldosterone (9,11,12,12-D_4, 98%) CP 97%	100 µg/mL in acetonitrile	1 mL
DLM-8438-C	Aldosterone (2,2,4,6,6,17,21,21-D_8)	100 µg/mL in acetonitrile	1 mL
DLM-8438	Aldosterone (2,2,4,6,6,17,21,21-D_8)	neat	1 mg, 2 mg, 5 mg
ULM-9134-C	Aldosterone (unlabeled)	100 µg/mL in acetonitrile	1 mL
ULM-9134	Aldosterone (unlabeled) CP 95%	neat	1 mg, 5 mg
DLM-10269	5α-Androstan-3β-ol-17-one (epiandrosterone) (2,2,4,4-D_4, 98%)	neat	1 mg, 5 mg
ULM-10270	5α-Androstan-3β-ol-17-one (epiandrosterone) (unlabeled)	neat	1 mg
CLM-10548	5α-Androstan-3,17-dione (androstanedione) (2,3,4-$^{13}C_3$, 98%)	neat	1 mg
ULM-8794-C	5α-Androstan-3,17-dione (androstanedione) (unlabeled) CP 95%	100 µg/mL in methanol	1 mL
ULM-8794	5α-Androstan-3,17-dione (androstanedione) (unlabeled)	neat	1 mg
DLM-8750	5β-Androstan-3α-ol-17-one (etiocholanolone) (16,16-D_2, 98%)	neat	Please inquire
DLM-10008-C	5β-Androstan-3α-ol-17-one (etiocholanolone) (2,2,3,4,4-D_5, 98%)	100 µg/mL in methanol	1 mL
DLM-10008	5β-Androstan-3α-ol-17-one (etiocholanolone) (2,2,3,4,4-D_5, 98%)	neat	1 mg
ULM-10009-C	5β-Androstan-3α-ol-17-one (etiocholanolone) (unlabeled)	100 µg/mL in methanol	1 mL
ULM-10009	5β-Androstan-3α-ol-17-one (etiocholanolone) (unlabeled)	neat	1 mg
DLM-9769-C	5α-Androstane-3α,17β-diol (16,16,17-D_3, 98%) CP 95%	100 µg/mL in methanol	1 mL
DLM-9769	5α-Androstane-3α,17β-diol (16,16,17-D_3, 98%) CP 95%	neat	1 mg
ULM-9752-C	5α-Androstane-3α,17β-diol (unlabeled)	100 µg/mL in methanol	1 mL
ULM-9752	5α-Androstane-3α,17β-diol (unlabeled)	neat	1 mg
ULM-10732	5α-Androstane-3β,17β-diol (unlabeled)	neat	1 mg
DLM-9787	Androstanediol glucuronide, sodium salt (16,16,17-D_3, 98%) CP 97%	neat	1 mg
DLM-10396	4-Androsten-11β-ol-3,17-dione (9,11,12,12-D_4, 98%)	neat	1 mg
DLM-9697	4-Androsten-11β-ol-3,17-dione (2,2,4,6,6,16,16-D_7, 98%)	neat	Please inquire
DLM-10397	4-Androsten-11β-17β-diol-3-one (9,11,12,12-D_4, 98%) CP 95%	neat	1 mg
DLM-10401-1.2	5-Androsten-3β-17β-diol (16,16,17-D_3, 98%) CP 95%	100 µg/mL in methanol	1.2 mL
DLM-10401	5-Androsten-3β-17β-diol (16,16,17-D_3, 98%) CP 95%	neat	1 mg
CLM-9135-D	4-Androstene-3,17-dione (2,3,4-$^{13}C_3$, 98%)	1000 µg/mL in methanol	1 mL
CLM-9135-C	4-Androstene-3,17-dione (2,3,4-$^{13}C_3$, 98%)	100 µg/mL in methanol	1 mL
CLM-9135	4-Androstene-3,17-dione (2,3,4-$^{13}C_3$, 98%)	neat	5 mg, 10 mg
DLM-8330	4-Androstene-3,17-dione (2,2,4,6,6-D_5, 98%)	neat	0.05 g, 0.1 g
DLM-7976	4-Androstene-3,17-dione (2,2,4,6,6,16,16-D_7, 97%)	neat	0.05 g, 0.1 g
ULM-8472	4-Androstene-3,17-dione (unlabeled)	neat	1 mg, 5 mg, 10 mg
DLM-10420-C	4-Androstene-6β,17β-diol-3-one (16,16,17-D_3, 98%) CP 95%	100 µg/mL in methanol	1 mL
DLM-10420	4-Androstene-6β,17β-diol-3-one (16,16,17-D_3, 98%)	neat	1 mg
DLM-7937	Androsterone (5α-androstan-3α-ol-17-one) (16,16-D_2, 98%)	neat	Please inquire
DLM-10402-C	Androsterone (5α-androstan-3α-ol-17-one) (2,2,4,4-D_4, 98%)	100 µg/mL in methanol	1 mL
DLM-10402	Androsterone (5α-androstan-3α-ol-17-one) (2,2,4,4-D_4, 98%) CP 95%	neat	1 mg
ULM-10403-C	Androsterone (5α-androstan-3α-ol-17-one) (unlabeled)	100 µg/mL in methanol	1 mL
ULM-10403	Androsterone (5α-androstan-3α-ol-17-one) (unlabeled)	neat	1 mg
DLM-9137	Androsterone glucuronide, sodium salt (2,2,4,4-D_4, 98%)	neat	Please inquire
ULM-9138	Androsterone glucuronide, sodium salt (unlabeled)	neat	5 mg, 10 mg
DLM-4700	5α-Cholestane (5α-cholane) (3,3-D_2, 98%)	neat	Please inquire
DLM-8276	Cholestenone (2,2,4,6,6-D_5, 98%)	neat	0.1 g
CLM-804	Cholesterol (3,4-$^{13}C_2$, 99%)	neat	0.1 g
CLM-9139-C	Cholesterol (2,3,4-$^{13}C_3$, 98%)	100 µg/mL in ethanol	1 mL

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Steroids and Hormones *(continued)*

Catalog No.	Description	Concentration	Unit Size
CLM-9139-B	Cholesterol (2,3,4-$^{13}C_3$, 98%)	50 µg/mL in ethanol	1 mL
CLM-9139	Cholesterol (2,3,4-$^{13}C_3$, 99%)	neat	2 mg, 5 mg
CLM-9587-1.2	Cholesterol (23,24,25,26,27-$^{13}C_5$, 99%)	100 µg/mL in methanol	1.2 mL
CLM-9587	Cholesterol (23,24,25,26,27-$^{13}C_5$, 99%)	neat	2 mg, 5 mg
DLM-1831	Cholesterol (3-D, 97%)	neat	Please inquire
DLM-7260	Cholesterol (25,26,26,26-D_4, 98%)	neat	Please inquire
DLM-2607-C	Cholesterol (2,2,3,4,4,6-D_6, 97-98%) CP 97%	100 µg/mL in ethanol	1 mL
DLM-2607	Cholesterol (2,2,3,4,4,6-D_6, 97-98%)	neat	0.1 g
DLM-3057	Cholesterol (25,26,26,26,27,27,27-D_7, 98%)	neat	10 mg, 0.1 g
OLM-7695	Cholesterol (^{18}O, 95%)	neat	Please inquire
ULM-9140-1.2	Cholesterol (unlabeled)	100 µg/mL in methanol	1.2 mL
ULM-9140	Cholesterol (unlabeled) CP 97%	neat	1 mg, 5 mg, 10 mg
CLM-3361	Cholesterol-3-octanoate (octanoate-1-^{13}C, 99%)	neat	1 g
DLM-10416	Cholesterol-3-sulfate, sodium salt (25,26,26,26,27,27,27-D_7, 98%)	neat	1 mg
DLM-11017-C	Corticosterone (9,11,12,12-D_4, 98%) CP 97%	100 µg/mL in acetonitrile	1 mL
DLM-11017	Corticosterone (9,11,12,12-D_4, 98%)	neat	1 mg, 5 mg
DLM-7347	Corticosterone (2,2,4,6,6,17α,21,21-D_8, 97-98%)	neat	10 mg
ULM-9988-C	Corticosterone (unlabeled)	100 µg/mL in acetonitrile	1 mL
ULM-9988	Corticosterone (unlabeled)	neat	1 mg
CLM-10371-C	Cortisol (2,3,4-$^{13}C_3$, 99%)	100 µg/mL in methanol	1 mL
DLM-2615	Cortisol (1,2-D_2, 98%)	neat	Please inquire
DLM-2057	Cortisol (9,12,12-D_3, 98%)	neat	10 mg
DLM-2218	Cortisol (9,11,12,12-D_4, 98%)	neat	0.1 mg, 10 mg
ULM-9141	Cortisol (unlabeled)	neat	1 mg, 5 mg, 10 mg
DLM-10471	Cortisol-21-sulfate, sodium salt (9,11,12,12-D_4, 98%) CP 95%	neat	1 mg
CLM-10536-C	Cortisone (2,3,4-$^{13}C_3$, 98%) CP 97%	100 µg/mL in methanol	1 mL
DLM-8863	Cortisone (1,2-D_2, 98%) CP 95%	neat	Please inquire
DLM-9142-C	Cortisone (2,2,4,6,6,12,12-D_7, 98%)	100 µg/mL in methanol	1 mL
DLM-9976	Cortisone (2,2,4,6,6,9,12,12-D_8, 98%)	neat	1 mg, 5 mg
ULM-9202-C	Cortisone (unlabeled)	100 µg/mL in methanol	1 mL
ULM-9202	Cortisone (unlabeled)	neat	1 mg, 5 mg, 10 mg
CLM-10537-C	Cortisone 21-sulfate, sodium salt (2,3,4-$^{13}C_3$, 98%) CP 95%	100 µg/mL in methanol	1 mL
DLM-4216	7-Dehydrocholesterol (25,26,26,26,27,27,27-D_7, 98%)	neat	Please inquire
CLM-10549-C	Dehydroepiandrosterone (DHEA) (2,3,4-$^{13}C_3$, 99%)	100 µg/mL in methanol	1 mL
CLM-10549	Dehydroepiandrosterone (DHEA) (2,3,4-$^{13}C_3$, 99%)	neat	1 mg
DLM-7714	Dehydroepiandrosterone (DHEA) (16,16-D_2, 97%)	neat	0.1 g
DLM-8049-C	Dehydroepiandrosterone (DHEA) (2,2,3,4,4,6-D_6, 97%)	100 µg/mL in methanol	1 mL
DLM-8049	Dehydroepiandrosterone (DHEA) (2,2,3,4,4,6-D_6, 98%) CP 97%	neat	5 mg
ULM-9143-D	Dehydroepiandrosterone (DHEA) (unlabeled)	1000 µg/mL in methanol	1 mL
ULM-9143-C	Dehydroepiandrosterone (DHEA) (unlabeled)	100 µg/mL in methanol	1 mL
ULM-9143	Dehydroepiandrosterone (DHEA) (unlabeled)	neat	1 mg, 5 mg, 10 mg
DLM-8701	Dehydroepiandrosterone sulfate, sodium salt (DHEAS) (16,16-D_2, 97%)	neat	Please inquire
ULM-9144-D	Dehydroepiandrosterone sulfate, sodium salt (DHEAS) (unlabeled)	1000 µg/mL in methanol	1 mL
ULM-9144-C	Dehydroepiandrosterone sulfate, sodium salt (DHEAS) (unlabeled)	100 µg/mL in methanol	1 mL
ULM-9144	Dehydroepiandrosterone sulfate, sodium salt (DHEAS) (unlabeled)	neat	1 mg, 5 mg, 10 mg
DLM-8337-C	Dehydroepiandrosterone sulfate, sodium salt·$2H_2O$ (DHEAS) (2,2,3,4,4,6-D_6, 95%)	100 µg/mL in methanol	1 mL
DLM-8337	Dehydroepiandrosterone sulfate, sodium salt·$2H_2O$ (DHEAS) (2,2,3,4,4,6-D_6, 95%)	neat	5 mg
CLM-10384-C	11-Deoxycortisol (2,3,4-$^{13}C_3$, 99%) CP 97%	100 µg/mL in methanol	1 mL
CLM-10384	11-Deoxycortisol (2,3,4-$^{13}C_3$, 99%) CP 97%	neat	1 mg
DLM-7209	11-Deoxycortisol (21,21-D_2, 96%)	neat	5 mg, 10 mg
DLM-8336-C	11-Deoxycortisol (2,2,4,6,6-D_5, 98%)	100 µg/mL in methanol	1 mL
DLM-8336	11-Deoxycortisol (2,2,4,6,6-D_5, 98%) CP 97%	neat	5 mg, 10 mg
ULM-9145-D	11-Deoxycortisol (unlabeled)	1000 µg/mL in methanol	1 mL

