UNIMORE
UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA

Centro Interdipartimentale Grandi Strumenti
CINQUANTA

Approcci di spettrometria di massa avanzati per la caratterizzazione strutturale dei lipidi

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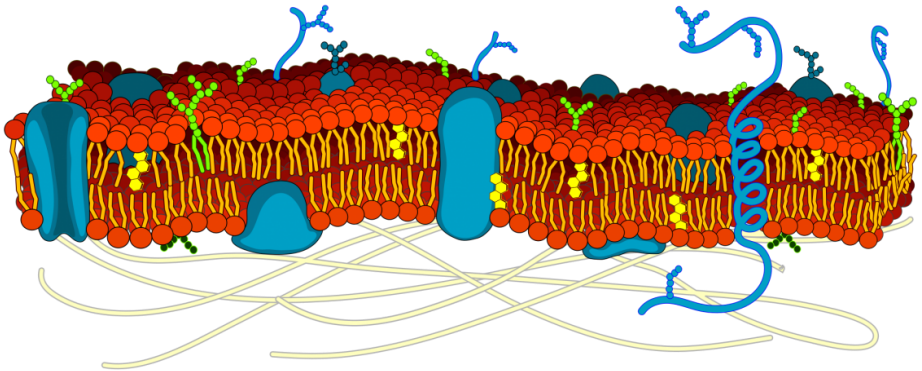
SAPIENZA
UNIVERSITÀ DI ROMA

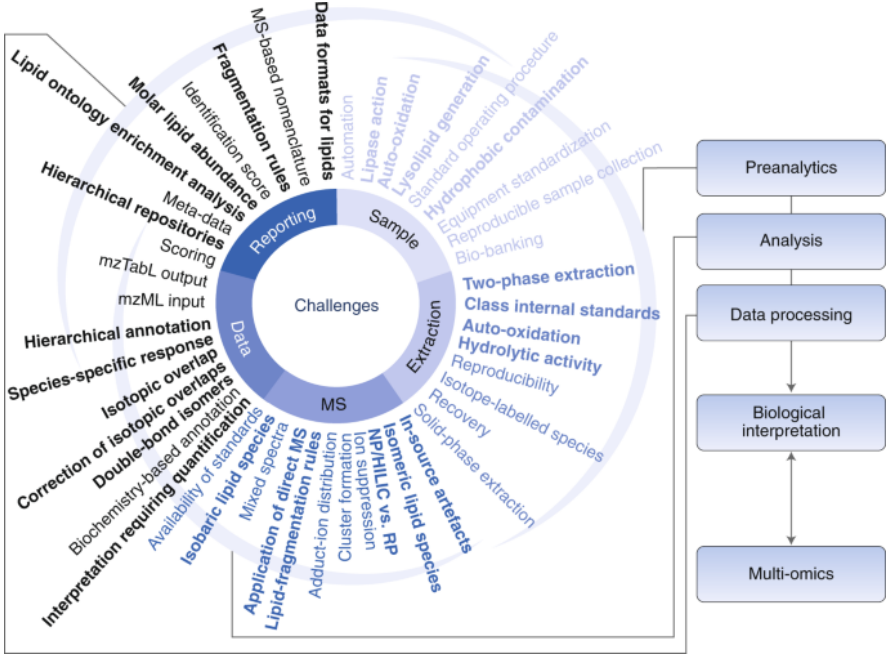
Fondazione VERONESI

Lipidomics

Lipids are defined as hydrophobic or amphipathic small molecules that originate entirely or in part by carbanion-based condensations of thioesters and/or by carbocation-based condensations of isoprene units.

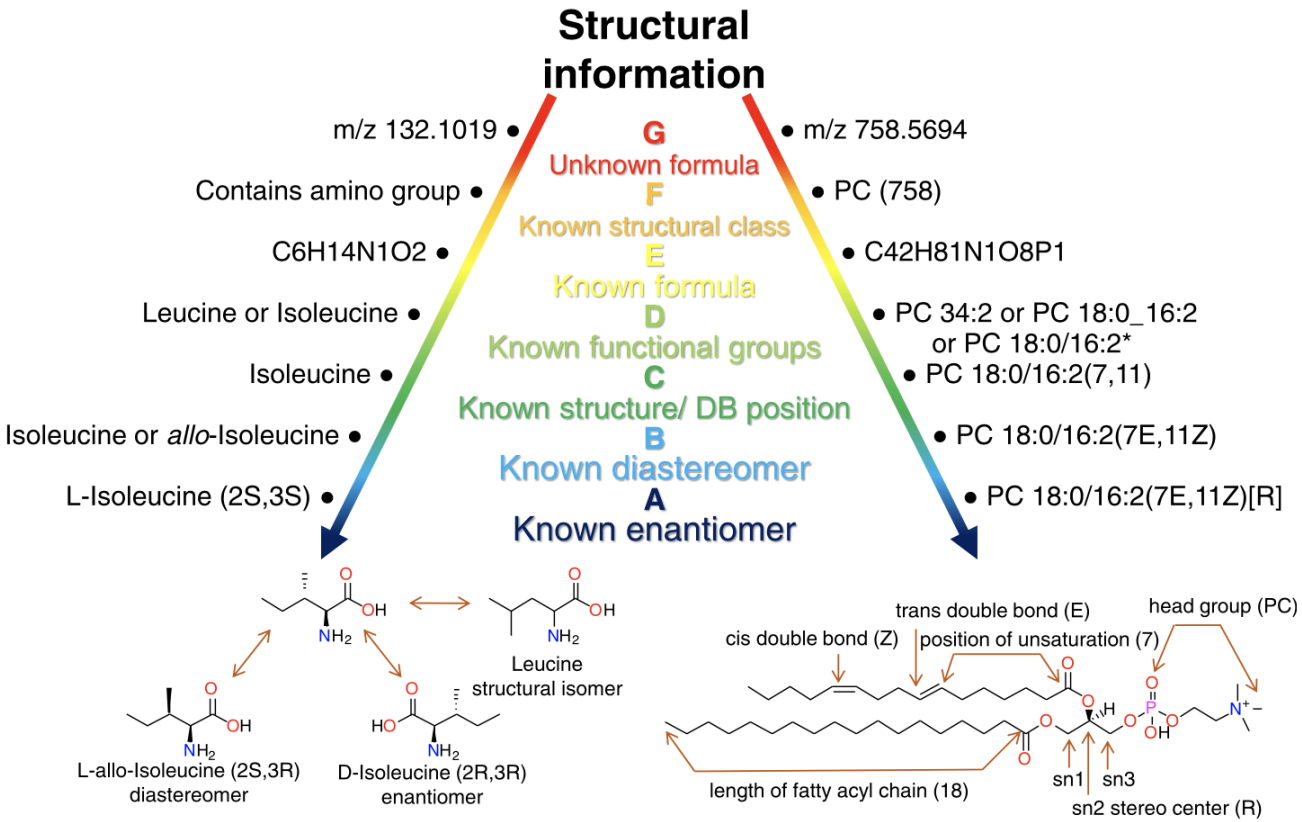
Lipids perform several biological functions within the body: (i) **structural components of cell membranes**, (ii) **energy storehouse**, (iii) **regulating and signaling**





