Glycomics and Lipidopics

Fatty Acid-based Membrane Lipidomics: Why, What and When

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Abstract:
Lipidomics and nutrilipidomics are tools at the disposal of health professionals involved in the diagnosis and care of patients, as well as in the management of optimal conditions for prevention [1]. Functional lipidomics, divided into membrane lipidomics, mediator lipidomics and biomarker lipidomics, addresses the three main tasks involving lipids in living organisms, following-up their types and levels in correlation with physiological and pathological conditions. Research in these fields opened the way to a full understanding of the lipid roles in recognition and immunity, tissue development, signaling for cell reactivity and regeneration, giving a dL˚ەerent wider, meaning also to the fat balance that is required from a nutritional point of view. Research in membrane lipidomics carried out in the last decade individuated a crucial level of lipid diversity in living organisms: indeed, the quality and quantity of phospholipid structures found as components of cell membranes represent not only the availability of the nutritional and metabolic pathways, but fulfill the important task of maintenance of the overall of cell homeostasis. HLs is realized in each tissue with the appropriate fatty acid balance , whose maintenance involves an active membrane remodeling process, known as Lands's cycle. Membrane lipidomics provides an interesting approach connecting biophysical requirements for life and the health approach given by molecular medicine, allowing the concept of membrane homeostasis to find diagnostic applications practically oriented toward membrane profiles in health and diseases [1]. Why Membrane Phospholipids Cell membranes in eukaryotes display a very important dL˚ەerence from prokaryotes in the fatty acid composition, in the latter being absent the polyunsaturated portion. For this reason the fatty acid composition of the eukaryotic cell membrane embeds the information on how the membrane homeostatic requirement can be fulfilled by an adequate fat supply, being dependent from the incorporation of essential elements from the diet since the organism is not able to prepare polyunsaturated fatty acids by de novo biosynthesis. Membrane functionality and essentiality are indeed the two factors that render the analysis of membrane phospholipid crucially important for evaluating health consequences. He use of circulating lipids for analysis is very dL˚ەuse but the

most direct information on the homeostatic and nutritional role of fats comes undoubtedly from the cell membrane analysis. Fatty acid-based membrane lipidomics is a powerful tool to checkup molecular unbalances and absence of essential elements. HLs information has an immediate e˚ەect for the evaluation of the molecular performances of the individual, since the membrane functionality cannot be optimized in the presence of an unbalance. In clinical practice this is translated into a basic prevention tool since the molecular unbalance does not represent per se a pathological sign, however does not allow the normal membrane functionality to be fulfilled Membrane lipidomics creates an opportunity for recovering the homeostasis through appropriated nutritional strategies, and this approach can become crucial especially when associated with therapeutical approaches. He classical example is represented by an LnflDmmDtor\ status, that is well known to be associated with the arachidonic acid content of membrane phospholipids and its balance with other PUFA moieties, such as omega-3 EPA and DHA as well as the omega-6 DGLA. He association of a dietary control of fatty acid balance together with the pharmacological blockage of arachidonic acid transformations (achieved by any of the non-steroidal DntLnflDmmDtor\ drug normally used in clinical practice) should be seen as an optimal combination for clinical use: in fact, the fatty acid balance will ensure the control of the production of lipid mediators by detachment of fatty acids from membrane phospholipids, therefore the drug dosage to obtain the control of arachidonic acid e˚ەects can be chosen more appropriately. It is also worth adding that the resolution of the LnflDmmDtor\ conditions also depends on the presence of the omega-3 counterparts, and membrane lipidomics can provide the complete membrane fatty acid asset in order to have a full overview of the PUFA content. What Cell To Examine He study of the representative cell in the human body able to convey such information led to the assessment of the mature red blood cells as a very reliable cell sample. He erythrocyte life time of 120 days o˚ەers a long period of stay in circulation all over the body tissues with a distinct behavior acquired in the mature state (>3 months) characterized by a small diameter and high hemoglobin content (easily separable by density dL˚ەerentLDtLon

Hese cells contains several pieces of information on the senescence progress, exposure to oxidative stress, together

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with the metabolic and nutritional eﬀects produced in the individual during a reasonably long time window. Erythrocyte membranes contains 23% MUFA, 43% SFA and 34% PUFA (both the ω-6 and ω-3 series), whereas the mature RBC have an increased PUFA content, that render them more informative on the real PUFA availability for other tissues. He possibility of separating this cells and their membrane fatty acids, nowadays eﬀected by a robotic equipment, that reduces tedious operations and manual errors, certainly render the fatty acid-based lipidomic analysis much more reliable and extendable to a large number of individuals. Fatty acid-based functional lipidomics dealing with the hydrophobic part of the phospholipids, expresses the Journal of Glycomics & availability of saturated, monounsaturated and polyunsaturated fatty acids from metabolism and diet, and can be successfully applied to the follow-up of human lipid profiles under normal and pathological conditions. When Analysis Can Be Useful From the scenario so far described it is clear that fatty acid based membrane lipidomics is a ready-to-use platform for clDssLficDtLon of health status through the molecular unbalance. In the analytical protocols of such analyses, a specLfic resolution tasks must be achieved: the full separation of all fatty acid types, either as geometrical cis and trans isomers, and as positional isomers, to correctly locate the double bond position along the hydrocarbon chain. He example provided by palmitoleic acid (9cis-C16:1), pointed out as sLgnLficDnt biomarker in obesity, is indicative since it requires appropriate gas chromatographic conditions to be separated from the positional isomer, i.e., sapienic acid (6cis-C16:1). HLs turned out to be very important in the correct examination of fatty acid profiles from the red blood cell membranes and cholesteryl esters of obese and healthy subjects, opening a metabolic alternative for delta-6 desaturase enzymes to process palmitic acid. Nowadays, check-up analyses are made to evaluate presence of essential elements in the body, such as vitamins, minerals, that are more and more revealing the pitfall of the nutrition in industrialized countries, as well as the loss of the nutritional values from the globalized food supply. Analogously, the fatty acid presence in the membrane compartment becomes a valuable information to be acquired in order to verify the membrane functionality and homeostasis of each individual. It can be used as an indicator of earlier unbalance, highlighting metabolic derangement or LnsuﬃcLent essential fatty acid intakes from the diet, which in each subject can have a specLfic reason and be targeted with personalized preventive strategies. Over the last decade fatty acid-based functional lipidomics showed its strong contribution to personalized medicine definLng

several human profiles in pathological conditions, such as obesity, autism , parenteral nutrition , among others, and in various physiological status. He dLﬀerences reported between healthy controls and groups of subjects with dLﬀerent pathologies created more and more awareness on the value of the associated molecular profiles He interesting approach of membrane lipid replacement is connected to the membrane lipidomics and is nowadays showing its success in various health conditions. Indeed, the membrane lipidomic data can be transferred to the assessment of personalized strategies based on lipid intakes from functional foods and nutraceuticals for recovering the physiological homeostasis of the subjects.

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