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Catalog No.	Description	Concentration	Unit Size
ULM-9145-C	11-Deoxycortisol (unlabeled)	100 µg/mL in methanol	1 mL
ULM-9145	11-Deoxycortisol (unlabeled)	neat	1 mg, 5 mg, 10 mg
DLM-8305	21-Deoxycortisol (2,2,4,6,6,21,21,21-D_8, 97%)	neat	10 mg
ULM-9987-C	21-Deoxycortisol (unlabeled)	100 µg/ml in methanol	1 mL
ULM-9987	21-Deoxycortisol (unlabeled)	neat	1 mg
DLM-170-D-1.2	Diethylstilbestrol (*cis*/*trans* mix) (ring-3,3′,5,5′-diethyl-1,1,1′,1′-D_8, 98%)	100 µg/mL in dioxane	1.2 mL
DLM-170	Diethylstilbestrol (*cis*/*trans* mix) (ring-3,3′,5,5′-diethyl-1,1,1′,1′-D_8, 98%)	neat	0.05 g, 0.1 g
CLM-9146-D	5α-Dihydrotestosterone (2,3,4-$^{13}C_3$, 99%) CP 97%	1000 µg/mL in methanol	1 mL
CLM-9146-C	5α-Dihydrotestosterone (2,3,4-$^{13}C_3$, 99%) CP 97%	100 µg/mL in methanol	1 mL
CLM-9146	5α-Dihydrotestosterone (2,3,4-$^{13}C_3$, 99%) CP 97%	neat	1 mg, 5 mg, 10 mg
DLM-3023	5α-Dihydrotestosterone (16,16,17-D_3, 98%)	neat	Please inquire
DLM-9041	5α-Dihydrotestosterone (2,2,4,4-D_4, 98%) CP 95%	neat	1 mg
ULM-8364-D	5α-Dihydrotestosterone (unlabeled)	1 mg/mL in methanol	1 mL
ULM-8364-C	5α-Dihydrotestosterone (unlabeled)	100 µg/mL in methanol	1 mL
ULM-8364	5α-Dihydrotestosterone (unlabeled)	neat	Please inquire
CLM-9222-C	L-3,3′-Diiodothyronine (T2) (phenoxy-$^{13}C_6$, 99%) CP 97%	100 µg/mL in 0.1 N ammonia in methanol	1 mL
CLM-9222	L-3,3′-Diiodothyronine (T2) (phenoxy-$^{13}C_6$, 99%) CP 97%	neat	1 mg, 5 mg
ULM-9223-C	L-3,3′-Diiodothyronine (T2) (unlabeled)	100 µg/mL in 0.1 N ammonia in methanol	1 mL
ULM-9223	L-3,3′-Diiodothyronine (T2) (unlabeled)	neat	1 mg, 5 mg, 10 mg
CLM-7768	Epicholesterol (3,4-$^{13}C_2$, 99%)	neat	0.1 g
DLM-9088	DL-Epinephrine (ring-D_3,1,2,2-D_3, 98%)	neat	Please inquire
CNLM-7889	DL-Epinephrine (1,2-$^{13}C_2$, 99%; ^{15}N, 98%)	neat	10 mg
CLM-803-1.2	Estradiol (3,4-$^{13}C_2$, 99%)	100 µg/mL in acetonitrile	1.2 mL
CLM-803	Estradiol (3,4-$^{13}C_2$, 99%)	neat	Please inquire
DLM-3694	Estradiol (16,16,17-D_3, 98%) CP 95%	neat	1 mg, 10 mg
DLM-2487	Estradiol (2,4,16,16-D_4, 95-97%)	neat	5 mg
ULM-7449-1.2	Estradiol (unlabeled)	100 µg/mL in acetonitrile	1.2 mL
ULM-7449	Estradiol (unlabeled)	neat	0.1 mg
CLM-7936-1.2	DL-Estradiol (13,14,15,16,17,18-$^{13}C_6$, 99%)	100 µg/mL in methanol	1.2 mL
CLM-7936	DL-Estradiol (13,14,15,16,17,18-$^{13}C_6$, 99%)	neat	0.1 mg
CLM-10404-C	Estradiol undecanoate (2,3,4-$^{13}C_3$, 98%) CP 95%	100 µg/mL in methanol	1 mL
CLM-10404	Estradiol undecanoate (2,3,4-$^{13}C_3$, 98%) CP 95%	neat	1 mg
CLM-9147-C	Estriol (16α-hydroxyestradiol) (2,3,4-$^{13}C_3$, 99%) CP 97%	100 µg/mL in methanol	1 mL
CLM-9147	Estriol (16α-hydroxyestradiol) (2,3,4-$^{13}C_3$, 99%) CP 97%	neat	0.1 mg, 0.25 mg, 0.5 mg, 1 mg
DLM-8586	Estriol (2,4,16-D_3, 98%) CP 96%	neat	5 mg, 10 mg
DLM-8343	Estriol (2,4,17-D_3, 98%) CP 96%	neat	Please inquire
ULM-8218	Estriol (unlabeled)	neat	0.1 mg
CLM-673-1.2	Estrone (3,4-$^{13}C_2$, 90%)	100 µg/mL in acetonitrile	1.2 mL
CLM-673	Estrone (3,4-$^{13}C_2$, 99%)	neat	Please inquire
CLM-9148-C	Estrone (2,3,4-$^{13}C_3$, 99%)	100 µg/mL in methanol	1 mL
CLM-9148-B	Estrone (2,3,4-$^{13}C_3$, 99%)	50 µg/mL in methanol	1 mL
CLM-9148	Estrone (2,3,4-$^{13}C_3$, 99%)	neat	1 mg, 5 mg
DLM-3976	Estrone (2,4,16,16-D_4, 97%)	neat	5 mg
CLM-7935-1.2	DL-Estrone (13,14,15,16,17,18-$^{13}C_6$, 99%) CP 95%	100 µg/mL in methanol	1.2 mL
CLM-7935	DL-Estrone (13,14,15,16,17,18-$^{13}C_6$, 99%) CP 95%	neat	0.1 mg
CLM-8033	DL-Estrone 3-methyl ether (13,14,15,16,17,18-$^{13}C_6$, 99%)	neat	0.1 mg
ULM-10356	Estrone 3-methyl ether (unlabeled)	neat	0.1 mg
CLM-3375-1.2	Ethynylestradiol (20,21-$^{13}C_2$, 99%) CP 97%	100 µg/mL in acetonitrile	1.2 mL
ULM-7211-1.2	Ethynylestradiol (unlabeled)	100 µg/mL in acetonitrile	1.2 mL

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Steroids and Hormones *(continued)*

Catalog No.	Description	Concentration	Unit Size
DLM-4691	17α-Ethynylestradiol (2,4,16,16-D_4, 97-98%)	neat	10 mg
DLM-8646	7β-Hydroxycholesterol (25,26,26,26,27,27,27-D_7, 98%) CP 97%	neat	Please inquire
ULM-10267	7α-Hydroxycholesterol (unlabeled)	neat	1 mg
ULM-10268	7β-Hydroxycholesterol (unlabeled)	neat	Please inquire
DLM-9150-C	18-Hydroxycorticosterone (9,11,12,12-D_4, 98%)	100 µg/mL in acetonitrile	1 mL
DLM-9150	18-Hydroxycorticosterone (9,11,12,12-D_4, 98%) CP 95%	neat	1 mg
ULM-9151-C	18-Hydroxycorticosterone (unlabeled) CP 95%	100 µg/mL in methanol	1 mL
ULM-9151	18-Hydroxycorticosterone (unlabeled) CP 95%	neat	1 mg
DLM-10006-C	18-Hydroxycortisol (9,11,12,12-D_4, 98%) CP 95%	100 µg/mL in methanol	1 mL
DLM-10006	18-Hydroxycortisol (9,11,12,12-D_4, 98%) CP 95%	neat	0.5 mg, 1 mg
ULM-10007-C	18-Hydroxycortisol (unlabeled) CP 97%	100 µg/mL in methanol	1 mL
ULM-10007	18-Hydroxycortisol (unlabeled) CP 95%	neat	1 mg
ULM-8134	2-Hydroxyestrone (unlabeled)	neat	0.1 mg
ULM-8261	4-Hydroxyestrone (unlabeled) CP 96%	neat	0.1 mg
CLM-8012	DL-2-Hydroxyestradiol (13,14,15,16,17,18-$^{13}C_6$, 99%)	neat	0.1 mg
ULM-8133	2-Hydroxyestrone-3-methyl ether (unlabeled) CP 97%	neat	0.1 mg
CLM-9153-C	16α-Hydroxyestrone (2,3,4-$^{13}C_3$,99%)	100 µg/mL in methanol	1 mL
ULM-9152-C	16α-Hydroxyestrone (unlabeled)	100 µg/mL in methanol	1 mL
CLM-9153	16α-Hydroxyestrone (2,3,4-$^{13}C_3$, 99%)	neat	0.1 mg, 0.25 mg, 0.5 mg, 1 mg
CLM-8011	DL-2-Hydroxyestrone (13,14,15,16,17,18-$^{13}C_6$, 99%)	neat	0.1 mg
CLM-8016	DL-2-Hydroxyestrone-3-methyl ether (13,14,15,16,17,18-$^{13}C_6$, 99%)	neat	0.1 mg
CLM-8013	DL-4-Hydroxyestrone (13,14,15,16,17,18-$^{13}C_6$, 99%) CP 97%	neat	0.1 mg
DLM-7206	17α-Hydroxypregnenolone (21,21,21-D_3, 97%)	neat	Please inquire
CDLM-9154-C	17α-Hydroxypregnenolone (20,21-$^{13}C_2$, 98%; 16,16-D_2, 98%)	100 µg/mL in methanol	1 mL
CDLM-9154	17α-Hydroxypregnenolone (20,21-$^{13}C_2$, 98%; 16,16-D_2, 98%)	neat	1 mg
ULM-9155-D	17α-Hydroxypregnenolone (unlabeled)	1000 µg/mL in methanol	1 mL
ULM-9155-C	17α-Hydroxypregnenolone (unlabeled)	100 µg/mL in methanol	1 mL
ULM-9155	17α-Hydroxypregnenolone (unlabeled)	neat	Please inquire
CLM-9157-D	17α-Hydroxyprogesterone (2,3,4-$^{13}C_3$, 98%)	1000 µg/mL in methanol	1 mL
CLM-9157-C	17α-Hydroxyprogesterone (2,3,4-$^{13}C_3$, 98%)	100 µg/mL in methanol	1 mL
CLM-9157	17α-Hydroxyprogesterone (2,3,4-$^{13}C_3$, 98%)	neat	1 mg, 5 mg
DLM-6598	17α-Hydroxyprogesterone (2,2,4,6,6,21,21,21-D_8, 98%)	neat	10 mg, 0.05 g
ULM-9156-C	17α-Hydroxyprogesterone (unlabeled) CP 95%	100 µg/mL in methanol	1 mL
ULM-9156	17α-Hydroxyprogesterone (unlabeled)	neat	1 mg, 5 mg, 10 mg
DLM-8647	7-Ketocholesterol (25,26,26,26,27,27,27-D_7, 99%)	neat	Please inquire
DLM-10395	11-Ketotestosterone (16,16,17-D_3) CP 95%	neat	1 mg
DLM-7101	Melatonin (acetyl-D_3, 98%)	neat	5 mg, 10 mg
DLM-3560	DL-Metanephrine·HCl (α,β,β-D_3, 98%)	neat	5 mg, 10 mg
CLM-8015	DL-2-Methoxyestradiol (13,14,15,16,17,18-$^{13}C_6$, 99%)	neat	0.1 mg
ULM-8137	DL-2-Methoxyestradiol (unlabeled)	neat	0.1 mg
CLM-8014	DL-2-Methoxyestrone (13,14,15,16,17,18-$^{13}C_6$, 99%)	neat	0.1 mg
CLM-8017	DL-4-Methoxyestrone (13,14,15,16,17,18-$^{13}C_6$, 99%)	neat	0.1 mg
ULM-8263	2-Methoxyestrone (unlabeled)	neat	0.1 mg
ULM-8262	4-Methoxyestrone (unlabeled)	neat	0.1 mg
DLM-8820	DL-Norepinephrine·HCl (ring-D_3,1,2,2-D_3, 99%)	neat	5 mg, 10 mg
CLM-2468	Norethindrone (ethynyl-$^{13}C_2$, 99%)	neat	10 mg
CLM-9980	Nestorone (16-methylene-^{13}C, 20,21-$^{13}C_2$, 99%) CP 96%	neat	Please inquire
DLM-8609	DL-Normetanephrine·HCl (α,β,β-D_3, 98%)	neat	5 mg, 10 mg
DLM-3979-1.2	19-Nortestosterone (16,16,17-D_3, 98%)	100 µg/mL in methanol	1.2 mL
DLM-3979	19-Nortestosterone (16,16,17-D_3, 98%)	neat	5 mg
ULM-4841-1.2	19-Nortestosterone (unlabeled)	100 µg/mL in methanol	1.2 mL
DLM-3754	5α-Pregnan-3α-ol-20-one (17,21,21,21-D_4, 96-98%) CP 95%	neat	10 mg

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
For research use only. Not for use in diagnostic procedures.