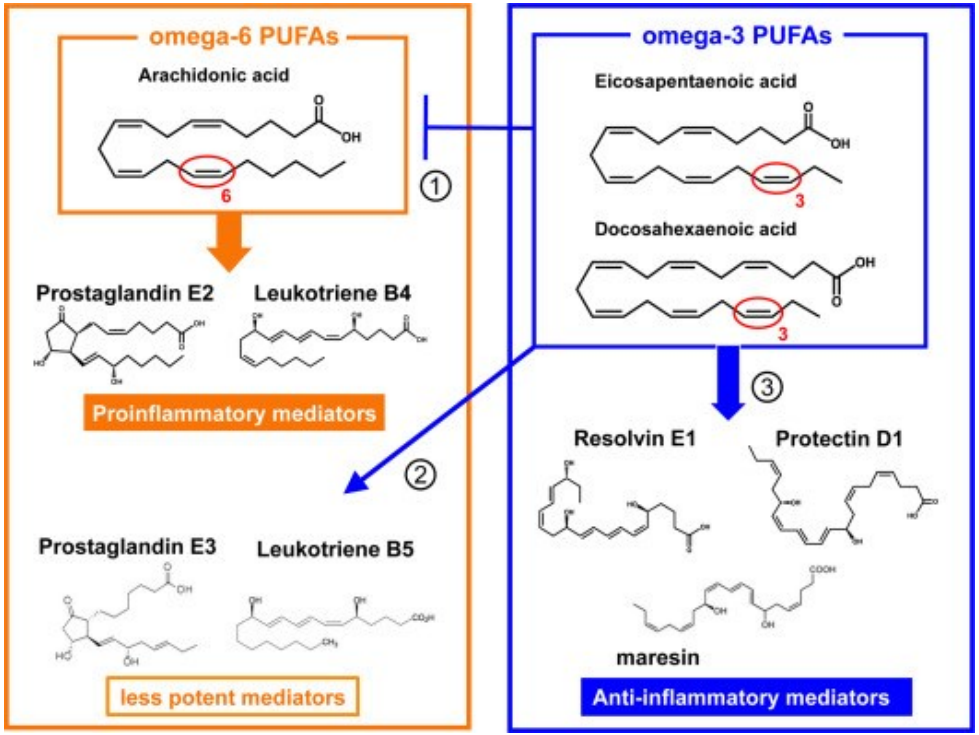
https://doi.org/10.1038/nrm.2017.138

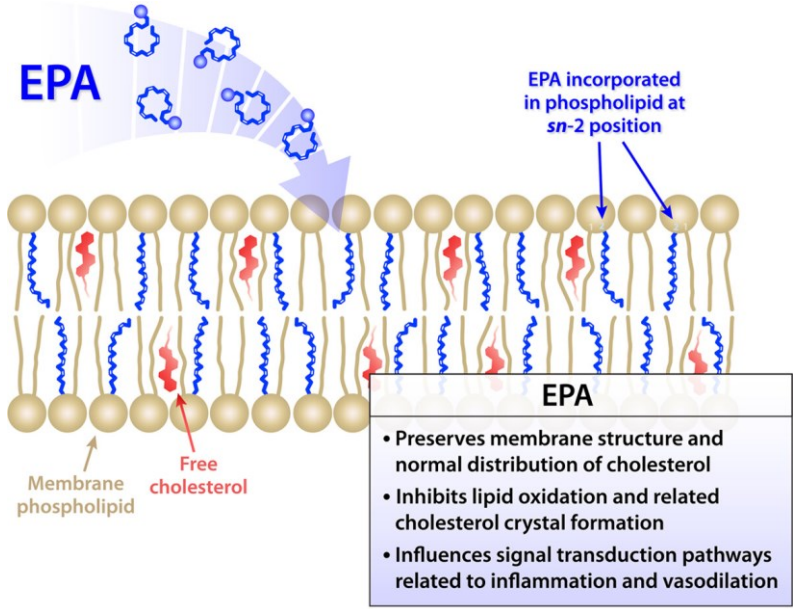
Lipidomics



https://dx.doi.org/10.1021/acs.analchem.0c04698

Lipid regioisomers





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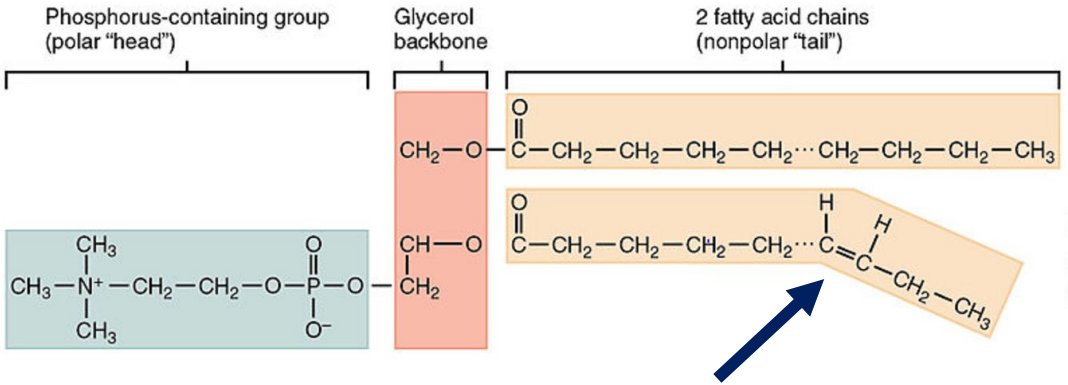

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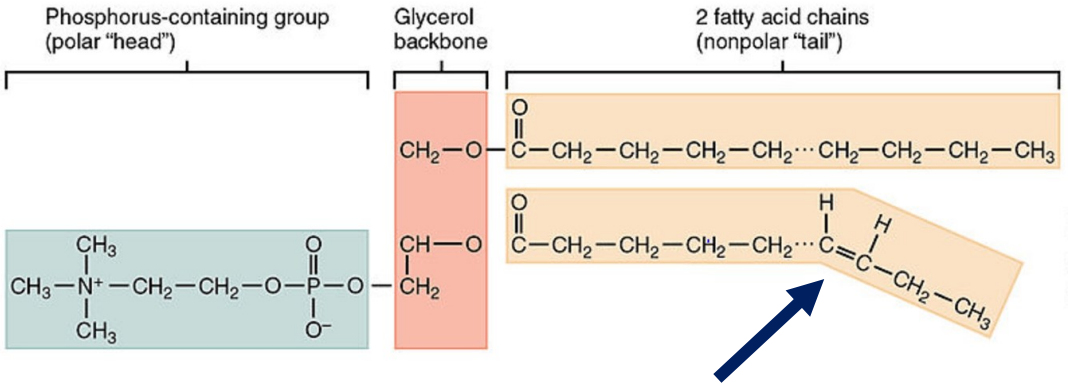

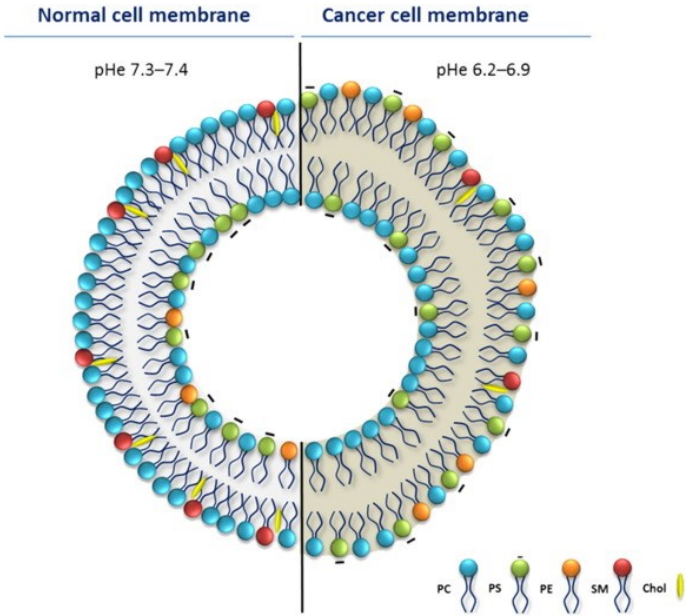

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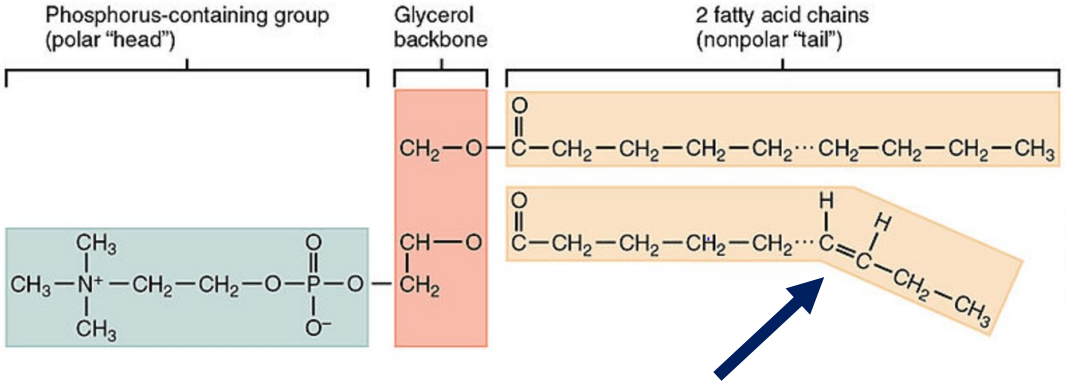
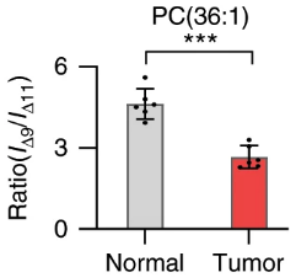


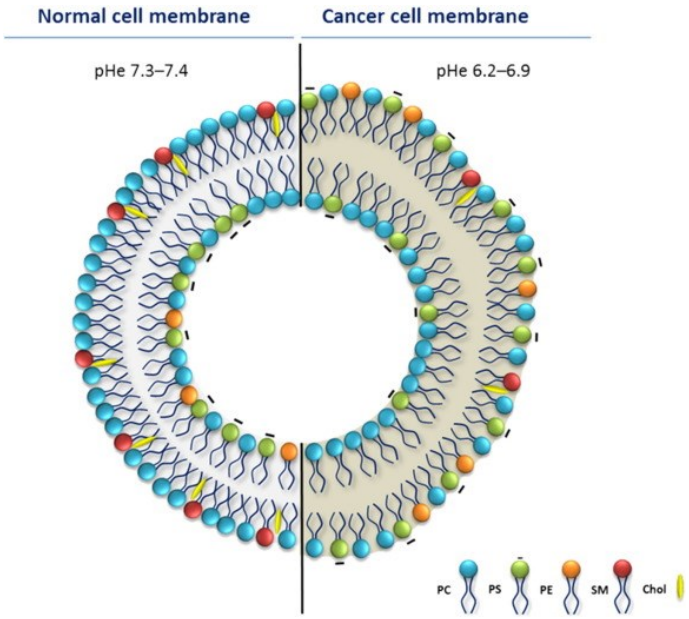
Article | Open access | Published: 17 January 2020

Large-scale lipid analysis with C=C location and *sn*-position isomer resolving power

Wenbo Cao, Simin Cheng, Jing Yang, Jiaxin Feng, Wenpeng Zhang, Zishuai Li, Qinhua Chen, Yu Xia, Ouyang & Xiaoxiao Ma

Nature Communications **11**, Article number: 375 (2020) | Cite this article



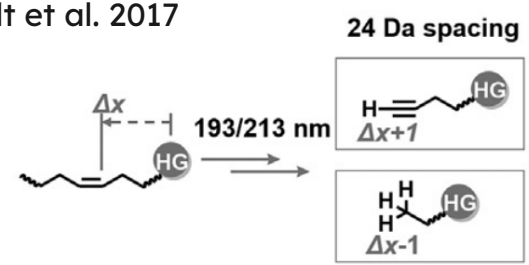


Emerging MS technologies for C=C elucidation

(i) Alternative ion dissociation methods

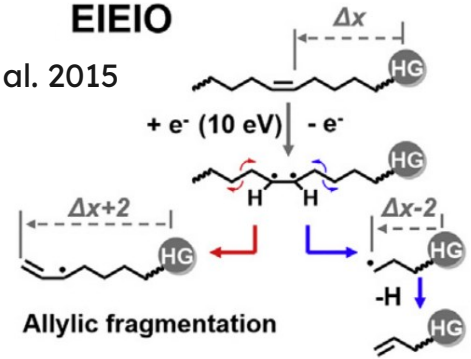
UVPD

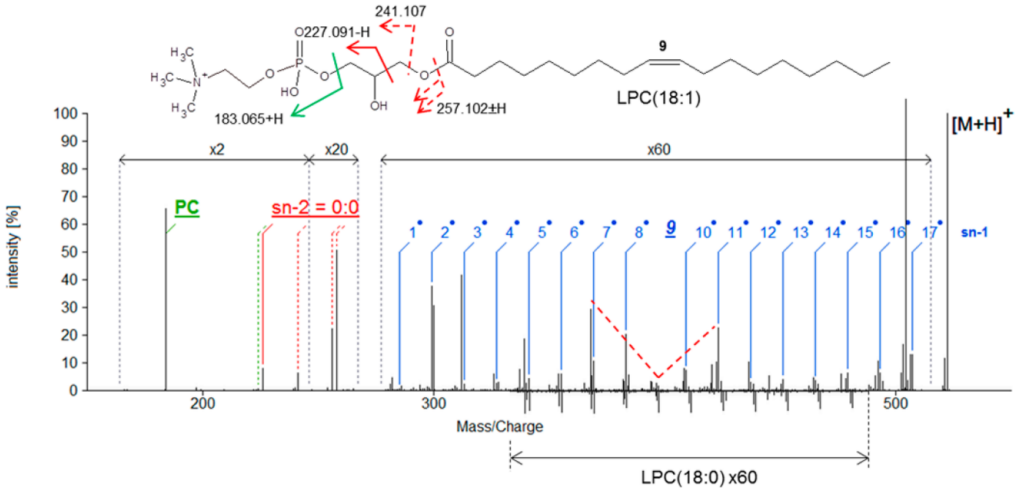
Brodbelt et al. 2017



EIEIO

Baba et al. 2015





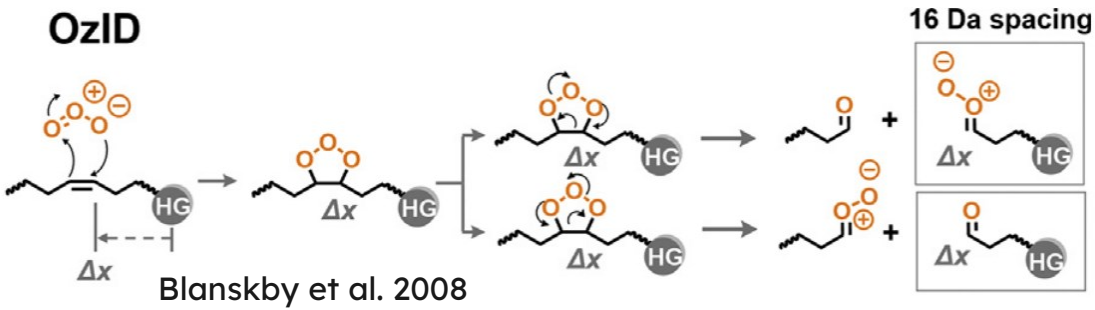
Pros: no derivatization, both regio- and stereoisomery

