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Lipidomics – A Novel Strategy for Probing into Systems Biology Operations: Networking between Glycome, Lipidome, Proteome, and Genome

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One of the fascinating and challenging marvels of biological systems is the dynamic cellular compartmentalization aided by the structure and function of diverse and complex molecules, mainly carbohydrates, lipids, proteins, and nucleic acids which constitute the glycome, lipidome, proteome, and genome, respectively. Nevertheless, these molecular entities are in a constant flux adapting to and modulating the functions of the biological system at the membrane, organelle, cellular, and organ levels and finally regulating the organismal structure and function(s). Remarkably, the microsystems (microcosms) including glycome, lipidome, proteome, and genome operate by interwoven networks and communicate with each other through the complex and dynamic molecular signal transduction mechanisms (Figure 1) involving enzymes, hormones, receptors, lipids, carbohydrates, nucleic acids, and bioactive molecules, to name a few [1,2]. Thus, the entire biological system (macrocosm) at the organismal level is constantly regulated (homeostasis) by the well-controlled interconnected operations of the microsystems.

The molecular nature of individual entities of glycome and lipidome such as the carbohydrates and lipids is highly complex due to their diversity and perpetual metabolic flux in a biological system at either microsystem or macrosystem levels. Metabolic processes such as synthesis and degradation or transformation of biomolecules dictate the system's operations, thus placing the metabolome at a higher hierarchy. Lipids occupy a vital place in the cellular machinery. However, cellular lipids are highly complex, diverse, and extremely non-polar (insoluble in water) as compared to the carbohydrates, proteins, and nucleic acids. Cellular lipids of the lipidome (i) constitute the biological membranes (phospholipids), (ii) regulate the transport processes, (iii) control electrical activities of cells, (iv) serve as energy reserves (triglycerides), (v) participate in inflammation and infection (eicosanoids), (vi) actively take part in signal transduction (bioactive lipids) and (vii) modulate several key cellular functions such as differentiation, proliferation, and death [3]. All these multifarious properties of the lipidome render the analysis of lipids complicated and time-consuming. Needless to mention, the OMICS technology supported by the efficient separation technique (liquid chromatography, LC) and the precise detection method (mass spectrometry, MS), has made the analysis of the complex lipid species of the biological system easier and faster through the utilization of the LC-MS analytical platform which has been rapidly undergoing evolution for better suitability, efficiency, and precision [4]. Of course, the other established analytical techniques such as the radioisotope tracer techniques, thin-layer chromatography, gas chromatography, enzymology, molecular biology methods, PROTEOMICS methods, GLYCOMICS techniques, and the GENOMICS strategies serve as the complementary and extremely useful methods to study the lipidome and metabolome of the system [5]. Thus, the LIPIDOMICS strategy of analysis of the plethora of lipid species in a chosen system has emerged to study the lipidome which is also an integral part of the metabolome. Hence, METABOLOMICS is a broader discipline which also includes the systems biology-focused investigation of lipids by applying the lipidomics approach [6]. Also, the spatio-temporal changes of the multifarious cellular lipid species need to be established in order to know the dynamics of system's metabolome. The rapidly evolving discipline of lipid bioinformatics supported by mathematical tools (algorithms) offers lucid and faster analysis of the lipidomics data towards a better

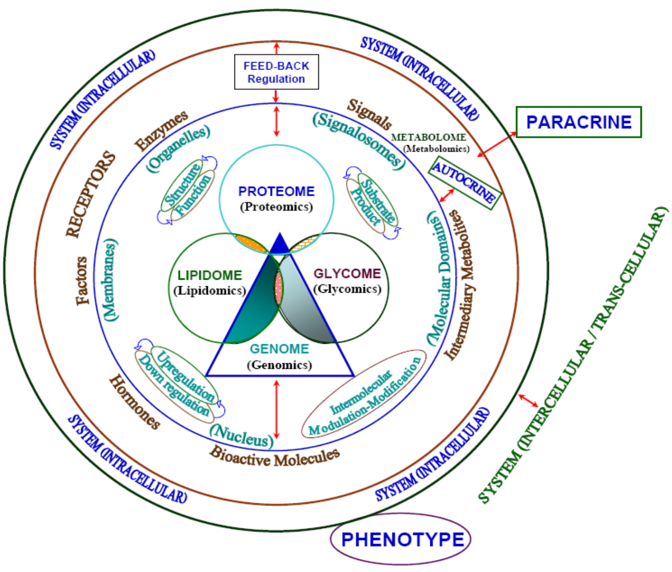

Figure 1: Schematic representation of the intricate assembly and communication of microsystems including the proteome, lipidome, glycome, and genome in macrosystem. The molecular effectors and affectors and their locations are shown here. The emergence of the metabolome from the microsystems and their interdependence are identified. The application of OMICS-based analyses has been identified at appropriate places. Overall, the cellular system as a whole is controlled or regulated by the structure and function of the microsystems which also dictate the intercellular or trans-cellular structure and function.

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and deeper understanding of the role and fate of individual lipid species in the metabolome of the system [7,8]. Thus, the analytical lipidomics is crucial for unraveling the mysteries of the system's metabolome.

It is becoming convincing that lipidomic analyses can offer deeper insights into the understanding of the mechanisms of several diseases for identifying molecular targets towards achieving effective treatments [9]. Lipidomic approaches are also emerging as suitable diagnostic tools for certain diseases in humans such as myocardial lipidomics and neurolipidomics. Thus, systems biology-centered lipidomics appears as a promising analytical platform in preventing or treating several lipidome-based disorders/diseases. This is the right time to launch the Journal of Glycomics and Lipidomics which will be a fitting stage for the investigators in the fields of glycomics and lipidomics to publish their discoveries.

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