Catalog No.	Description	Concentration	Unit Size
DLM-7492	5α-Pregnan-3β-ol-20-one (17α,21,21,21-D_4, 97%) CP 96%	neat	Please inquire
ULM-8242	5α-Pregnan-3β-ol-20-one (unlabeled)	neat	1 mg
DLM-10969-C	5α-Pregnan-3α,11β,17,21-tetrol-20-one (2,2,3,4,4-D_5, 98%)	100 µg/mL in methanol	1 mL
DLM-10969	5α-Pregnan-3α,11β,17,21-tetrol-20-one (2,2,3,4,4-D_5, 98%)	neat	1 mg
DLM-11010-C	5α-Pregnan-3α,17,21-triol-11,20-dione (2,2,4,4-D_4, 98%)	100 µg/mL in methanol	1 mL
DLM-11010	5α-Pregnan-3α,17,21-triol-11,20-dione (2,2,4,4-D_4, 98%)	neat	Please inquire
DLM-11009-C	5α-Pregnan-3α,17,21-triol-11,20-dione (2,2,3,4,4-D_5, 98%)	100 µg/mL in methanol	1 mL
DLM-11009	5α-Pregnan-3α,17,21-triol-11,20-dione (2,2,3,4,4-D_5, 98%)	neat	Please inquire
DLM-2294	5β-Pregnan-3α-ol-20-one (17,21,21,21-D_4, 96-98%)	neat	10 mg
DLM-8751	5β-Pregnan-3α,11β,17α,21-tetrol-20-one (9,11α,12-D_3, 95%)	neat	Please inquire
DLM-11014-C	5β-Pregnan-3α,11β,17α,21-tetrol-20-one (2,2,3,4,4-D_5, 98%)	100 µg/mL in methanol	1 mL
DLM-11014	5β-Pregnan-3α,11β,17α,21-tetrol-20-one (2,2,3,4,4-D_5, 98%)	neat	1 mg
ULM-11015-C	5β-Pregnan-3α,11β,17α,21-tetrol-20-one (unlabeled)	100 µg/mL in methanol	1 mL
ULM-11015	5β-Pregnan-3α,11β,17α,21-tetrol-20-one (unlabeled)	neat	1 mg
DLM-11012-C	5β-Pregnan-3α,11β,21-triol-20-one (2,2,3,4,4-D_5, 98%) CP 95%	100 µg/mL in methanol	1 mL
DLM-11012	5β-Pregnan-3α,11β,21-triol-20-one (2,2,3,4,4-D_5, 98%) CP 95%	neat	1 mg
ULM-11011-C	5β-Pregnan-3α,11β,21-triol-20-one (unlabeled)	100 µg/mL in methanol	1 mL
ULM-11011	5β-Pregnan-3α,11β,21-triol-20-one (unlabeled)	neat	1 mg
DLM-11013-C	5β-Pregnan-3α,17,21-triol-11,20-dione (2,2,3,4,4-D_5, 98%)	100 µg/mL in methanol	1 mL
DLM-11013	5β-Pregnan-3α,17,21-triol-11,20-dione (2,2,3,4,4-D_5, 98%)	neat	1 mg
DLM-8753	5β-Pregnan-3α,17α,20-triol (20,21,21,21-D_4, 98%) (mix of 20α and 20β)	neat	Please inquire
CLM-10411	5β-Pregnane-3α-20α-diol (2,3,4,20,21-$^{13}C_5$, 99%) CP 95%	neat	1 mg
DLM-10413	5β-Pregnane-3α-20α-diol (2,2,3,4,4-D_5, 98%), 99%) CP 95%	neat	1 mg
CLM-10412	5β-Pregnane-3α-20α-diol glucuronide, sodium salt (2,3,4,20,21-$^{13}C_5$, 99%) CP 95%	neat	1 mg
DLM-3910	5α-Pregnane-3α,21-diol-20-one (17,21,21-D_3, 95%)	neat	10 mg
ULM-10385	5α-Pregnane-3α,21-diol-20-one (unlabeled)	neat	1 mg
DLM-3816	5α-Pregnane-3,20-dione (1,2,4,5,6,7-D_6, 95%)	neat	10 mg, 0.05 g
DLM-9901	5β-Pregnane-3,20-dione (2,2,4,4,17α,21,21,21-D_8, 98%) CP 97%	neat	Please inquire
CLM-10010-C	4-Pregnen-21-ol-3,20-dione (2,3,4-$^{13}C_3$, 99%)	100 µg/mL in methanol	1 mL
CLM-10010	4-Pregnen-21-ol-3,20-dione (2,3,4-$^{13}C_3$, 99%)	neat	Please inquire
DLM-7228	4-Pregnen-21-ol-3,20-dione (2,2,4,6,6,17,21,21-D_8, 96%) CP 97%	neat	Please inquire
ULM-10011-C	4-Pregnen-21-ol-3,20-dione (unlabeled)	100 µg/mL in methanol	1 mL
ULM-10011	4-Pregnen-21-ol-3,20-dione (unlabeled)	neat	1 mg
DLM-6896	Pregnenolone (17,21,21,21-D_4, 98%)	neat	10 mg
CDLM-9158-C	Pregnenolone (20,21-$^{13}C_2$, 99%;16,16-D_2, 98%)	100 µg/mL in acetonitrile	1 mL
CDLM-9158	Pregnenolone (20,21-$^{13}C_2$, 98%;16,16-D_2, 98%)	neat	1 mg, 5 mg
ULM-9159-C	Pregnenolone (unlabeled)	100 µg/mL in methanol	1 mL
ULM-9159	Pregnenolone (unlabeled)	neat	1 mg, 5 mg, 10 mg
CDLM-9160	Pregnenolone sulfate, sodium salt (20,21-$^{13}C_2$, 99%; 16,16-D_2, 98%)	neat	1 mg, 5 mg
ULM-9161	Pregnenolone sulfate, sodium salt (unlabeled)	neat	1 mg, 5 mg, 10 mg
CLM-457	Progesterone (3,4-$^{13}C_2$, 90%)	neat	10 mg
CLM-9162-C	Progesterone (2,3,4-$^{13}C_3$, 99%)	100 µg/mL in acetonitrile	1 mL
CLM-9162-B	Progesterone (2,3,4-$^{13}C_3$, 99%)	50 µg/mL in acetonitrile	1 mL
CLM-9162	Progesterone (2,3,4-$^{13}C_3$, 99%)	neat	1 mg, 5 mg
CLM-10414	Progesterone (2,3,4,20,21-$^{13}C_5$, 99%)	neat	1 mg
DLM-7953-1.2	Progesterone (2,2,4,6,6,17α,21,21,21-D_9, 98%)	100 µg/mL in *p*-dioxane	1.2 mL
DLM-7953	Progesterone (2,2,4,6,6,17α,21,21,21-D_9, 98%)	neat	10 mg
ULM-8219-1.2	Progesterone (unlabeled)	100 µg/mL in *p*-dioxane	1.2 mL
DLM-3627	Prostaglandin A2 (3,3,4,4-D_4, 98%)	500 µg/mL in methyl acetate	Please inquire
DLM-3728	Prostaglandin E1 (3,3,4,4-D_4, 98%)	500 µg/mL in methyl acetate	Please inquire
DLM-3628	Prostaglandin E2 (3,3,4,4-D_4, 98%)	500 µg/mL in methyl acetate	Please inquire
DLM-3558	Prostaglandin-F2α (3,3,4,4-D_4, 98%)	Please inquire	Please inquire

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
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Steroids and Hormones *(continued)*

Catalog No.	Description	Concentration	Unit Size
DLM-7457	Sodium 17β-estradiol 3-sulfate (2,4,16,16-D_4, 98%) (stabilized with 50% w/w Tris)	neat	Please inquire
DLM-7456	Sodium estrone 3-sulfate (2,4,16,16-D_4, 98%) (stabilized with 50% w/w Tris)	neat	Please inquire
ULM-8132	Sodium estrone 3-sulfate (unlabeled)	neat	0.1 mg
CLM-8018	DL-Sodium estrone 3-sulfate (13,14,15,16,17,18-$^{13}C_6$, 99%) (12-13% sodium acetate)	neat	0.1 mg
DLM-9503	Stigmastanol (2,2,3,4,4-D_5, 98%)	neat	10 mg
CLM-159	Testosterone (3,4-$^{13}C_2$, 99%)	neat	10 mg
CLM-9164-C	Testosterone (2,3,4-$^{13}C_3$, 99%)	100 µg/mL in methanol	1 mL
CLM-9164	Testosterone (2,3,4-$^{13}C_3$, 99%)	neat	5 mg, 10 mg
DLM-683-1.2	Testosterone (1,2-D_2, 98%)	100 µg/mL in methylene chloride	1.2 mL
DLM-683	Testosterone (1,2-D_2, 98%)	neat	0.1 g
DLM-6224-C	Testosterone (16,16,17-D_3, 98%)	100 µg/mL in methanol	1 mL
DLM-6224	Testosterone (16,16,17-D_3, 98%)	neat	5 mg
DLM-8085-D-1.2	Testosterone (2,2,4,6,6-D_5, 98%)	100 µg/mL in dioxane	1.2 mL
DLM-8085-1.2	Testosterone (2,2,4,6,6-D_5, 98%)	100 µg/mL in methylene chloride	1.2 mL
DLM-8085	Testosterone (2,2,4,6,6-D_5, 98%)	neat	Please inquire
ULM-8081-1.2	Testosterone (unlabeled)	100 µg/mL in methylene chloride	1.2 mL
DLM-8265	Testosterone diacetate (testosterone-D_4, acetate methyl-D_6, 98%)	neat	Please inquire
DLM-11016-C	3α,5β-Tetrahydroaldosterone (2,2,4,4,6,6-D_6, 98%) CP 95%	100 µg/mL in acetonitrile	1 mL
DLM-11016	3α,5β-Tetrahydroaldosterone (2,2,4,4,6,6-D_6, 98%) CP 95%	neat	Please inquire
ULM-9163	3α,5β-Tetrahydroaldosterone (unlabeled)	neat	1 mg, 5 mg
CLM-7185-C	3,3',5-Triiodo-L-thyronine·HCl (T3) (ring-$^{13}C_6$, 99%)	100 µg/mL 0.1 N NH_3 in methanol	1 mL
CLM-7185	3,3',5-Triiodo-L-thyronine·HCl (ring-$^{13}C_6$, 99%) CP 95%	neat	1 mg, 5 mg, 10 mg
CLM-10596	3,3',5-Triiodo-L-thyronine (ring-$^{13}C_{12}$, 99%) CP 94%	neat	Please inquire
ULM-10573-C	3,3',5-Triiodo-L-thyronine·HCl (T3) (unlabeled) CP 95%	100 µg/mL 0.1 N NH_3 in methanol	1 mL
ULM-10573	3,3',5-Triiodo-L-thyronine·HCl (T3) (unlabeled) CP 95%	neat	1 mg, 5 mg, 10 mg
CLM-10601-C	Reverse 3,3',5-triiodo-L-thyronine·HCl (rev T3) (diiodophenyl-ring-$^{13}C_6$, 99%)	100 µg/mL 0.1 N NH_3 in methanol	1 mL
CLM-10601	Reverse 3,3',5-triiodo-L-thyronine·HCl (rev T3) (diiodophenyl-ring-$^{13}C_6$, 99%) CP 95%	neat	1 mg, 5 mg, 10 mg
ULM-10602-C	Reverse 3,3',5-triiodo-L-thyronine·HCl (rev T3) (unlabeled) CP 95%	100 µg/mL 0.1 N NH_3 in methanol	1 mL
DLM-10026	Triamcinolone hexacetonide (16,17-isopropylidenedioxy-D_6, 98%)	neat	Please inquire
DLM-6989	Tryptamine·HCl (α,α,β,β-D_4, 97%)	neat	Please inquire

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
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Vitamins and Their Metabolites

Vitamins are organic compounds that directly or indirectly participate in organisms' biochemical reactions. These are divided into two classes, based on their solubility in fat (includes A, D, E, and K) and water (includes B and C).