Cons: expensive and scarcely accessible instrumentation, poor ion intensity

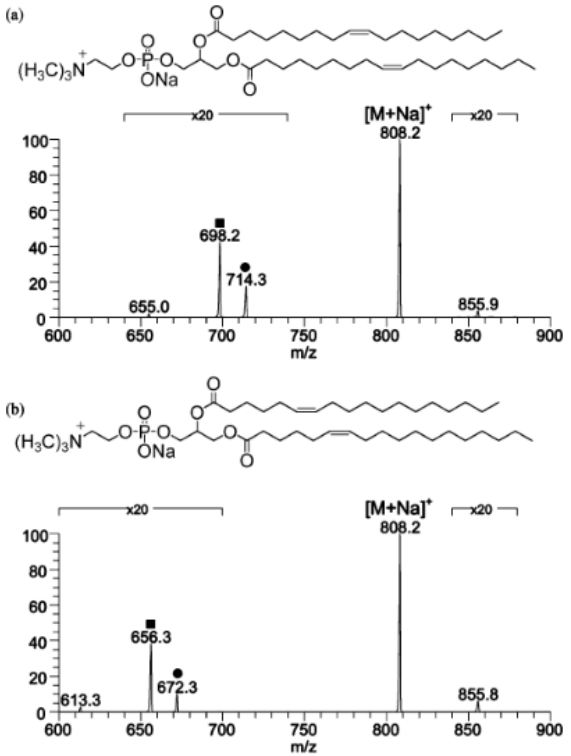
https://doi.org/10.1016/j.jlr.2022.100219
https://doi.org/10.1021/acs.analchem.5b01460

Emerging MS technologies for C=C elucidation

(ii) Gas-phase reactions



Blanskby et al. 2008



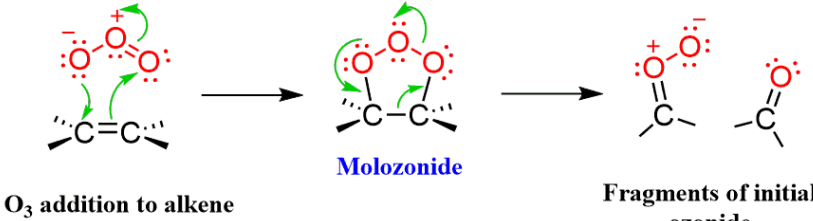
Pros: no derivatization, compatible with some common MS facilities

Cons: need for hardware modification

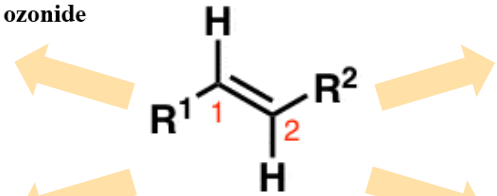
https://doi.org/10.1016/j.jlr.2022.100219
https://doi.org/10.1021/ac7017684

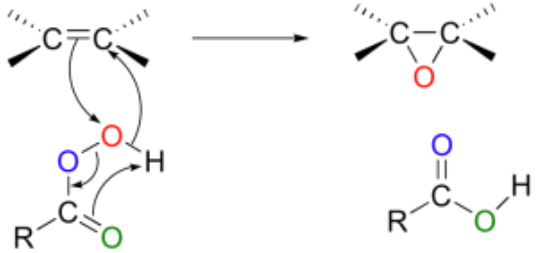
Emerging MS technologies for C=C elucidation

(iii) Derivatization before MS analysis



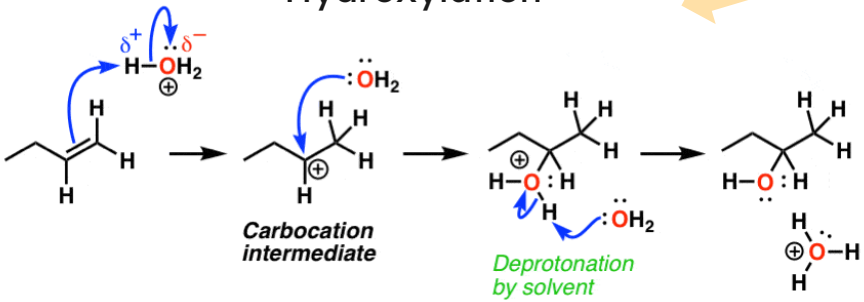
Ozonolysis



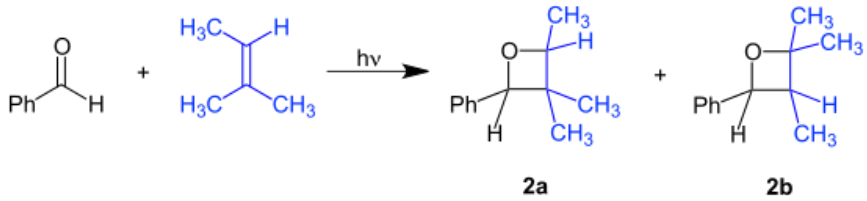


Epoxydation

Hydroxylation



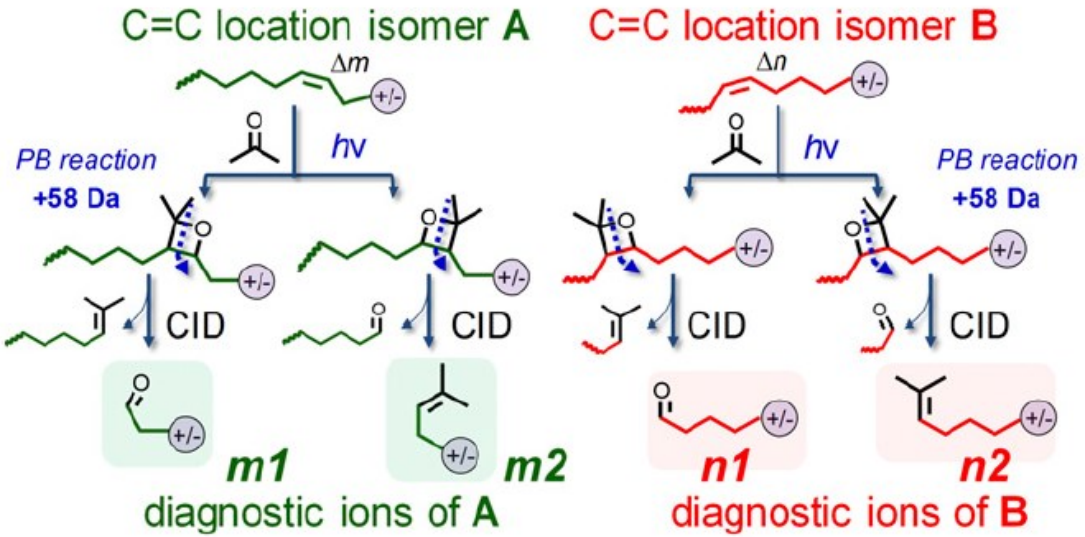
Paternò–Büchi reactions

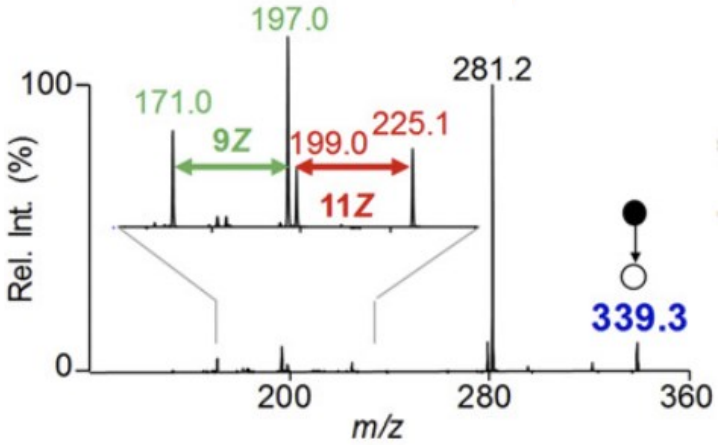


https://doi.org/10.1021/acs.analchem.1c00061
https://doi.org/10.1007/s00216-021-03425-1

PB reaction in lipidomics

In 2016, the group of prof. Xia proposed for the first time a shotgun lipidomics approach enabled by photochemical PB reaction

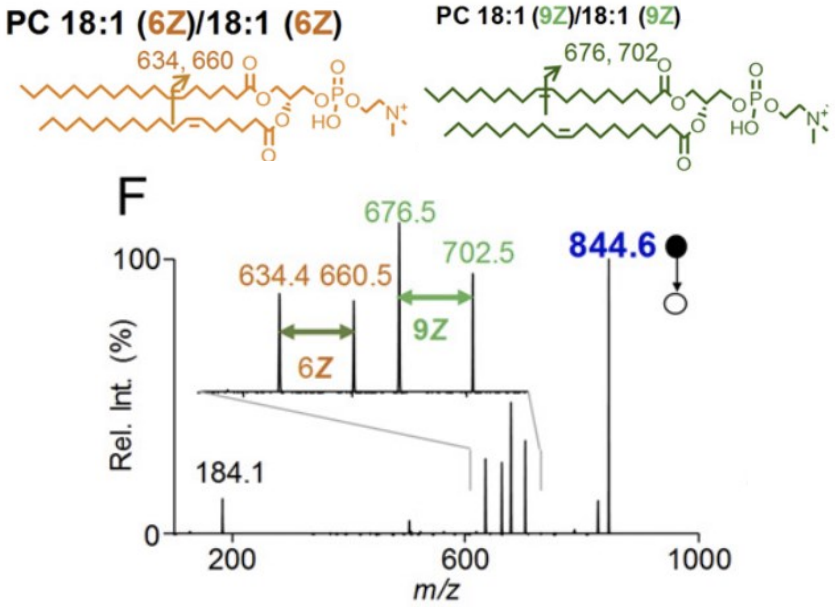


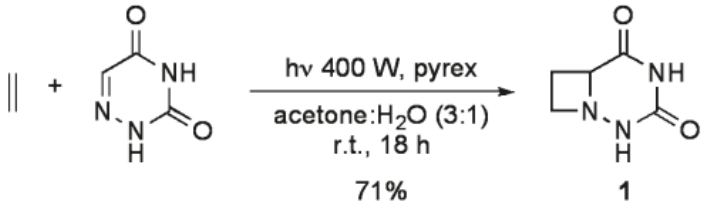


https://doi.org/10.1073/pnas.1523356113

aPB: an alternative to PB

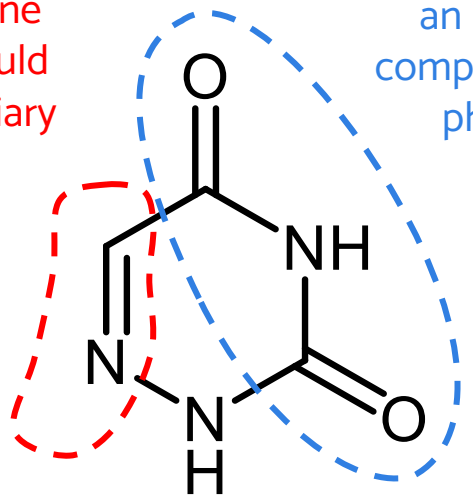
For GP, PB-HRMS is carried out in positive ion mode by taking into account neutral losses



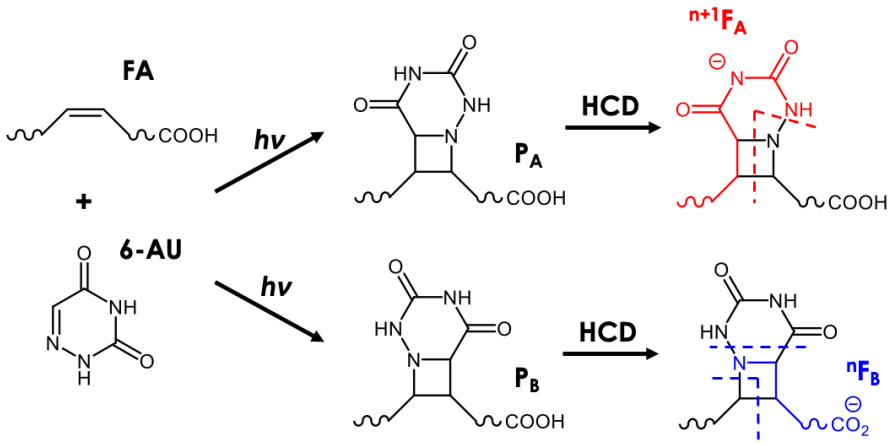


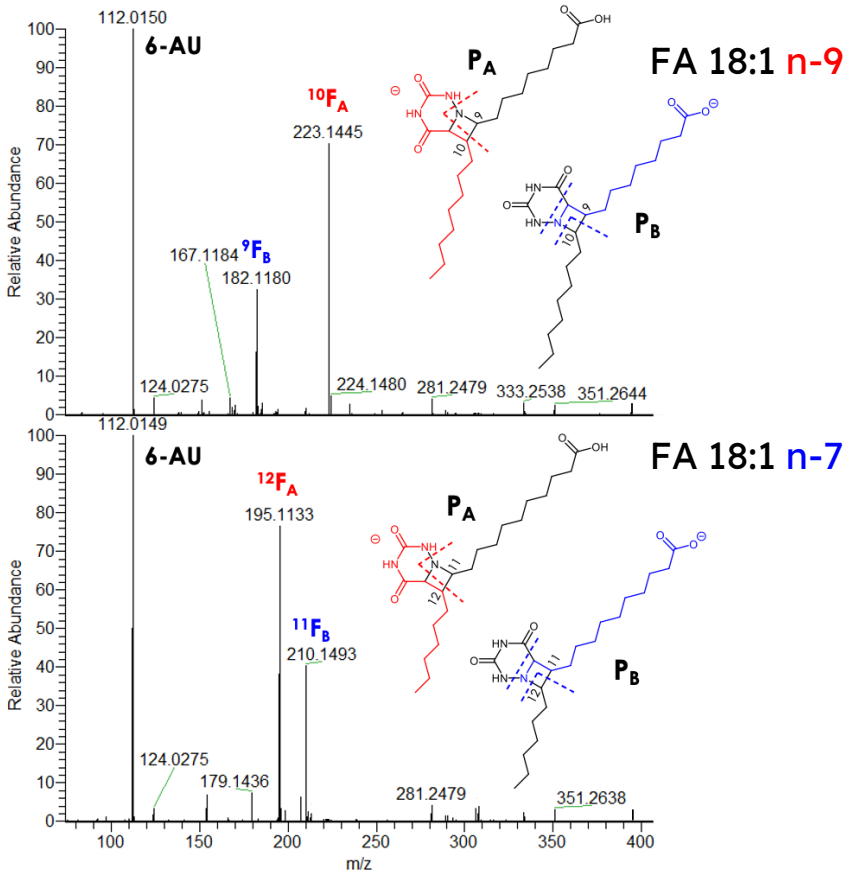
i) Reactive imine group that would turn into a tertiary amine

ii) Imide group with an acidity comparable to phenol



aPB: an alternative to PB





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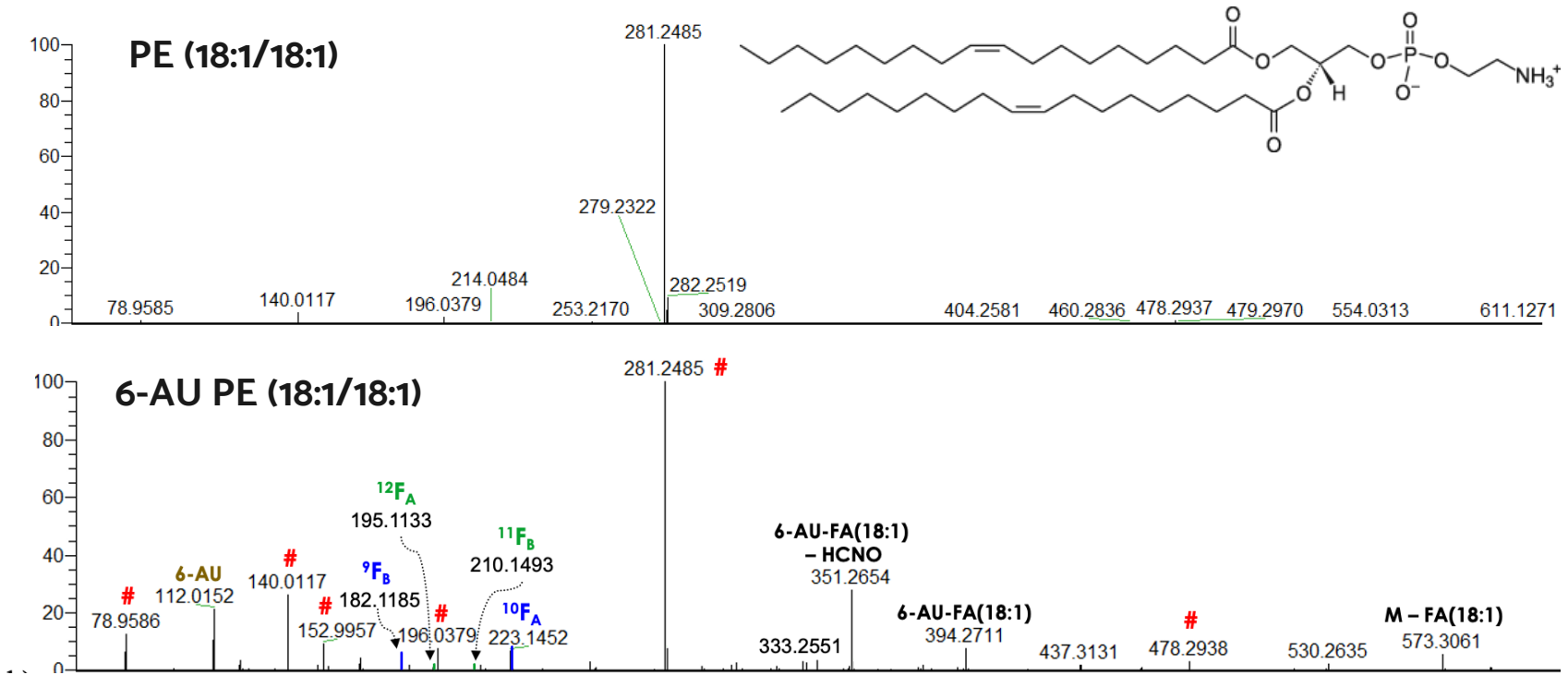
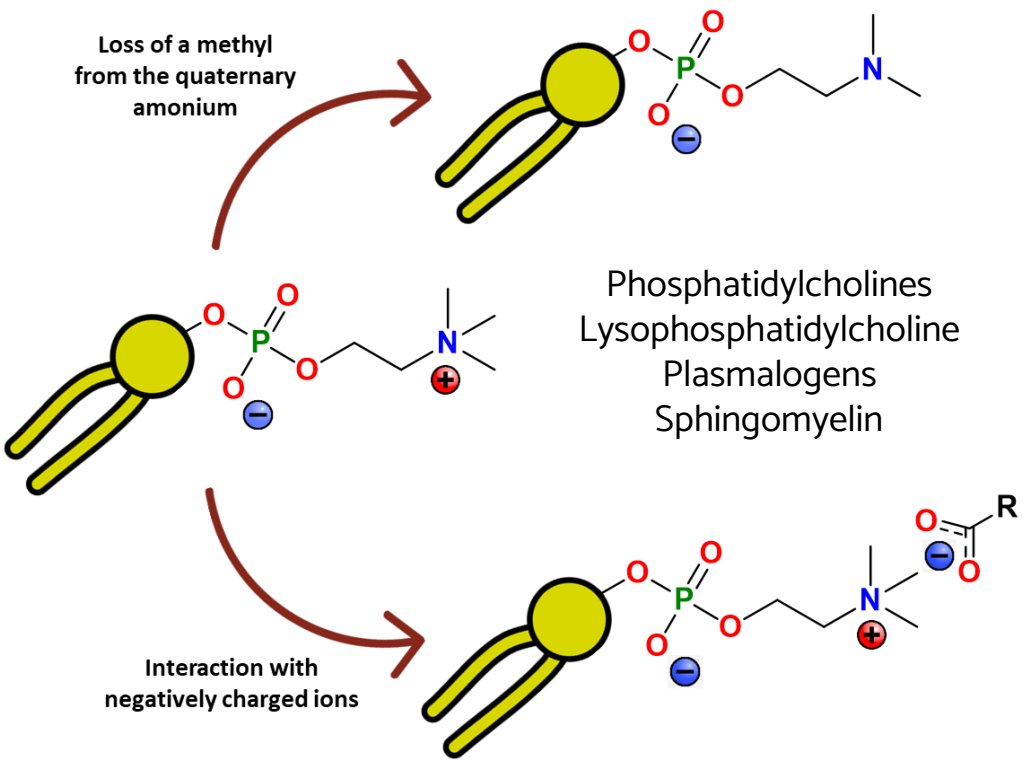