CIL offers unlabeled and stable isotope-labeled vitamins as neat compounds and/or in solution at specified concentrations. These can be used in a wide range of applications, such as metabolism and pathophysiology explorations, as well as disease biomarker evaluation in pre-clinical and clinical MS studies (e.g., vitamin D deficiency). These standards help facilitate accurate and precise quantification of endogenous metabolites in biological matrices.

Water Soluble

Catalog No.	Description	Concentration	Unit Size
CLM-9548	5-Methyltetrahydrofolic acid (glutamic acid-$^{13}C_5$, 99%) CP 95%	neat	1 mg, 5 mg
CLM-7321-N	5-Methyltetrahydrofolic acid, calcium salt (glutamic acid-$^{13}C_5$, 98%) CP 95%	neat	1 mg, 5 mg
DLM-9793-N	Pyridoxal phosphate (mix of 5-,3-isomers) (methyl-D_3, 97%)	neat	1 mg
CLM-7667	Vitamin B_1 hydrochloride (thiamine hydrochloride) (4,5,4-methyl-$^{13}C_3$, 99%) CP 97%	neat	5 mg
ULM-10004	Vitamin B_1 hydrochloride (thiamine hydrochloride) (unlabeled)	neat	1 mg, 5 mg, 10 mg
DLM-8741	Vitamin B_1 pyrophosphate chloride (thiamine pyrophosphate chloride) (pyrimidyl-methyl-D_3, 98%)	neat	1 mg
V-053*	Vitamin B_1 pyrophosphate (thiamine pyrophosphate) (unlabeled)	1 mg/mL in methanol:water (1:1)	1 mL
CNLM-8851	Vitamin B_2 (riboflavin) ($^{13}C_4$, 99%; $^{15}N_2$, 98%) CP 97%	neat	1 mg, 5 mg, 10 mg
ULM-9123	Vitamin B_2 (riboflavin) (unlabeled) CP 97%	neat	1 mg, 5 mg, 10 mg
CNLM-10744	Vitamin B_2 phosphate (riboflavin phosphate) ($^{13}C_4$, 99%; $^{15}N_2$, 98%) CP 90%	neat	1 mg
CLM-9925	Vitamin B_3 (nicotinamide) ($^{13}C_6$, 99%)	neat	1 mg, 5 mg
DLM-6883	Vitamin B_3 (nicotinamide) (D_4, 98%)	neat	0.1 g, 0.5 g
CNLM-9757	Vitamin B_3 (nicotinamide) (2,6-carbonyl-$^{13}C_3$, 99%; ring-1-^{15}N, 98%)	neat	1 mg
CLM-9954	Vitamin B_3 (nicotinic acid) ($^{13}C_6$, 99%)	neat	1 mg, 5 mg
DLM-4578	Vitamin B_3 (nicotinic acid) (D_4, 98%)	neat	5 mg, 1 g
DLM-2872	Vitamin B_3, ethyl ester (nicotinic acid, ethyl ester) (2,4,5,6-D_4, 98%)	neat	5 g
CNLM-9512	Vitamin B_3 (nicotinic acid) (2,6,carboxyl-$^{13}C_3$, 99%; ^{15}N, 98%) CP 97%	neat	1 mg
CNLM-7694	Vitamin B_5, calcium salt·H_2O (calcium pantothenate·H_2O) (β-alanyl-$^{13}C_3$, 99%; ^{15}N, 98%)	neat	10 mg
ULM-10003	Vitamin B_5, calcium salt·H_2O (calcium pantothenate·H_2O) (unlabeled)	neat	1 mg, 5 mg, 10 mg
DLM-9069	Vitamin B_6 (pyridoxal) (methyl-D_3, 98%)	neat	1 mg, 5 mg, 10 mg
ULM-9118	Vitamin B_6 (pyridoxal·HCl) (unlabeled)	neat	1 mg, 5 mg, 10 mg
DLM-9119	Vitamin B_6 (pyridoxamine·2HCl) (methyl-D_3, 98%)	neat	1 mg, 5 mg, 10 mg
ULM-9120	Vitamin B_6 (pyridoxamine·2HCl) (unlabeled)	neat	1 mg, 5 mg, 10 mg
CLM-7563	Vitamin B_6 (pyridoxine·HCl) (4,5-bis(hydroxymethyl)-$^{13}C_4$, 99%)	neat	10 mg
DLM-8754	Vitamin B_6 (pyridoxine·HCl) (5-hydroxymethyl-D_2, 98%)	neat	1 mg, 5 mg
DLM-9121	Vitamin B_6 (pyridoxine·HCl) (methyl-D_3, 98%) CP 96%	neat	1 mg, 5 mg, 10 mg
ULM-9122	Vitamin B_6 (pyridoxine·HCl) (unlabeled) CP 96%	neat	1 mg, 5 mg, 10 mg
DLM-8806	Vitamin B_7 (biotin) (ring-6,6-D_2, 98%) CP 97%	neat	5 mg, 10 mg, 20 mg
DLM-9751	Vitamin B_7 (biotin) (3',3',4',4'-D_4, 98%) CP 95%	neat	1 mg
ULM-9129	Vitamin B_7 (biotin) (unlabeled)	neat	1 mg, 5 mg
CLM-7861-N	Vitamin B_9 (folic acid) (glutamic acid-$^{13}C_5$, 99%) CP 95%	neat	1 mg, 5 mg
CLM-7861	Vitamin B_9 (folic acid) (glutamic acid-$^{13}C_5$, 95%) (contains ~10% H_2O)	neat	Please inquire
CNLM-9564	Vitamin B_9 (folic acid) (glutamic acid-$^{13}C_5$, 99%; ^{15}N, 98%) CP 95%	neat	1 mg, 5 mg
CLM-9770-E	Vitamin B_{12} (cyanocobalamin) ($^{13}C_7$, 99%) CP 95%	1 µg/mL in methanol	1 mL
ULM-10005-E	Vitamin B_{12} (cyanocobalamin) (unlabeled)	1 µg/mL in methanol	1 mL
CLM-3085	Vitamin C (L-ascorbic acid) (1-^{13}C, 99%)	neat	0.05 g, 0.1 g, 0.25 g, 0.5 g
CLM-10991	Vitamin C (L-ascorbic acid) (1,2-$^{13}C_2$, 99%)	neat	Please inquire
CLM-7283	Vitamin C (L-ascorbic acid) (U-$^{13}C_6$, 98%)	neat	0.05 g, 0.1 g
V-038*	Vitamin C (L-ascorbic acid) (unlabeled)	1 mg/mL in acetonitrile:water (1:1)	1 mL

**Products listed with an asterisk are available only in the US, Switzerland, and Australia.*

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
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Vitamins and Their Metabolites *(continued)*

Fat Soluble

Catalog No.	Description	Concentration	Unit Size
CLM-6126	β-Carotene (10,10′,11,11′-$^{13}C_4$, 99%)	neat	Please inquire
CLM-9641	β-Carotene (12,12′,13,13′,14,14′,15,15′,20,20′-$^{13}C_{10}$, 99%) CP 97%	neat	Please inquire
DLM-3829	β-Carotene (19,19,19,19′,19′,19′-D_6, 98%)	neat	Please inquire
DLM-2439	β-Carotene (10,10′,19,19,19,19′,19′,19′-D_8, 97%)	neat	Please inquire
ULM-9106-C	1,25-Dihydroxyvitamin D2 (unlabeled) CP 95%	100 µg/mL in ethanol	1 mL
ULM-9106-B	1,25-Dihydroxyvitamin D2 (unlabeled) CP 95%	50 µg/mL in ethanol	1 mL
ULM-9106	1,25-Dihydroxyvitamin D2 (unlabeled) CP 95%	neat	0.1 mg, 1 mg
DLM-9107-C	1,25-Dihydroxyvitamin D3 (6,19,19-D_3, 97%) CP 95%	100 µg/mL in ethanol	1 mL
DLM-9107-B	1,25-Dihydroxyvitamin D3 (6,19,19-D_3, 97%) CP 95%	50 µg/mL in ethanol	1 mL
DLM-9107	1,25-Dihydroxyvitamin D3 (6,19,19-D_3, 97%) CP 95%	neat	1 mg
ULM-9108-C	1,25-Dihydroxyvitamin D3 (unlabeled) CP 95%	100 µg/mL in ethanol	1 mL
ULM-9108-B	1,25-Dihydroxyvitamin D3 (unlabeled) CP 95%	50 µg/mL in ethanol	1 mL
ULM-9108	1,25-Dihydroxyvitamin D3 (unlabeled) CP 95%	neat	0.5 mg, 1 mg
ULM-9109-C	24,25-Dihydroxyvitamin D2 (unlabeled)	100 µg/mL in ethanol	1 mL
ULM-9109	24,25-Dihydroxyvitamin D2 (unlabeled)	neat	1 mg
DLM-9404-C	24*R*,25-Dihydroxyvitamin D3 (26,26,26,27,27,27-D_6, 98%) CP 97%	100 µg/mL in ethanol	1 mL
DLM-9404	24*R*,25-Dihydroxyvitamin D3 (26,26,26,27,27,27-D_6, 98%) CP 97%	neat	1 mg
ULM-10610-C	24*R*,25-Dihydroxyvitamin D3 (unlabeled) CP 97%	100 µg/mL in ethanol	1 mL
ULM-10610	24*R*,25-Dihydroxyvitamin D3 (unlabeled) CP 97%	neat	1 mg
ULM-9110-C	3-*epi*-25-Hydroxyvitamin D2 (unlabeled)	100 µg/mL in ethanol	1 mL
ULM-9110-B	3-*epi*-25-Hydroxyvitamin D2 (unlabeled)	50 µg/mL in ethanol	1 mL
ULM-9110	3-*epi*-25-Hydroxyvitamin D2 (unlabeled)	neat	1 mg
DLM-9114-C	25-Hydroxyvitamin D2 (6,19,19-D_3, 97%)	100 µg/mL in ethanol	1 mL
DLM-9114-B	25-Hydroxyvitamin D2 (6,19,19-D_3, 97%)	50 µg/mL in ethanol	1 mL
DLM-9114-A	25-Hydroxyvitamin D2 (6,19,19-D_3, 97%)	5 µg/mL in ethanol	1 mL
DLM-9114	25-Hydroxyvitamin D2 (6,19,19-D_3, 97%)	neat	1 mg
DLM-10219	25-Hydroxyvitamin D2 (26,26,26,27,27,27-D_6, 96%) CP 95%	neat	Please inquire
ULM-9115-C	25-Hydroxyvitamin D2 (unlabeled)	100 µg/mL in ethanol	1 mL
ULM-9115-B	25-Hydroxyvitamin D2 (unlabeled)	50 µg/mL in ethanol	1 mL
ULM-9115-A	25-Hydroxyvitamin D2 (unlabeled)	5 µg/mL in ethanol	1 mL
ULM-9115	25-Hydroxyvitamin D2 (unlabeled)	neat	1 mg
DLM-10611-C	25-Hydroxyvitamin D2 sulfate, sodium salt (6,19,19-D_3, 97%) CP 97%	100 µg/mL in ethanol	1 mL
ULM-10612-C	25-Hydroxyvitamin D2 sulfate, sodium salt (unlabeled) CP 97%	100 µg/mL in ethanol	1 mL
CLM-10266-C	3-*epi*-25-Hydroxyvitamin D3 (23,24,25,26,27-$^{13}C_5$, 99%) CP 96%	100 µg/mL in ethanol	1 mL
DLM-9111-C	3-*epi*-25-Hydroxyvitamin D3 (6,19,19-D_3, 98%)	100 µg/mL in ethanol	1 mL
DLM-9111-B	3-*epi*-25-Hydroxyvitamin D3 (6,19,19-D_3, 98%)	50 µg/mL in ethanol	1 mL
DLM-9111	3-*epi*-25-Hydroxyvitamin D3 (6,19,19-D_3, 98%)	neat	1 mg
DLM-10912	3-*epi*-25-Hydroxyvitamin D3 (26,26,26,27,27,27-D_6, 96%) CP 95%	neat	Please inquire
ULM-9112-C	3-*epi*-25-Hydroxyvitamin D3 (unlabeled)	100 µg/mL in ethanol	1 mL
ULM-9112-B	3-*epi*-25-Hydroxyvitamin D3 (unlabeled)	50 µg/mL in ethanol	1 mL
ULM-9112	3-*epi*-25-Hydroxyvitamin D3 (unlabeled)	neat	1 mg
CLM-10025-C	25-Hydroxyvitamin D3 (23,24,25,26,27-$^{13}C_5$, 99%) CP 95%	100 µg/mL in ethanol	1 mL
CLM-10025	25-Hydroxyvitamin D3 (23,24,25,26,27-$^{13}C_5$, 99%) CP 95%	neat	1 mg
DLM-9116-C	25-Hydroxyvitamin D3 (6,19,19-D_3, 97%)	100 µg/mL in ethanol	1 mL
DLM-9116-B	25-Hydroxyvitamin D3 (6,19,19-D_3, 97%)	50 µg/mL in ethanol	1 mL
DLM-9116-A	25-Hydroxyvitamin D3 (6,19,19-D_3, 97%)	5 µg/mL in ethanol	1 mL
DLM-9116	25-Hydroxyvitamin D3 (6,19,19-D_3, 97%)	neat	1 mg, 5 mg
ULM-9117-C	25-Hydroxyvitamin D3 (unlabeled)	100 µg/mL in ethanol	1 mL
ULM-9117-B	25-Hydroxyvitamin D3 (unlabeled)	50 µg/mL in ethanol	1 mL
ULM-9117-A	25-Hydroxyvitamin D3 (unlabeled)	5 µg/mL in ethanol	1 mL
ULM-9117	25-Hydroxyvitamin D3 (unlabeled)	neat	5 mg

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Catalog No.	Description	Concentration	Unit Size
DLM-7708-C	25-Hydroxyvitamin D3 monohydrate (26,26,26,27,27,27-D_6, 98%) CP 97%	100 µg/mL in ethanol	1 mL
DLM-7708-B	25-Hydroxyvitamin D3 monohydrate (26,26,26,27,27,27-D_6, 98%) CP 97%	50 µg/mL in ethanol	1 mL
DLM-7708	25-Hydroxyvitamin D3 monohydrate (26,26,26,27,27,27-D_6, 98%) CP 97%	neat	1 mg
DLM-10782-C	25-Hydroxyvitamin D3 sulfate, sodium salt (6,19,19-D_3, 97%) CP 97%	100 µg/mL in ethanol	Please inquire
DLM-10781-C	25-Hydroxyvitamin D3 sulfate, sodium salt (unlabeled) CP 97%	100 µg/mL in ethanol	Please inquire
CLM-331	Vitamin A (retinoic acid) (10-^{13}C, 99%)	neat	Please inquire
CLM-328	Vitamin A (retinoic acid) (11-^{13}C, 98%)	neat	Please inquire
CLM-329	Vitamin A (retinoic acid) (14-^{13}C, 99%)	neat	Please inquire
CLM-330	Vitamin A (retinoic acid) (15-^{13}C, 99%)	neat	Please inquire
CLM-4343	Vitamin A (retinoic acid) (10,11,14,15-$^{13}C_4$, 99%)	neat	Please inquire
DLM-7720	Vitamin A (retinoic acid) (19,19,19,20,20,20-D_6, 96%)	neat	Please inquire
CLM-10259	Vitamin A (retinol) (12,13,14,20-$^{13}C_4$, 99%)	neat	Please inquire
DLM-9305	Vitamin A (retinol) (10,19,19,19-D_4, 96%)	neat	1 mg
DLM-8113	Vitamin A (retinol) (19,19,19,20,20,20-D_6, 97%)	neat	1 mg
DLM-9306	Vitamin A (retinol) (10,14,19,19,19,20,20,20-D_8, 90%) CP 96%	neat	Please inquire
CLM-8870	Vitamin A acetate (retinol acetate) (12,13,14,20-$^{13}C_4$, 99%)	neat	Please inquire
CLM-4831	Vitamin A acetate (retinol acetate) (8,9,10,12,13,14,19,20-$^{13}C_8$, 99%)	neat	Please inquire
CLM-7277	Vitamin A acetate (retinol acetate) (8,9,10,11,12,13,14,15,19,20-$^{13}C_{10}$, 99%)	neat	Please inquire
DLM-2244	Vitamin A acetate (retinol acetate) (10,19,19,19-D_4, 96%) (3-4% *cis*)	neat	Please inquire
DLM-3828	Vitamin A acetate (retinol acetate) (19,19,19,20,20,20-D_6, 96%) (3-4% *cis*)	neat	Please inquire
DLM-4203	Vitamin A acetate (retinol acetate) (10,14,19,19,19,20,20,20-D_8, 90%) (3-4% *cis*)	neat	Please inquire
CLM-320	Vitamin A aldehyde (retinal) (10-^{13}C, 99%)	neat	Please inquire
CLM-325	Vitamin A aldehyde (retinal) (11-^{13}C, 99%)	neat	Please inquire
CLM-326	Vitamin A aldehyde (retinal) (14-^{13}C, 99%)	neat	Please inquire
CLM-327	Vitamin A aldehyde (retinal) (15-^{13}C, 98%)	neat	Please inquire
CLM-10772	Vitamin A aldehyde (retinal) (12,13,14,20-$^{13}C_4$, 96%)	neat	Please inquire
DLM-7719	Vitamin A aldehyde (retinal) (19,19,19,20,20,20-D_6, 96%)	neat	Please inquire
CLM-9395	Vitamin A palmitate (retinyl palmitate) (12,13,20-$^{13}C_3$, 98%) (all *trans*, <4% *cis,* 50 ppm butylated hydroxytoluene – "BHT")	neat	Please inquire
CLM-10838	Vitamin A palmitate (retinyl palmitate) (8,9,10,11,12,13,14,15,19,20-$^{13}C_{10}$, 99%) (all *trans*, <4% *cis,* 50 ppm butylated hydroxytoluene – "BHT")	neat	Please inquire
DLM-4902	Vitamin A palmitate (retinyl palmitate) (10,19,19,19-D_4, 96%) (all *trans*, <4% *cis,* 50 ppm butylated hydroxytoluene – "BHT")	neat	1 mg
DLM-9309	Vitamin A palmitate (retinyl palmitate) (19,19,19,20,20,20-D_6, 97%) (all *trans*, <4% *cis,* 50 ppm butylated hydroxytoluene – "BHT")	neat	Please inquire
DLM-8985-D	Vitamin D_2 (ergocalciferol) (6,19,19-D_3, 97%)	1000 µg/mL in ethanol	1 mL
DLM-8985-C	Vitamin D_2 (ergocalciferol) (6,19,19-D_3, 97%)	100 µg/mL in ethanol	1 mL
DLM-8985	Vitamin D_2 (ergocalciferol) (6,19,19-D_3, 97%)	neat	1 mg
ULM-9124-D	Vitamin D_2 (ergocalciferol) (unlabeled)	1000 µg/mL in ethanol	1 mL
ULM-9124-C	Vitamin D_2 (ergocalciferol) (unlabeled)	100 µg/mL in ethanol	1 mL
ULM-9124	Vitamin D_2 (ergocalciferol) (unlabeled)	neat	1 mg, 5 mg, 10 mg
DLM-10478-C	Vitamin D_2 sulfate, sodium salt (ergocalciferol sulfate) (6,19,19-D_3, 98%) CP 97%	100 µg/mL in ethanol	1 mL
ULM-10477-C	Vitamin D_2 sulfate, sodium salt (ergocalciferol sulfate) (unlabeled) CP 97%	100 µg/mL in ethanol	1 mL
CLM-7850	Vitamin D_3 (cholecalciferol) (23,24-$^{13}C_2$, 99%) CP 90%	neat	Please inquire
CLM-10470-D	Vitamin D_3 (cholecalciferol) (23,24,25,26,26-$^{13}C_5$, 98%) CP 97%	1000 µg/mL in ethanol	1 mL
CLM-10470-C	Vitamin D_3 (cholecalciferol) (23,24,25,26,26-$^{13}C_5$, 98%) CP 97%	100 µg/mL in ethanol	1 mL
DLM-8853-D	Vitamin D_3 (cholecalciferol) (6,19,19-D_3, 97%) CP 97%	1000 µg/mL in ethanol	1 mL
DLM-8853-C	Vitamin D_3 (cholecalciferol) (6,19,19-D_3, 97%) CP 97%	100 µg/mL in ethanol	1 mL
DLM-10749-D	Vitamin D_3 (cholecalciferol) (26,26,26,27,27,27-D_6, 98%) CP 95%	1 mg/mL in ethanol	1 mL
DLM-10749-C	Vitamin D_3 (cholecalciferol) (26,26,26,27,27,27-D_6, 98%) CP 95%	100 µg/mL in ethanol	1 mL
ULM-9125-D	Vitamin D_3 (cholecalciferol) (unlabeled)	1000 µg/mL in ethanol	1 mL

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Vitamins and Their Metabolites *(continued)*

Catalog No.	Description	Concentration	Unit Size
ULM-9125-C	Vitamin D_3 (cholecalciferol) (unlabeled)	100 µg/mL in ethanol	1 mL
ULM-9125	Vitamin D_3 (cholecalciferol) (unlabeled)	neat	1 mg, 5 mg, 10 mg
DLM-10475-C	Vitamin D_3 sulfate, sodium salt (cholecalciferol sulfate) (6,19,19-D_3, 98%) CP 97%	100 µg/mL in ethanol	1 mL
ULM-10474-C	Vitamin D_3 sulfate, sodium salt (cholecalciferol sulfate) (unlabeled) CP 97%	100 µg/mL in ethanol	1 mL
CLM-10274	Vitamin E (DL-α-tocopherol) (trimethylphenyl-$^{13}C_3$, 99%) CP 96%	neat	1 mg
CLM-10273	Vitamin E (α-tocopherol) (trimethyl-$^{13}C_3$ phenyl, 99%) CP 96%	neat	1 mg
CLM-10275	Vitamin E (α-tocopherol) (phenyl-$^{13}C_6$, 99%) CP 96%	neat	1 mg
CLM-10276	Vitamin E (α-tocopherol) (trimethylphenyl-$^{13}C_9$, 99%) CP 96%	neat	1 mg
DLM-9126	Vitamin E (α-tocopherol) (5-methyl-D_3, 7-methyl-D_3, 98%)	neat	2 mg, 5 mg, 10 mg
CDLM-11053-1.2	Vitamin E (α-tocopherol) (dimethyl-$^{13}C_2$, 99%; dimethyl-D_6, 98%)	100 µg/mL in methanol	1.2 mL
ULM-9127-1.2	Vitamin E (α-tocopherol) (unlabeled)	100 µg/mL in methanol	1.2 mL
ULM-9127	Vitamin E (α-tocopherol) (unlabeled) CP 96%	neat	1 mg, 5 mg, 10 mg
DLM-8847	Vitamin E acetate (α-tocopherol acetate) (acetyl-D_3, 98%)	neat	Please inquire
CDLM-11054-1.2	Vitamin E acetate (α-tocopherol acetate) (dimethyl-$^{13}C_2$, acetyl-$^{13}C_2$, 99%; dimethyl-D_6, 98%)	100 µg/mL in methanol	1.2 mL
ULM-11055-1.2	Vitamin E acetate (α-tocopherol acetate) (unlabeled)	100 µg/mL in methanol	1.2 mL
CLM-9566	Vitamin K_1 (phylloquinone) (4α,5,6,7,8,8α-$^{13}C_6$, 99%)	neat	1 mg
DLM-7702	Vitamin K_1 (phylloquinone) (ring-D_4, 98%)	neat	1 mg
DLM-9130	Vitamin K_1 (phylloquinone) (D_7, 99%) CP 97%	neat	1 mg, 5 mg, 10 mg
ULM-9131	Vitamin K_1 (phylloquinone) (unlabeled) CP 97%	neat	1 mg, 5 mg, 10 mg
CLM-10376	Vitamin K_2 (menaquinone MK-4) (4',5,6,7,8,8'-$^{13}C_6$, 99%) CP 95%	neat	1 mg
DLM-10379	Vitamin K_2 (menaquinone MK-4) (5,6,7,8-D_4, 2-methyl-D_3, 98%) CP 95%	neat	1 mg
CLM-10377	Vitamin K_2 (menaquinone MK-7) (4',5,6,7,8,8'-$^{13}C_6$, 99%) CP 95%	neat	1 mg
DLM-10380	Vitamin K_2 (menaquinone MK-7) (5,6,7,8-D_4, 2-methyl-D_3, 98%) CP 95%	neat	1 mg
CLM-10378	Vitamin K_2 (menaquinone MK-9) (4',5,6,7,8,8'-$^{13}C_6$, 99%) CP 95%	neat	1 mg
DLM-10381	Vitamin K_2 (menaquinone MK-9) (5,6,7,8-D_4, 2-methyl-D_3, 98%) CP 95%	neat	1 mg
DLM-10382	Vitamin K_2 2,3-epoxide (menaquinone-4 2,3-epoxide) (5,6,7,8-D_4, 2-methyl-D_3, 98%) CP 95%	neat	1 mg
ULM-10383	Vitamin K_2 2,3-epoxide (menaquinone-4 2,3-epoxide) (unlabeled) CP 95%	neat	1 mg
DLM-9132	Vitamin K_3 (menadione) (D_8, 98%) CP 97%	neat	10 mg, 0.05 g
ULM-9133	Vitamin K_3 (menadione) (unlabeled) CP 97%	neat	1 mg, 5 mg, 10 mg

“Quantitative analysis in clinical diagnostics using mass spectrometry remains a difficult endeavor particularly for small molecules due to chemical similarity and isobaric forms of many substances. Both chromatography and the use of isotopically labeled internal standards to perform small molecule quantification are required to obtain good quantitative results in many applications. The use of isotopically labeled internal standards remains the best solution as these standards ideally match the chemical behavior of their analytes, thus leading to better quantification than obtained when using structure homologues with physicochemical characteristics.”