Phosphocholine-containing lipids



Phosphatidylcholines
Lysophosphatidylcholine
Plasmalogens
Sphingomyelin

PCL do not produce $[M - H]^-$ ions, even at extremely low abundance. Standard annotation algorithms fail to correctly determine demethylated adducts if they do not also find the deprotonated one.

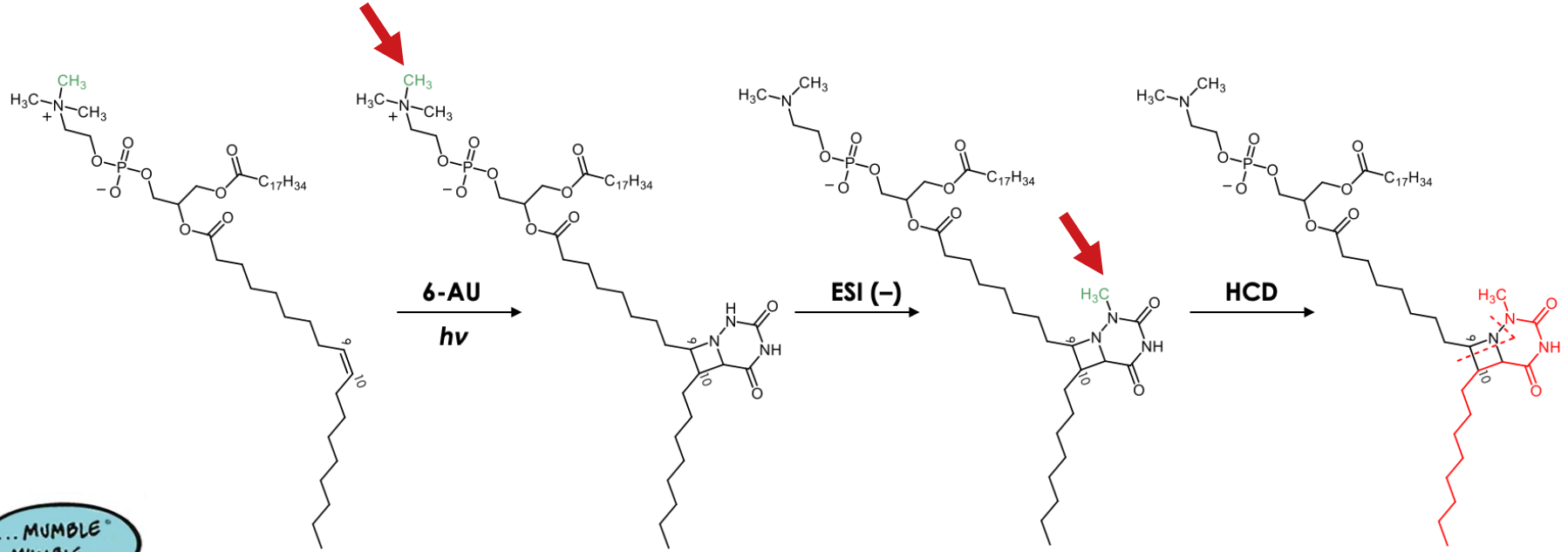
$$[PC_n - CH_3]^- = [PC_{n-1} - H]^-$$
$$[PC_n - CH_3]^- = [PE_{n+2} - H]^-$$

Acetate and formate adducts present the same molecular composition and both adducts present the same molecular composition of deprotonated PS:

$$[PC_n + AA]^- = [PC_{n+1} + FA]^-$$
$$[PC_n + AA]^- = [PS_{n-4} - H]^-$$
$$[PC_n + FA]^- = [PS_{n-3} - H]^-$$

https://doi.org/10.1021/acs.analchem.1c02944

Phosphocholine-containing lipids



Phosphatidylcholines did not generate in-source fragments or acetate adducts and generate fragment with an extra CH2

analytical chemistry

pubs.acs.org/ac Article

Novel Aza-Paternò-Büchi Reaction Allows Pinpointing Carbon–Carbon Double Bonds in Unsaturated Lipids by Higher Collisional Dissociation

Andrea Cerrato, Anna Laura Capriotti,* Chiara Cavaliere, Carmela Maria Montone, Susy Piovesana, and Aldo Laganà

Application of aPB lipidomics to hempseeds

crea
Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria

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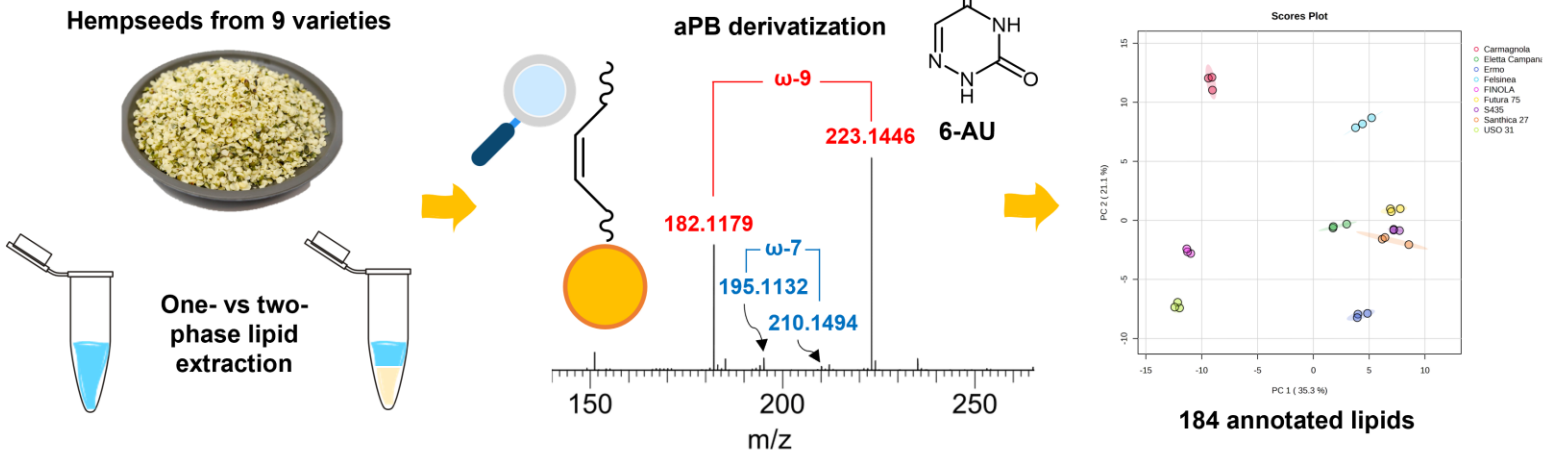
Contents lists available at ScienceDirect
Talanta
journal homepage: www.elsevier.com/locate/talanta

One-phase extraction coupled with photochemical reaction allows the in-depth lipid characterization of hempseeds by untargeted lipidomics

Andrea Cerrato [a], Sara Elsa Aita [a], Giuseppe Cannazza [b,c], Chiara Cavaliere [a], Alberto Cavazzini [d], Cinzia Citti [b,c], Carmela Maria Montone [a,*], Enrico Taglioni [a], Aldo Laganà [a]

[a] Department of Chemistry, Sapienza University of Rome, Piazzale Aldo Moro 5, 00185, Rome, Italy
[b] Department of Life Sciences, University of Modena and Reggio Emilia, Via Campi 103, Modena, 41125, Italy
[c] Institute of Nanotechnology – CNR NANOTEC, Campus Ecotekne, Via Monteroni, Lecce, 73100, Italy
[d] Department of Chemical, Pharmaceutical and Agricultural Sciences, University of Ferrara, Via L. Borsari 46, Ferrara, 44121, Italy



Application of aPB lipidomics to seaweeds

Progetto PRIN 2022 PNRR
DreamWEEDme

8 analyzed seaweeds (brown, red, and green algae)

Triple data processing

618 lipid sum compositions
918 molecular lipids

Analytical and Bioanalytical Chemistry
https://doi.org/10.1007/s00216-024-05573-6

RESEARCH PAPER

Check for updates

Detailed lipid investigation of edible seaweeds by photochemical derivatization and untargeted lipidomics

Carmela Maria Montone[1] · Chiara Cavaliere[1] · Andrea Cerrato[1] · Aldo Laganà[1] · Susy Piovesana[1] · Enrico Taglioni[1] · Anna Laura Capriotti[1]

Received: 11 August 2024 / Revised: 16 September 2024 / Accepted: 24 September 2024

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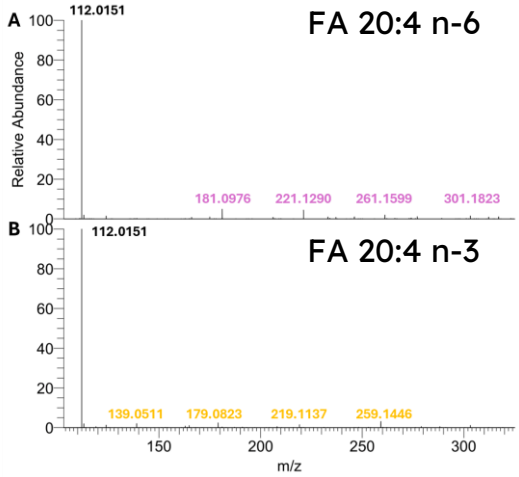

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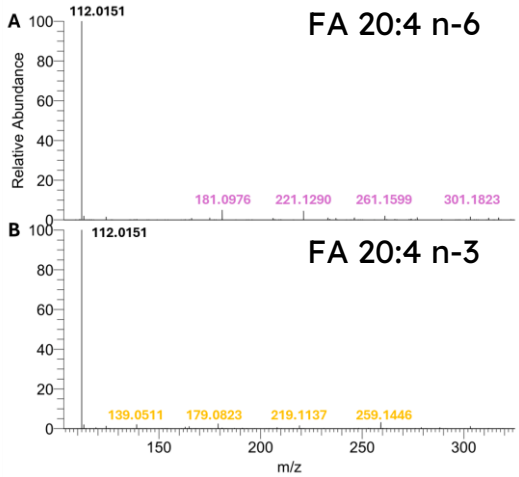
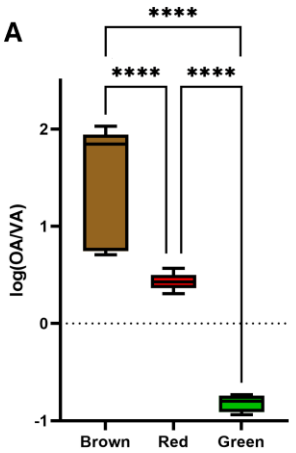
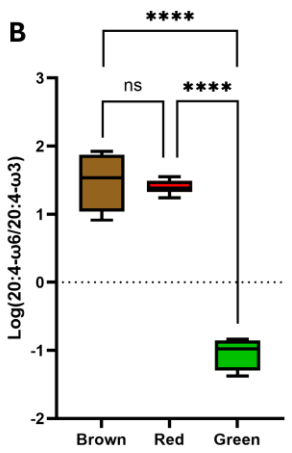
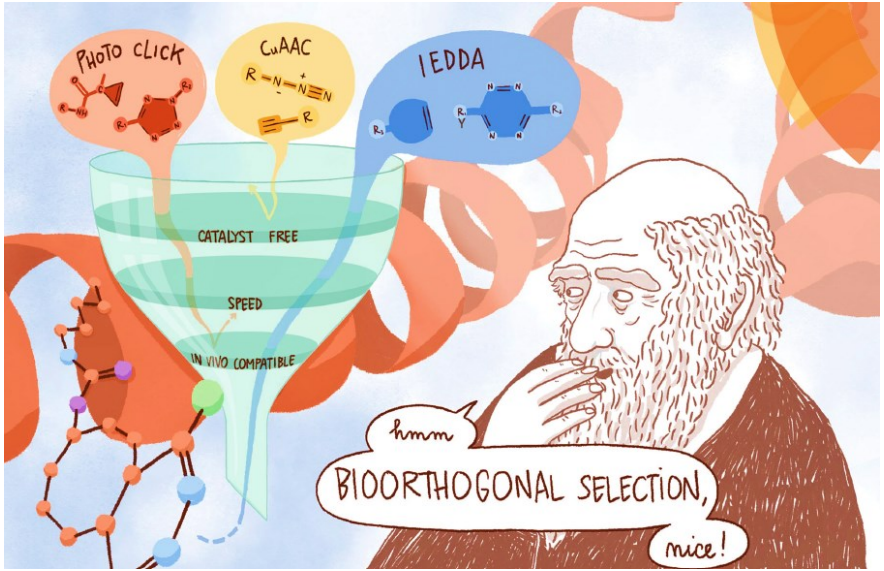


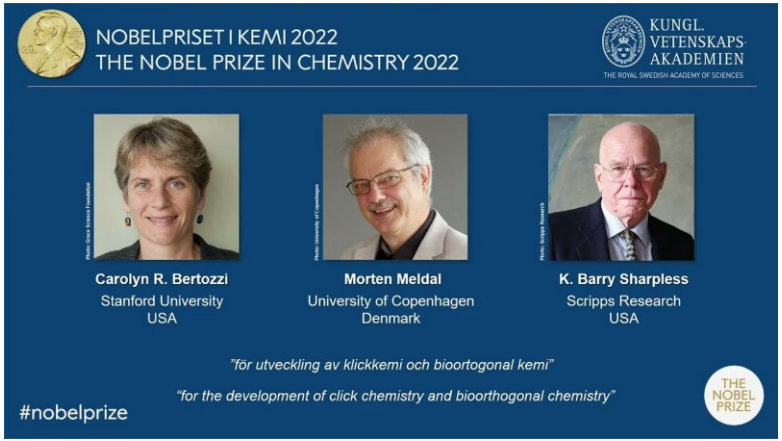


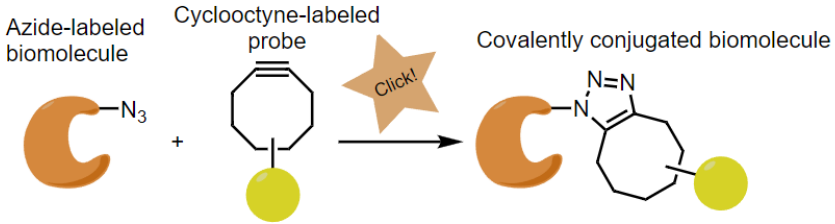


Beyond PB lipidomics

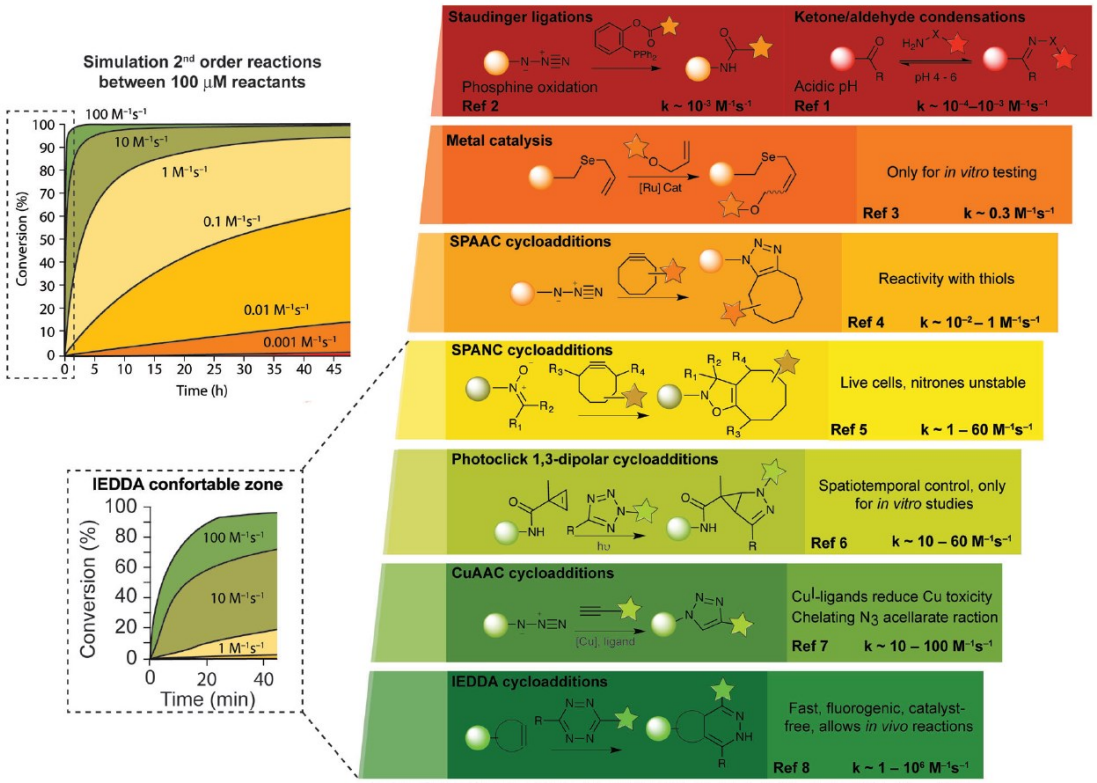
- Photochemical by reactions, cis/trans isomerization
- Asymmetry of PB reagents causes multiple derivatives







IEDDA cycloadditions



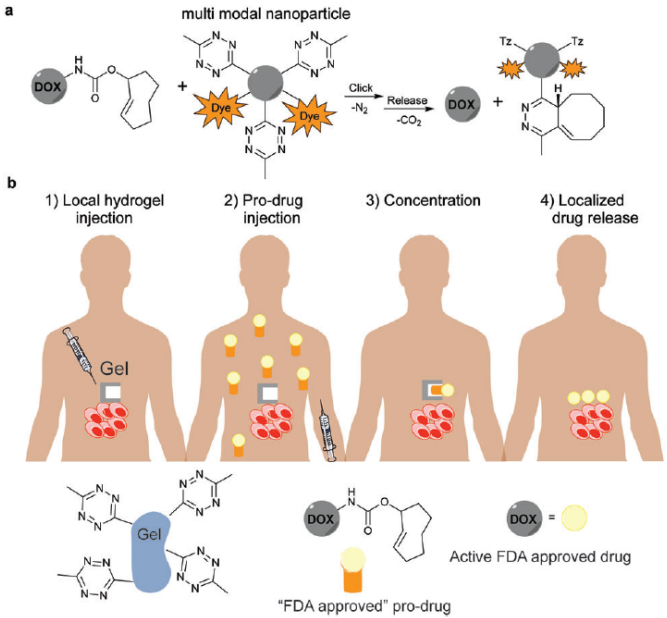
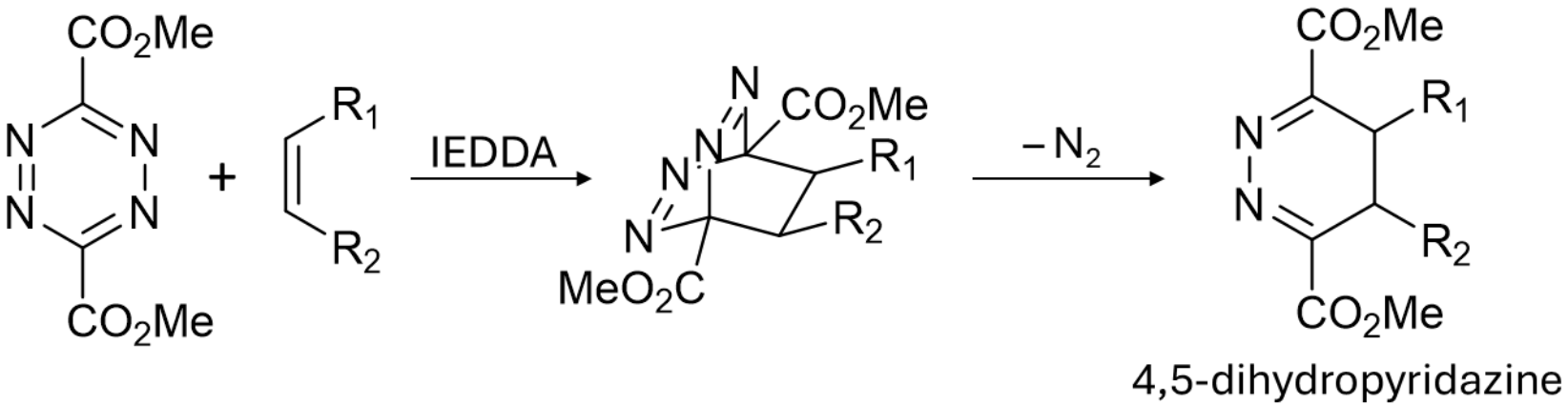


Fig. 51 (a) NP functionalization with tetrazines and fluorescent probes for image-guided prodrug activation. (b) "Click-to-release" for concentration and activation of pro-drugs at a diseased site.