David C. Kasper, PhD
CEO, ARCHIMED Life Science

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Water

CIL offers a variety of singly and doubly labeled water compounds for use in MS- and NMR-based studies (see list below). These could be applied, for example, in energy-expenditure research or in virtual biopsy methods, as described in the Hellerstein article that follows.

Catalog No.	Description	Unit Size
DLM-4	Deuterium oxide (D, 99.9%)	10 g, 25 g, 50 g, 100 g, 1000 g
DLM-4-99.8	Deuterium oxide (D, 99.8%)	1000 g
DLM-2259	Deuterium oxide (D, 99.8%) microbiologically tested	100 mL, 250 mL, 1 L
DLM-4-99	Deuterium oxide (D, 99%)	1000 g, 5000 g
DLM-4-70	Deuterium oxide (D, 70%)	1000 g
DLM-2259-70	Deuterium oxide (D, 70%) microbiologically tested	Please inquire
OLM-782-90	Water (^{17}O, 90%)	1 g
OLM-782-70	Water (^{17}O, 70%)	Please inquire
OLM-782-40	Water (^{17}O, 35-40%)	1 g
OLM-782-20	Water (^{17}O, 20%)	1 g
OLM-782-10	Water (^{17}O, 10%)	1 g
OLM-240-97	Water (^{18}O, 97%)	1 g
OLM-240-10	Water (^{18}O, 10%)	1 g, 5 g, 10 g
DOLM-242	Water (D_2, 98%; ^{18}O, 97%)	1 g

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Stable Isotopes in Drug Development and Personalized Medicine: Biomarkers that Reveal Causal Pathway Fluxes and the Dynamics of Biochemical Networks

Researcher Perspective

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The combination of stable isotope labeling with powerful mass spectrometric analytic techniques is providing increasingly important diagnostic tools for drug development and clinical diagnostics in the emerging era of personalized medicine.

The Problem: High Attrition Rates in Contemporary Drug Development

Although it is widely believed that we live in a golden era of breakthroughs in new medicines, the opposite is true. Recent years have witnessed the lowest rate of new drug approvals in a generation, despite greatly increased pharmaceutical industry investment.[1] These disappointing facts hold true for all classes of disease, but are particularly worrisome for growing epidemics of chronic disease, such as Alzheimer's disease, diabetes, osteoarthritis, and obesity-related disorders.

The problem is not a lack of molecular targets or candidate drugs. The molecular target-based approach to drug discovery, which has dominated pharmaceutical research for the past 20 years, has generated huge lists of genes, proteins and potential drug therapies. The problem is that the attrition rate of drug leads has gotten worse, not better, with >98% of leads now failing for efficacy or safety reasons, including 90% failure rates in human trials.[2,3] This attrition is largely responsible for the high cost of each successful drug eventually approved.

Losing the War with Complexity

Attrition, in turn, is largely due to the unpredictability of the complex networks that comprise living systems in response to targeted interventions at specific nodes.[2] Unanticipated functional consequences of targeted interventions, both undesirable and beneficial, are the rule rather than the exception in such systems (**Figure 1**). Pathogenic heterogeneity among individuals within each disease magnifies this problem, requiring different intervention strategies for different subsets of patients. The latter issue is embodied by the notion of personalized medicine.

The Missing Link: Metrics for Navigating through the Complex Biology of Disease

The key missing factors for navigating through the complex biology of disease are objective measures that guide drug developers toward the goals of safe and efficacious outcomes.[4] These metrics, called biomarkers, must be predictive of clinical outcomes and translatable from preclinical models into humans. The most reliable way to achieve these goals is to capture the underlying biologic processes driving each disease (i.e., the disease modifying pathways or underlying pathogenesis). Metrics of this type can serve to guide rational drug discovery and development and allow monitoring of clinical response.

Nowhere will this need for functionally informative biomarkers be greater than in the field of "personalized medicine"–the right

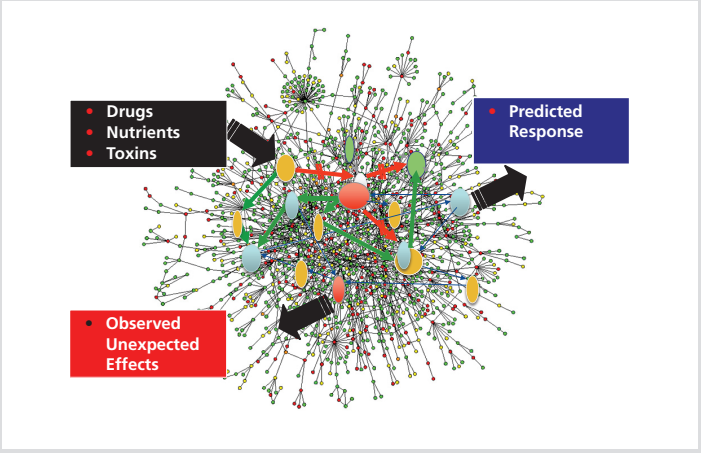

Figure 1. Losing the war with complexity: unpredictability of complex dynamic networks.

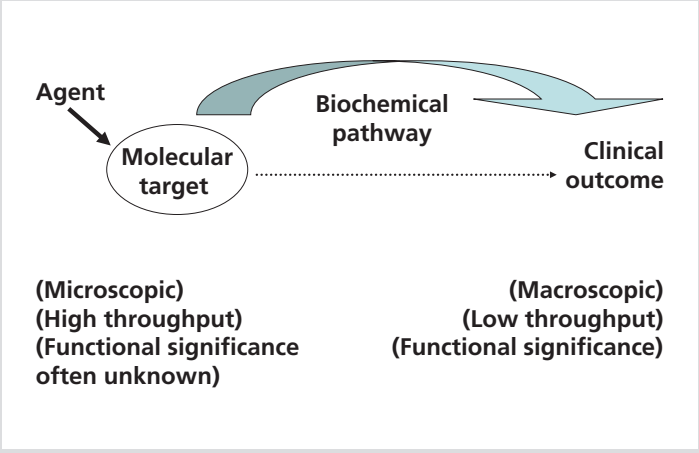

Figure 2. Pathway fluxes as the link between molecular targets and clinical outcomes.

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patient, the right drug, at the right time, and in the right dose. Companion diagnostic tests are extremely high value examples of this trend.

Stable Isotopes Are Essential for a New Class of Biomarkers: Tests that Predict Clinical Outcomes by Revealing Functionally Interpretable Information about Underlying Disease Processes

A new class of biomarkers is needed that are predictive of clinical outcomes.[4,5] The biologic pathways that underlie chronic diseases – the causal processes responsible for initiation, progression, severity and therapeutic reversal of disease – generally involve the flow of molecules through a pathway that is itself complex and influenced by numerous factors[5-8] (**Figure 2**). Stable isotopic techniques have made all of these causal pathways measurable in higher organisms.

What Stable Isotopes Bring to Diagnostic Biomarkers

Stable isotopes allow fluxes through metabolic pathways and the dynamics of global biochemical networks to be measured, without toxicity and often noninvasively, for two reasons: first, experimental administration of stable isotopes introduces an "asymmetry" in the dimension of time (label not present, then present), which allows the timing of dynamic processes to be measured; and, second, biochemical research over the past century has established the pathways that link molecules in cells and organisms, allowing the fates of labeled substrates to be traced *in vivo*.

Importantly, stable isotopes have been used for over 70 years in humans and experimental animals and have almost no known toxicities. The FDA policy toward stable isotope-labeled products is clear and has been consistent for decades: no regulatory approval is required to administer stable isotope-labeled compounds, beyond what is needed to administer their natural abundance congeners (sterility, pyrogenicity, etc.). It should be noted that stable isotopic-mass spectrometric biomarkers are not radiographic imaging techniques, but require a sample from the body (blood, urine, CSF, tissue, saliva).

Two Broad Categories of Stable Isotope-Based Kinetic Biomarkers Are Available

There are two broad categories of stable isotope-based biomarkers that are most useful in drug development and diagnostics: (1) Kinetics of targeted causal pathways and, (2) Interrogation of network dynamics for unbiased discovery of kinetic signatures and unanticipated causal pathways. Both types are available and useful in drug discovery and development.[5-16]

Kinetics of Targeted Causal Pathways as Biomarkers for Drug Discovery and Development

Some common examples of causal pathways in disease are shown (**Table 1**). These include: synthesis of collagen and extracellular matrix in fibrotic diseases; myelin synthesis and metabolism in multiple sclerosis; turnover of amyloid plaque and synthesis of amyloid beta 1-42 in Alzheimer's disease; synthesis of muscle myosin and biogenesis of mitochondria in sarcopenia; angiogenesis and proliferation and death of tumor cells in cancer; transport of cargo molecules through axons in neurodegenerative conditions; autophagic flux in Huntington's, Parkinson's, and other diseases characterized by protein aggregates; clot formation and lysis in thromboembolic diseases; insulin-mediated glucose uptake and pancreatic beta cell proliferation in insulin-resistant states; adipose tissue lipid dynamics and remodeling in obesity; reverse cholesterol transport in atherosclerosis; activation of the complement cascade in inflammatory states; HIV replication and turnover of CD4+T-cells in AIDS; and many others.

Table 1. **Examples of Causal Pathways:**

A) Neurobiology

- Cargo transport through axons
- Amyloid beta synthesis and plaque turnover
- Neurogenesis
- Myelination/remyelination
- Neurotransmitter release and turnover
- Neuronal mitochondrial biogenesis
- Neuroinflammation, microglia activation
- Cytokine release
- Hungtingtin protein turnover
- Prion turnover
- Synaptic plasticity

B) Obesity/T2DM

- Pancreatic beta cell proliferation and mass
- Insulin-mediated glucose uptake
- Hepatic glucose production
- Adipogenesis and TG deposition
- Adipose tissue fatty acid oxidation/brown fat transition
- Adipose tissue remodeling
- Hepatic TG synthesis and release
- Atheroma cholesterol removal and deposition
- Adipose tissue macrophage proliferation and activation
- Muscle mitochondrial beta-oxidation and biogenesis

C) Cancer/Neoplasia

- Tumor cell proliferation and death rate
- Angiogenesis
- Lymphangiogenesis/metastatic spread
- Tumor-specific T-cell proliferation
- DNA methylation/demethylation
- Ribonucleotide reductase activity
- Histone deacetylation
- Precancer evolution to aggressive phenotypic
- Extracellular matrix turnover

The ability to measure the activity of any of these functionally relevant processes that are believed to play causal roles in disease is potentially transformative for drug discovery and development in these fields (e.g. Parkinson's Disease.[10,11]).

Interrogation of Network Dynamics

Perhaps the most exciting advance in stable isotope biomarkers in recent years is the emergence of "network dynamics": unbiased

Continued ➤

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Stable Isotopes in Drug Development and Personalized Medicine: Biomarkers that Reveal Causal Pathway Fluxes and the Dynamics of Biochemical Networks *(continued)*

interrogation of the dynamic behavior of complex biochemical networks that comprise living systems. This has been successfully applied to preclinical models and humans for the dynamics of the global proteome, or dynamic proteomics.[12,13] This provides a new type of systems biology, with great potential as an unbiased screening tool for biomarker discovery.