Inverse electron demand Diels–Alder reactions in chemical biology, Chem. Soc. Rev., 2017,46, 4895-4950, https://doi.org/10.1039/C7CS00184C

IEDDA cycloadditions



4,5-dihydropyridazine

Inverse electron demand Diels–Alder reactions in chemical biology, Chem. Soc. Rev., 2017,46, 4895-4950, https://doi.org/10.1039/C7CS00184C

IEDDA cycloadditions

1) Diagnostic product ions following HCD
2) Acceptable conversion rates
3) Fast kinetics
4) Relative quantitation of C=C isomers

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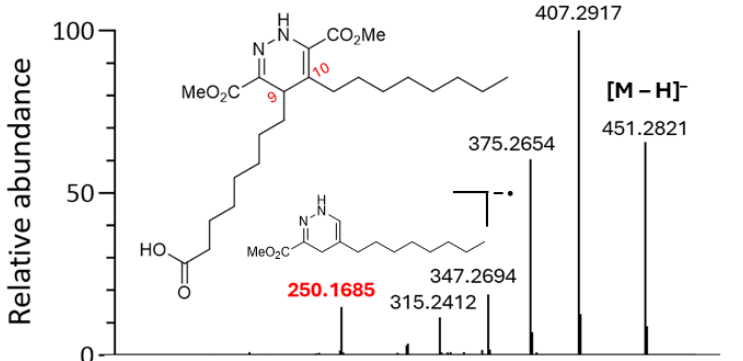
FA 18:1 n-9



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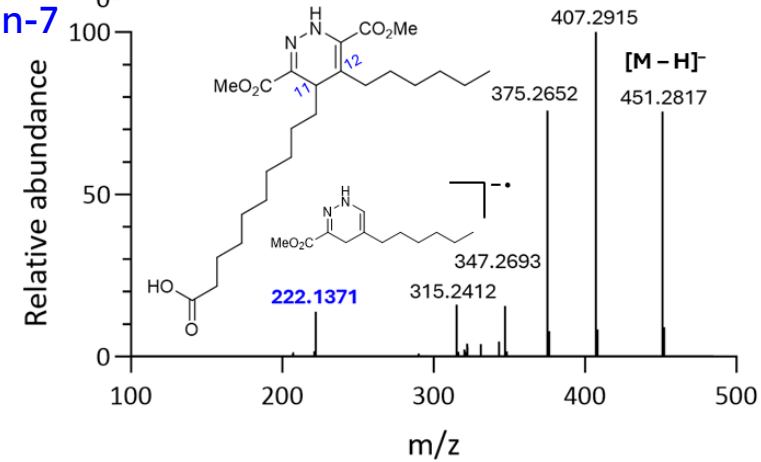

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IEDDA cycloadditions

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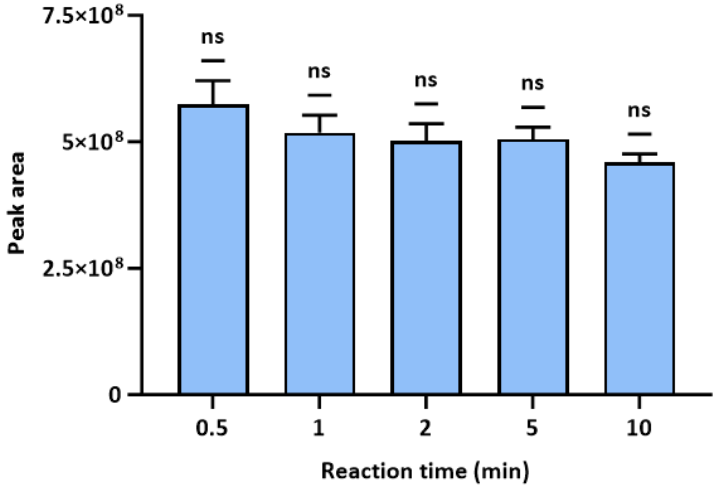
2) Acceptable conversion rates
3) Fast kinetics
4) Relative quantitation of C=C isomers



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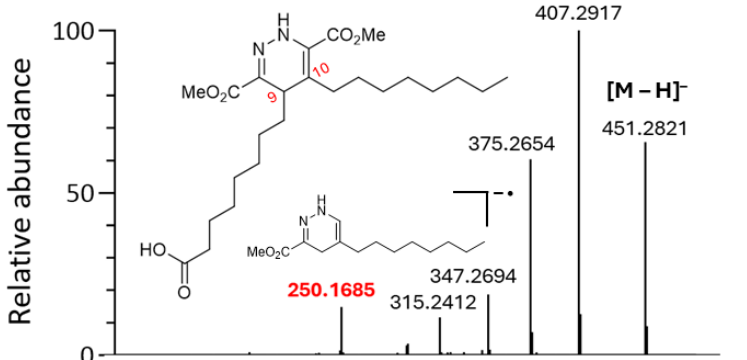

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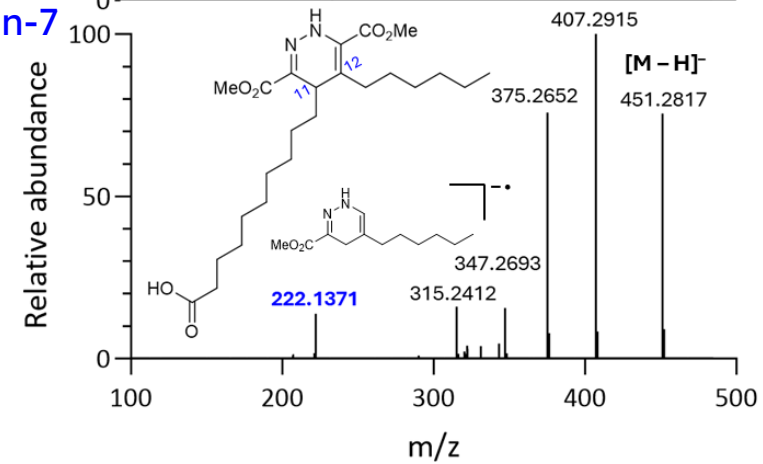

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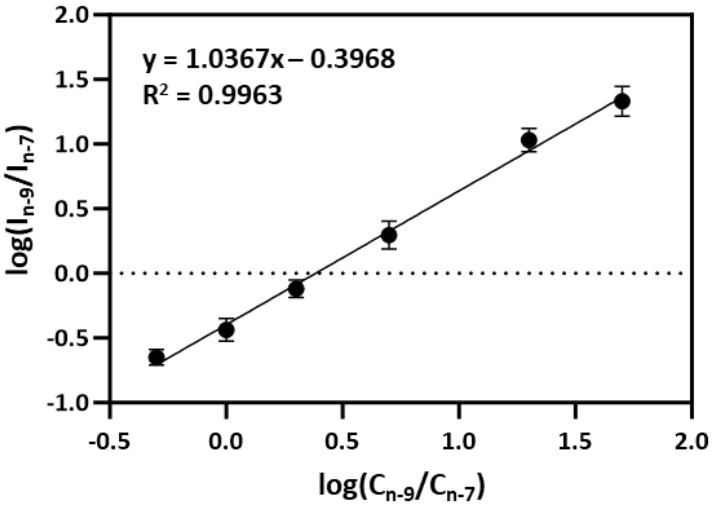

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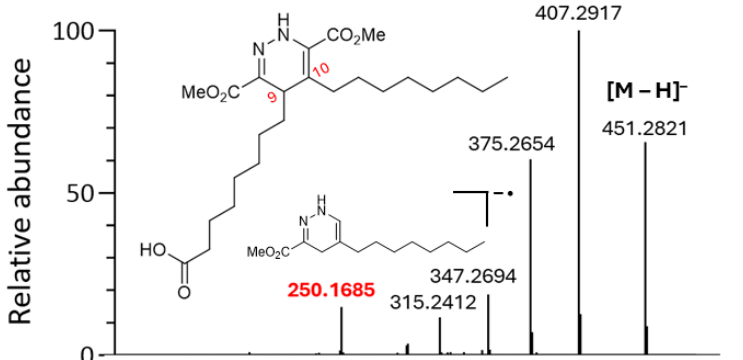

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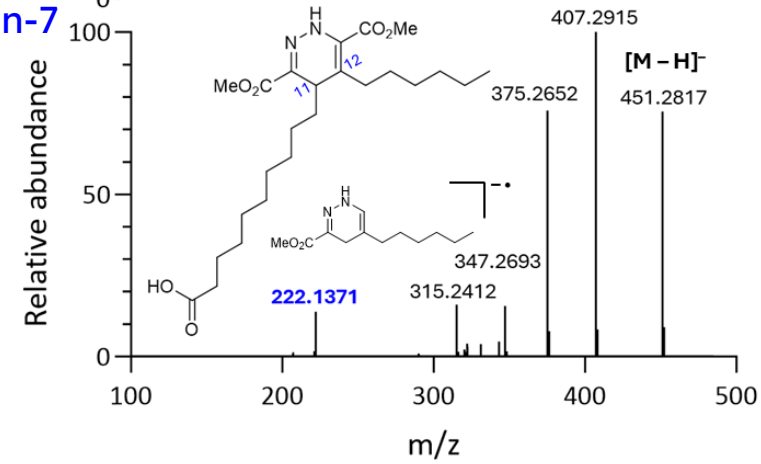
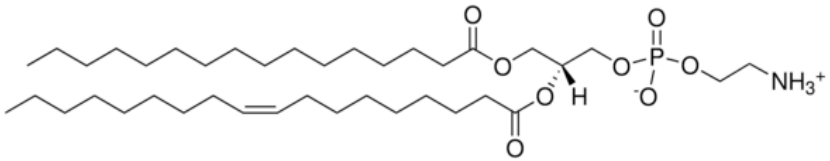
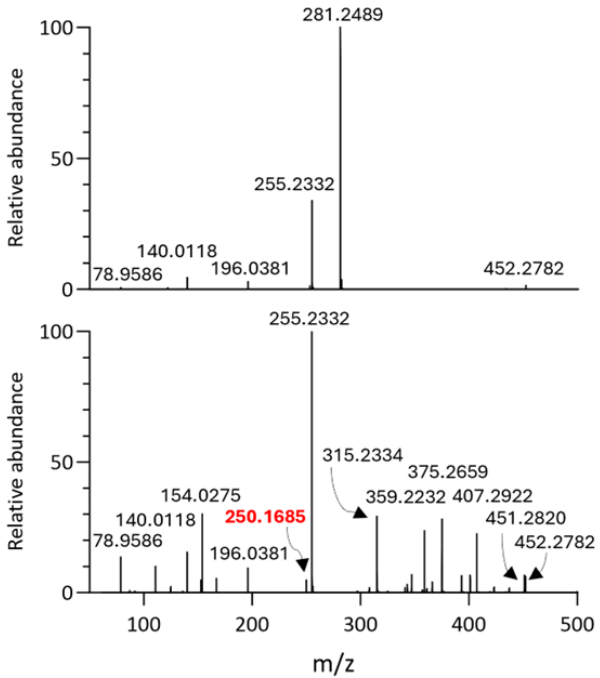
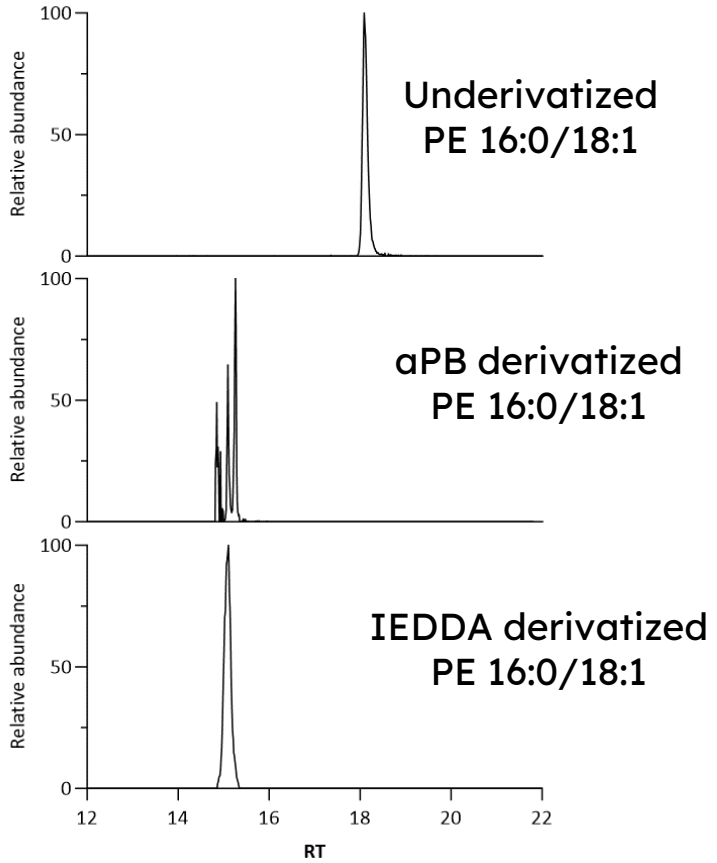


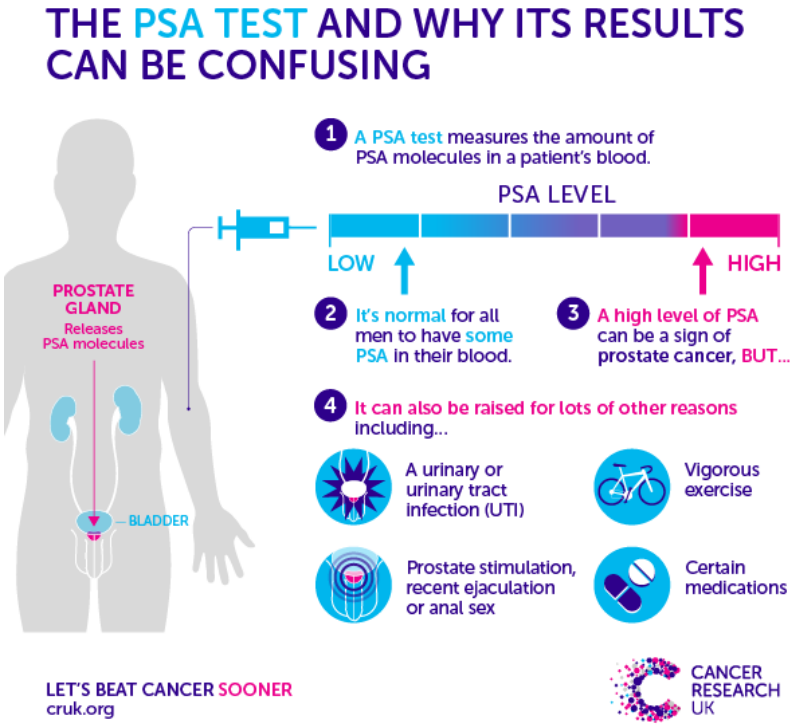
Derivatization of conjugated FA

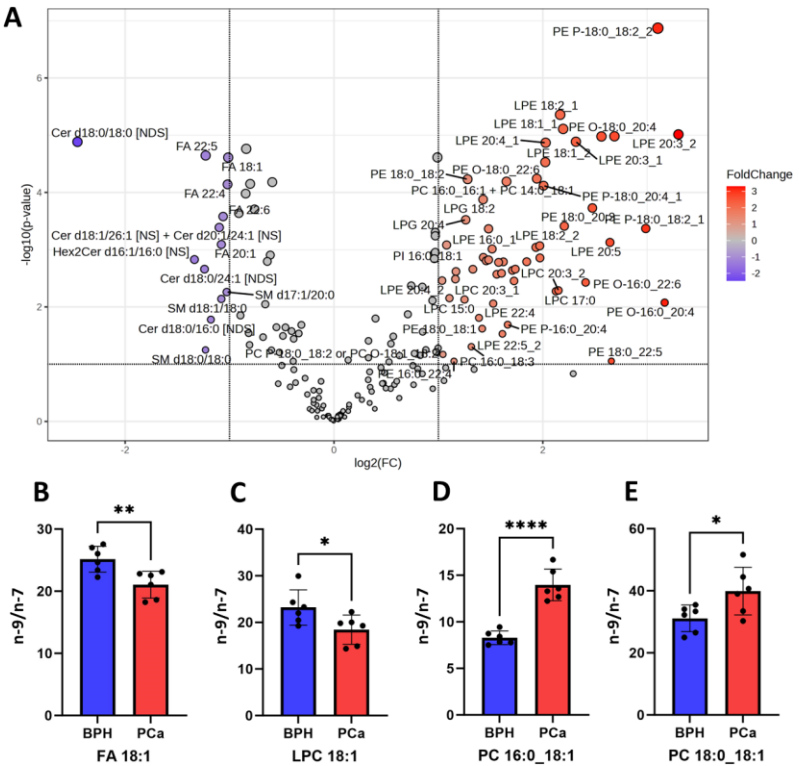






Application to PCA vs BPH sera





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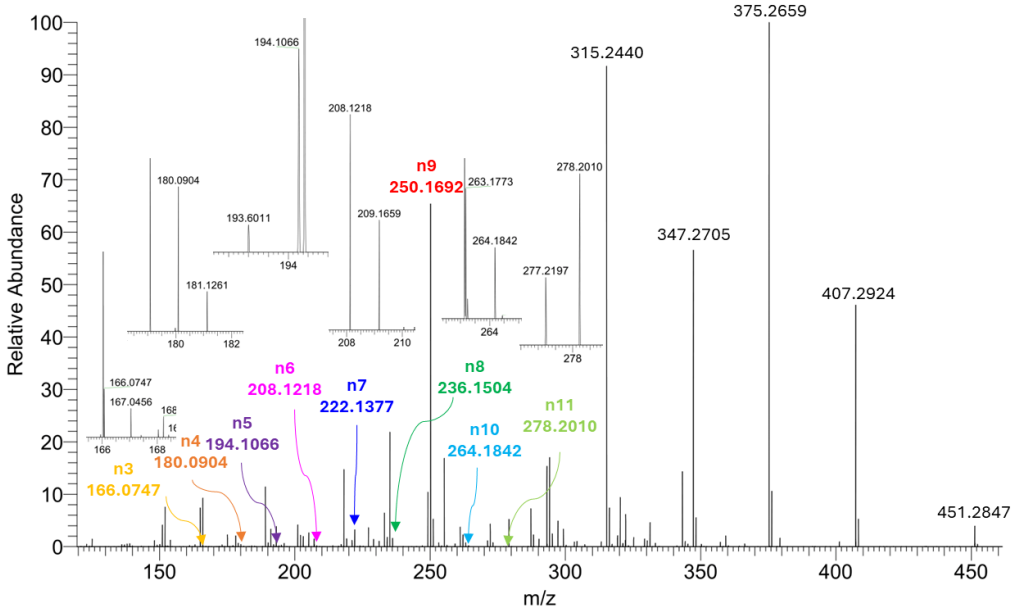

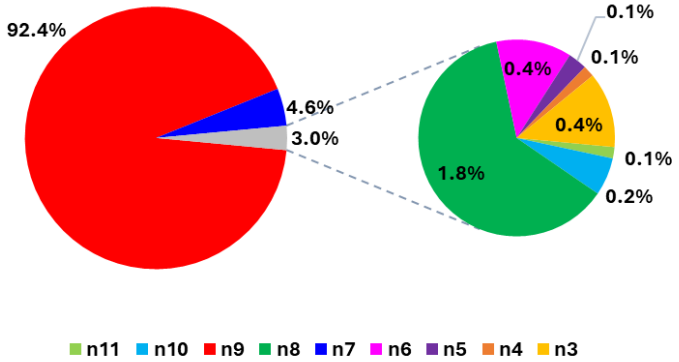

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First Proof of Concept of a Click Inverse Electron Demand Diels–Alder Reaction for Assigning the Regiochemistry of Carbon–Carbon Double Bonds in Untargeted Lipidomics

Andrea Cerrato, Chiara Cavaliere, Aldo Laganà, Carmela Maria Montone, Susy Piovesana, Alessandro Sciarra, Enrico Taglioni, and Anna Laura Capriotti*

Cite This: *Anal. Chem.* 2024, 96, 10817–10826 Read Online

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