Dynamic proteomics represents the most functionally interpretable of the "omics" technologies – i.e., providing not just heat maps or informatics, but functionally interpretable systems biology information. The operational flow chart for measuring the dynamics of a proteome is shown (**Figure 3**). This approach has been applied with great success to questions such as the effects of calorie restriction of cellular proteostasis, including mitochondrial biogenesis and mitophagy; the proteome dynamic signature of poor prognosis in chronic lymphocytic leukemia tumor cells; differentiating between pancreatic islets successfully compensating for insulin resistance in obese animals vs. islets that are failing and becoming "exhausted"; the effects of exercise on muscle proteome turnover; the effects of neuroinflammation on CSF proteome turnover; the dynamics of the high-density lipoproteins (HDL) proteome in dyslipidemic states; and other questions of interest in physiology and pathophysiology.

'Virtual Biopsy' Approach for Noninvasive Biomarkers of Intracellular Pathways

Unbiased screening of proteome dynamics in a tissue can also lead to discovery of targeted protein biomarkers that are accessible to sampling in a body fluid. Called the "virtual biopsy" technique (**Figure 4**), this is a powerful method for measuring the rate of protein synthesis or protein breakdown in an inaccessible tissue of origin, such as skeletal muscle, heart, brain, kidney, liver, or a cancer tissue, through a measurement made from an accessible body fluid, such as blood, cerebrospinal fluid, saliva, or urine. The method comprises administering a stable isotope tracer (e.g., deuterium oxide (D, 70%) (DLM-4-70); L-leucine ($^{13}C_6$, 99%) (CLM-2262); glycine (^{15}N, 98%) (NLM-202); spirulina whole cells (lyophilized powder) (U-^{15}N, 98%) (NLM-8401)) that is metabolically incorporated into newly synthesized proteins. These proteins then escape into an accessible body fluid, from which they are isolated and analyzed for isotopic content or pattern. The measured replacement rate of the escaped protein reflects the synthesis or breakdown rate of the protein back in the tissue of origin. A "virtual biopsy" of the tissue of origin has thereby been carried out.

The virtual biopsy method has utility for discovering and validating biomarkers for use in drug discovery and development, for identifying disease subsets in personalized medicine and for clinical diagnosis and management of patients. This approach has been developed and applied to blood-based measurements of tissue fibrosis and skeletal muscle protein synthesis and CSF-based measurements of axonal transport of cargo[10] and neuro-inflammation. An example is plasma creatine kinase-MM (derived from skeletal muscle), for measuring skeletal muscle protein anabolism from a blood test. Many other applications can be envisioned.

in Situ Kinetic Histochemistry: Combining Histopathology with Stable Isotopes and Mass Spectrometry

It is also now possible to visualize the kinetics of targeted molecules of interest spatially, within a histopathologic specimen.[14] Linking spatial histologic information with molecular flux rates provides a remarkable new dimension to pathologic diagnosis and monitoring of disease. This can be carried out by either laser microdissection or physical microdissection of slides (**Figure 5**). An example of tissue microdissection after introducing stable isotopes has been published for prostate cancer. The proliferative gradient of prostate cells, for example, has been shown to correlate closely with histologic grade in biopsy specimens from men with prostate cancer and is reflected by the proliferative rate of prostate epithelial cells isolated from seminal fluid, as a potential noninvasive biomarker.[14]

Kinetic Imaging of Tissue Samples

Kinetic or metabolic flux imaging is now possible by combining stable isotope labeling with mass spectrometric imaging of tissues, through NIMS- or MALDI-based spatial visualization of histologic slides. Spatially defined kinetic lipidomics in cancer models has revealed anatomic differences in tumor behavior that correlate with *in vivo* aggressiveness in mouse mammary cancer models.[15]

Practical Uses of Stable Isotope-Based Biomarkers in Drug Development

There are many uses for stable isotope-based biomarkers in drug discovery and development (**Table 2**). These include target validation; translating preclinical results rapidly into man; "quick-kill" of agents or classes with poor activity against the targeted

Table 2. Applications of Causal Pathway Metrics

Less guessing about:

1. Picking targets
2. Choosing chemical class and best compound in class
3. Identifying the right patients (excluding nonresponders subsets at risk for toxicities)
4. Finding the best dose and regimen for clinical trials
5. Selecting intermediate end-points to measure and variability to expect in patients
6. Dosing to avoid minimize toxicities
7. Testing whether personalization can improve response
8. Deciding whether to get out early (quick kill)

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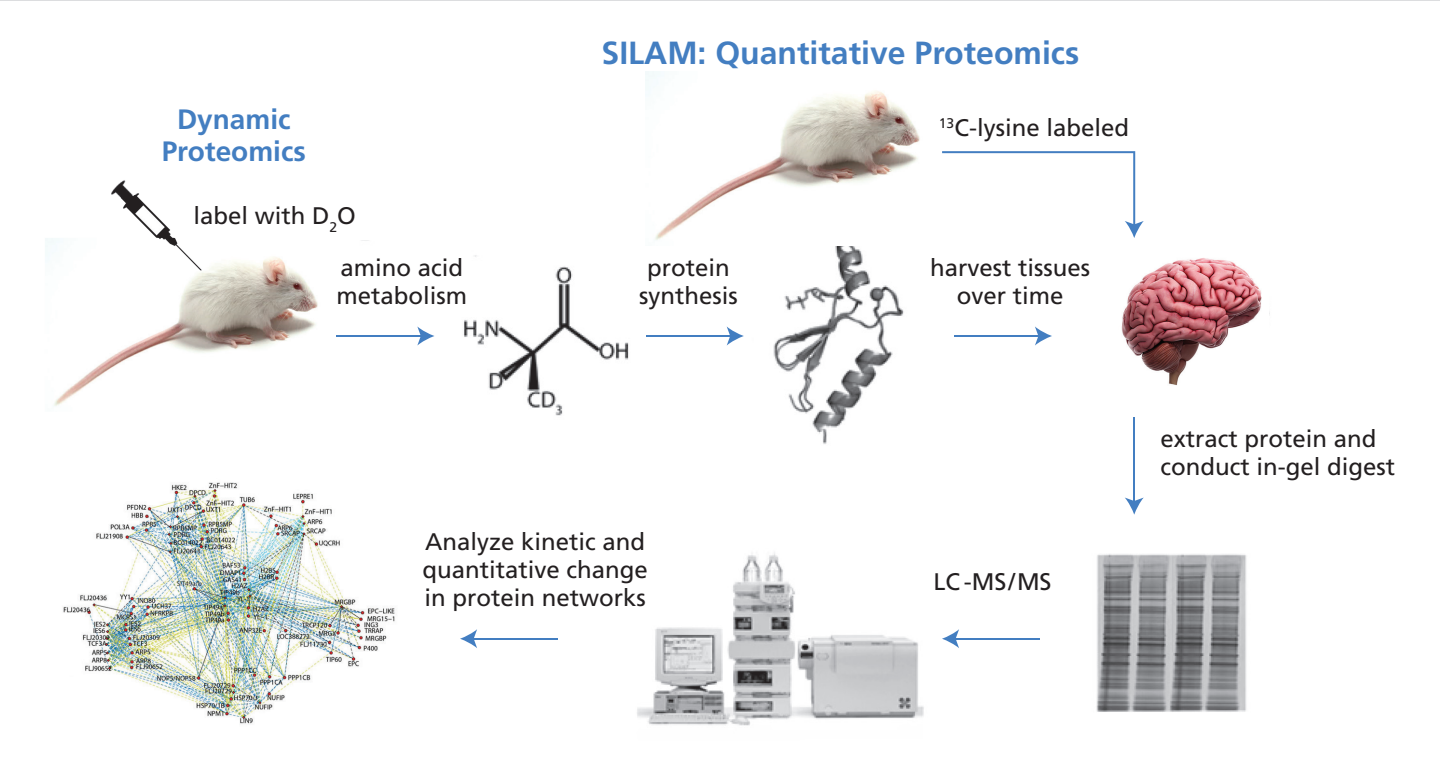

Figure 3. Dynamic proteomics: measuring proteome kinetics and concentrations via stable isotope labeling *in vivo*.

pathway; identifying the right subsets of patients for treatment; identifying optimal dose, regime, measurement end-points and intersubject variability of response; medical personalization (companion diagnostics); and anticipating toxicities or avoiding toxicities through dose adjustment. Translational markers that are predictive of disease outcomes also allow the selection of animal models that best reflect human disease, or the de-emphasis or even gradual elimination of animal models from the drug-development process.

Stable Isotope-Based Kinetic Biomarkers Have Advantages over but Are Complementary to Static Biomarkers

Traditional static biomarkers provide information about the concentration, presence or structure of molecules in a living system. In contrast, kinetic biomarkers reveal the dynamic behavior of the pathways that lead to and from these molecules. The amount of collagen in a tissue, for example, does not reveal the rate at which collagen is being synthesized (fibrogenesis) in a disease setting or after starting a therapeutic intervention. Nor does the content of mitochondrial proteins tell us the degree to which mitochondrial biogenesis or mitophagy was induced by an intervention. Similarly, the concentration of a protein in the cerebrospinal fluid does inform us the efficiency at which neurons in the brain transported this molecule through axons to nerve terminals. These latter processes all involve, at their core, the flux of molecules through often complex pathways and networks.

The activity of these pathogenic processes or disease pathways are in principle the metrics most closely related to the initiation, severity, progression and therapeutic reversal of a disease. The only way to measure molecular flux rates is by the introduction of isotopic labels, as noted above. Although static parameters can provide key complementary information, such as pool size and net gain or loss of a molecular component, the functional activity of underlying pathogenic processes can only be revealed through kinetic measurements.

The same considerations apply to "Network Dynamics," such as dynamic proteomics, when compared to static "-omics" biomarkers, but with an additional point that is worth noting. Protein synthesis and breakdown rates typically represent a pro-active decision by a cell or organism that is functionally interpretable in context of health or disease. By way of example for proteins, ubiquitin-proteosome-based removal, transcription factor-stimulated synthesis, assembly during biogenesis of an organelle, packaging and secretion in vesicles, modulation through the unfolded protein response, deposition as extracellular matrix, induction as part of a protein signaling cascade, *etc.* – these can all be thought about in functional terms by physiologists, toxicologists and clinicians. The same cannot always be said for the simple presence or concentration of a protein. Because of this marriage between intrinsic functional significance and broad, hypotheses-free screening, dynamic proteomics is a particularly powerful technology for biomarker and target discovery.

Continued ➤

Chemical purity (CP) is 98% or greater, unless otherwise specified. MPT (microbiological and pyrogen tested) may be available; please inquire.
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Stable Isotopes in Drug Development and Personalized Medicine: Biomarkers that Reveal Causal Pathway Fluxes and the Dynamics of Biochemical Networks *(continued)*

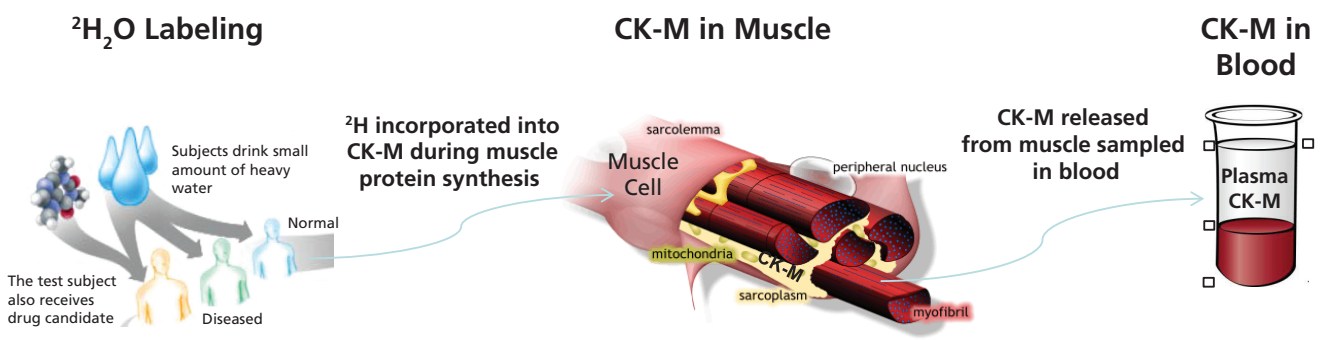

Figure 4. "Virtual biopsy" technique for kinetic biomarkers. Example of skeletal muscle protein synthesis from plasma creatine kinase M-type (CK-M).

Summary and Conclusions

In summary, the recent addition of stable isotope-based biomarkers to the diagnostic repertoire has brought a new and rapidly expanding dimension to drug development. These biomarkers provide functionally interpretable, decision-relevant information about the underlying biology of disease, capturing the activity of causal pathways that are the driving forces underlying disease and therapy. Kinetic biomarkers thereby predict clinical response and its relation to target engagement or the effects of a clinical treatment regimen. Stable isotope-based kinetic biomarkers are particularly powerful additions in the emerging era of personalized medicine.

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More information is available at www.kinemed.com.

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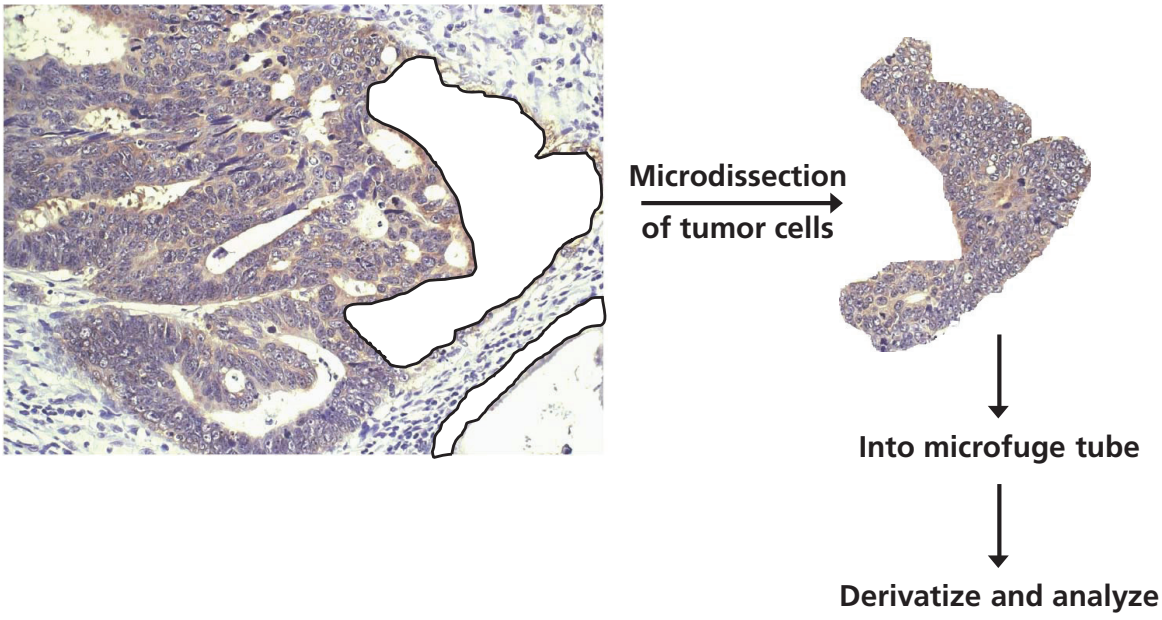

Figure 5. Microdissection of normal and tumor tissues for mass spectrometric kinetic analysis.

Related Products

Catalog No.	Description
DLM-4-70	Deuterium oxide (D, 70%)
CLM-1396	D-Glucose (U-$^{13}C_6$, 99%)
CLM-1822-H	L-Glutamine ($^{13}C_5$, 99%)
NLM-202	Glycine (^{15}N, 98%)
CLM-2262-H	L-Leucine ($^{13}C_6$, 99%)
NLM-8401	Spirulina Whole Cells (lyophilized powder) (U-^{15}N, 98%)

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Research Use of Products

CIL manufactures highly pure research biochemicals that are produced for research applications. As a service to our customers, some of these materials have been tested for the presence of *S. aureus, P. aeruginosa, E. coli, Salmonella sp.,* aerobic bacteria, yeast, and mold, as well as the presence of endotoxin in the bulk material by taking a random sample of the bulk product. Subsequent aliquots are not retested. Presence of endotoxin is assessed by determining endotoxin content following established protocols and standardized limulus amebocyte lysate (LAL) reagents. Any materials listed in our catalog or website that are designated as "MPT" in the item product number (e.g., DLM-349-MPT) contain these tests as part of release specifications.

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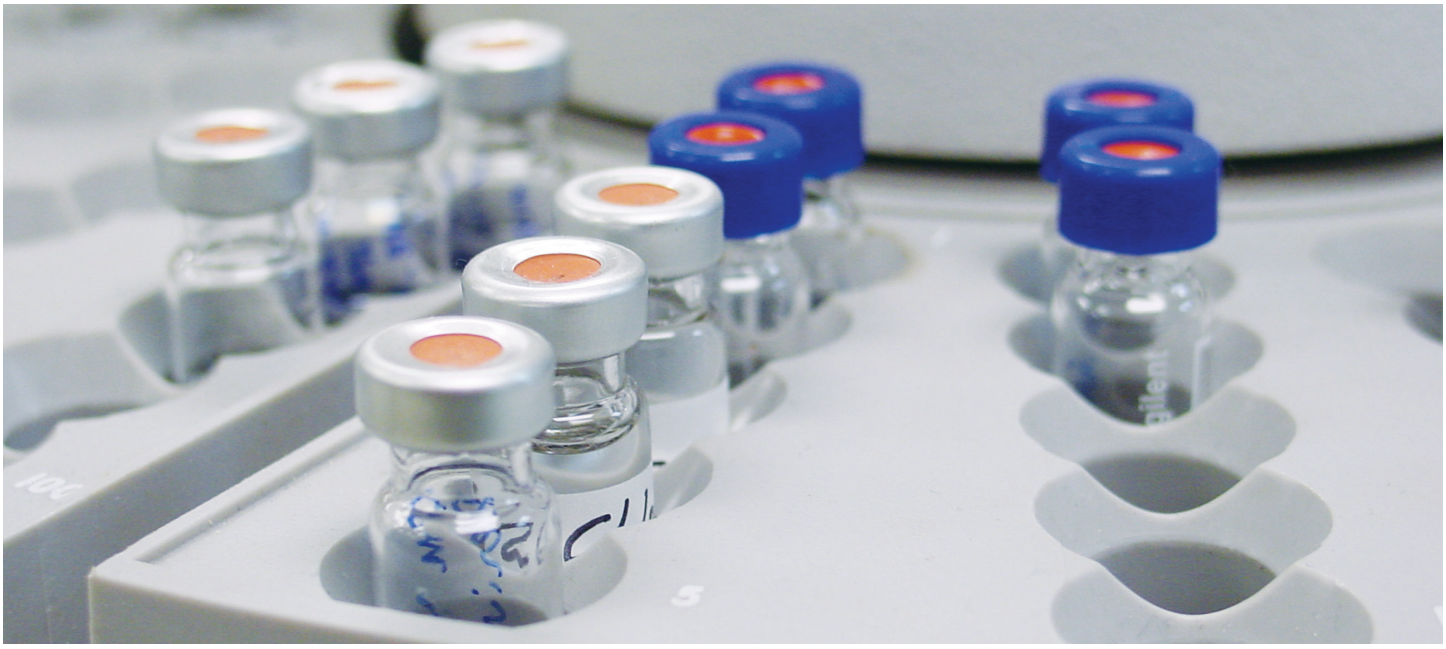
CLM-XXX-**PK**	Research grade
CLM-XXX-**MPT-PK**	Microbiologically and Pyrogen Tested
CLM-XXX-**CTM**	Manufactured following ICH Q7, Section XIX
CLM-XXX-**GMP**	Good Manufacturing Practices grade

➤ **For more information on controls in manufacturing and testing of the different grades, go to: Search → Literature → Product Quality Designations from the isotope.com home page.**



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CIL offers the option of an Enhanced Data Package (EDP). This technical data package is available for most MPT products. It includes all of the data currently included with the MPT products, as well as the additional information listed below. You have the option of purchasing this package at the time of order or at a later date.

Please note that if you choose to purchase at a later date, some of the information listed below may not be available. Also, the EDP may not be available for all lots. In some cases, only a partial EDP may be available. Please confirm availability and content prior to order.

EDP Contents

- Product description: structural formula, stereochemical description, molecular formula.
- Product physical properties: melting point, pH, optical rotation (mix of literature or measured values).
- Outline of the synthesis route (including details of solvents used).
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- Certificates of Analysis of raw materials, where appropriate.
- Informal stability data: estimated and measured.
  - This will be either actual shelf life data, if it can be obtained from CIL history or by analysis of in-stock batches, or
  - If no data is available, CIL will commit to assaying the batch provided after six months and one year. Data will be provided after one year, unless the batch fails assay after six months. This option will not be available if the Enhanced Data Package is ordered at a later date.

cGMP Production Capabilities

With increasing requirements from institutional review boards (IRBs) and governmental agencies, partnering with CIL for your next stable isotope cGMP (current good manufacturing practices) project can help ensure your regulatory compliance. With the world's largest ^{13}C and ^{18}O isotope-separation plants, CIL is able to provide the raw materials necessary for your project. Your compound of interest most likely already appears in CIL's extensive list of research compounds – if not, CIL's team of PhD chemists can determine the best method of synthesis for incorporating ^{13}C, ^{15}N, D, ^{17}O, and/or ^{18}O into your compound.

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Products of Interest

Catalog No.	Description
CLM-804-CTM	Cholesterol (3,4-$^{13}C_2$)
DLM-349-CTM	D-Glucose (6,6-D_2)
CLM-2262-CTM	L-Leucine ($^{13}C_6$)
DLM-1259-CTM	L-Leucine (5,5,5-D_3)
CLM-762-CTM	L-Phenylalanine (1-^{13}C)
CLM-8077-CTM	Pyruvic acid (1-^{13}C)
CLM-156-CTM	Sodium acetate (1-^{13}C)
CLM-440-CTM	Sodium acetate (1,2-$^{13}C_2$)
CLM-311-GMP	Urea (^{13}C)

➤ **Other products may be available as CTM/cGMP. Please inquire for details.**

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CTM: manufactured following ICH Q7, Section XIX
GMP: good manufacturing practices grade

Newborn Screening Standards

CE Mark *in vitro* Diagnostics (IVD)

Newborn screening (NBS) is an analytical or physical screening process used to test neonates for inherited or congenital disorders related to inborn errors of metabolism (IEM). IEMs are caused by the deficiency, absence, or alteration of specific enzymatic reactions. The goal of NBS is to detect metabolic errors at the earliest stage of development, such that treatment can be initiated and irreversible damage to the central nervous system can ultimately be avoided.

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Catalog No.	Description	Unit Size
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IVD

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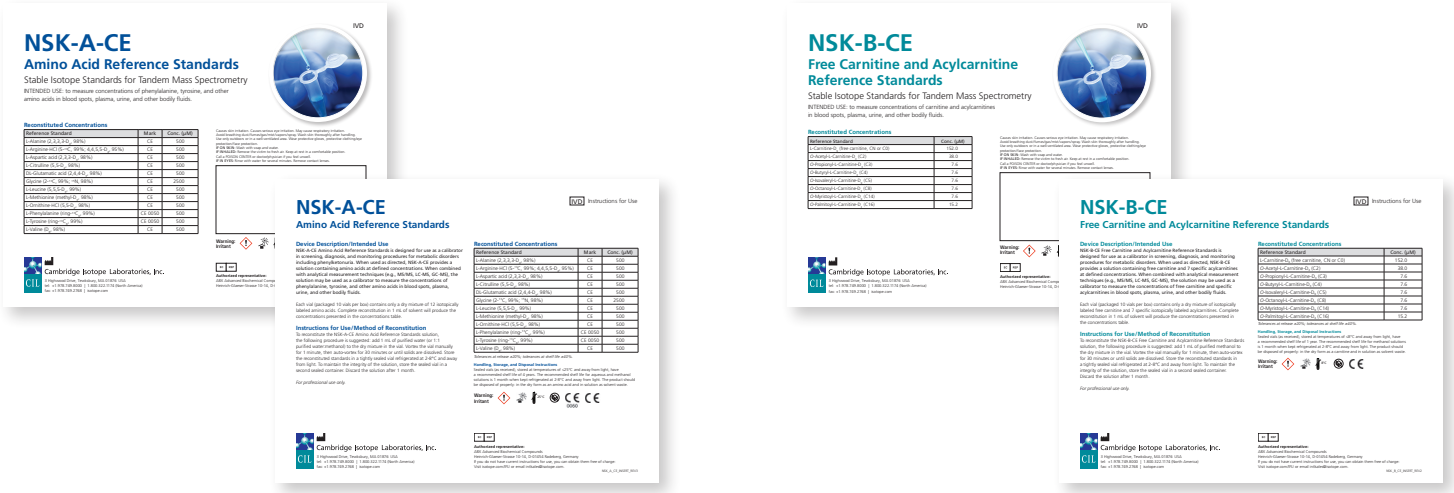

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