EUROPEAN CONFERENCE

Conference Proceedings

VI International Science Conference «Prospects for the development of modern science and education: problems and ways of development»

February 10-12, 2025

Plovdiv, Bulgaria

PROSPECTS FOR THE DEVELOPMENT OF MODERN SCIENCE AND EDUCATION: PROBLEMS AND WAYS OF DEVELOPMENT

Abstracts of VI International Scientific and Practical Conference

Plovdiv, Bulgaria
(February 10-12, 2025)

UDC 01.1

ISBN – 9-789-40378-462-5

The VI International scientific and practical conference «Prospects for the development of modern science and education: problems and ways of development», February 10-12, 2025, Plovdiv, Bulgaria. 191 p.

 Collection of scientific articles published is the scientific and practical publication, which contains scientific articles of students, graduate students, Candidates and Doctors of Sciences, research workers and practitioners from Europe, Ukraine and from neighboring countries and beyond. The articles contain the study, reflecting the processes and changes in the structure of modern science. The collection of scientific articles is for students, postgraduate students, doctoral candidates, teachers, researchers, practitioners and people interested in the trends of modern science development.

The recommended citation for this publication is: Yakovenko R., Chepurnyi R., Chepurnyi V. Application of plant growth regulators in horticulture. Abstracts of VI International Scientific and Practical Conference. Plovdiv, Bulgaria. Pp. 9-11.

URL: https://eu-conf.com/en/events/prospects-for-the-development-of-modern-science-and-education-problems-and-ways-of-development/

STRUCTURE AND FUNCTION OF SPHINGOLIPIDS IN CELL MEMBRANES

Valentyna Slipchuk
Doctor of Sciences in Pedagogy, Professor,
Professor of the Department of Medical Biochemistry
and Molecular Biology,
Bogomolets National Medical University

Anastasiia Yefymenko
student of medical faculty №1,
specialty 222 “Medicine”,
Bogomolets National Medical University,
Kyiv, Ukraine

The study of the chemical structure of sphingolipids, their role in maintaining membrane stability and structure, as well as their impact on cell membrane permeability is relevant. They are recognized by bacteria, bacterial toxins, and viruses, which directly affects the vital functions of the cell and the body as a whole.

Sphingolipids are membrane lipids consisting of one molecule of the amino alcohol sphingosine, one molecule of a long-chain fatty acid and a polar head group. Ceramides are the structural precursors of all sphingolipids [1, p. 1011].

There are three subclasses of sphingolipids that are derived from ceramide: sphingomyelins, neutral glycolipids, and gangliosides. Sphingomyelins contain phosphocholine or phosphoethanolamine as the polar head group, so they are classified as phospholipids together with glycerophospholipids. Sphingomyelins are present in the plasma membranes of animal cells and are particularly prominent in myelin, the membrane sheath that insulates the axons of some neurons [1, p. 1012].

Glycosphingolipids, which are found mainly on the outer surface of membranes, have one or more sugar residues and do not contain phosphates. Glycosphingolipids are divided into cerebrosides containing a D-glucose or D-galactose residue and globosides containing two or more D-glucose, D-galactose or N-acetyl-D-galactosamine residues [1, p. 1012].

Gangliosides contain oligosaccharides as polar headgroups and one or more residues of N-acetyIneuraminic acid (Neu5Ac), a sialic acid, at the termini [1, p. 1012].

Many biological functions are associated with sphingolipids, including cellular regulation, signaling, and metabolism.

Cellular sphingolipids can interact with complementary ligands (i.e. extracellular matrix proteins/receptors), with other carbohydrates and with proteins on the same cell surface, can control the location of a protein and change its conformation and activity [2].

Ceramides and sphingosine-1-phosphate (S1P) are the most studied sphingolipids in relation to immune cell functions. External signals, such as tumor necrosis factor-α

(TNF-α) and lipopolysaccharides (LPS) and/or internal modulators, such as cytosolic kinases and transcriptional modulators, can cause ceramides to accumulate, and ceramides, when elevated, can selectively turn on/off intracellular mechanisms. In addition, the enrichment of intracellular ceramide content can control the rate of protein transport to the Golgi complex and membrane, which can cause cellular senescence [3].

For example, S1P acts as a regulator of mast cell response through calcium mobilization, can function both inside the cell as a secondary messenger and outside the cell by binding to S1P receptors and transmitting signals through them. S1P binds G-protein-coupled receptors (GPCR) on the surface of surrounding cells to transactivate receptors S1P 1 and 2, which are involved in mast cell migration and degranulation, respectively [4].

The scientific paper "A reference map of sphingolipids in murine tissues" proves that 114 sphingolipids were isolated and studied in 21 mouse tissues. The scientists concluded: 11 types of sphingolipids are common to all tissues, which contributes to the regulation of the cell cycle, but each tissue has its own qualitative and quantitative distribution of sphingolipids. A similar qualitative and quantitative distribution of sphingolipids was found among functionally similar tissues. The presence of tissue-specific sphingolipids provides insight into the possible mechanisms of specific pathologies [5].

Since sphingolipids of different tissues differ in their qualitative and quantitative composition, a blood test can reveal the status of an organ that may be damaged or inflamed. The skin, stomach and intestines have a similar lipid composition, which explains the barrier function of tissues by creating thicker membranes compared to the membranes of the spleen, thymus and lymph nodes [5].

As a means of attachment and penetration, sphingolipids can be recognized by viruses, bacteria, and bacterial toxins. Sphingolipids are also produced by the intestinal bacteria Bacteroidetes (including the common species Bacteroides, Prevotella and Porphyromonas), which make up 30-40% of the human gut microbiome. These representatives of the human gut microbiome possess the essential enzyme serine palmitoyltransferase (SPT), which is responsible for the first step in the synthesis of sphingolipids, which can ultimately be absorbed by the portal hepatic vein and circulatory system [3, 6]. With the help of absorbed sphingolipids, commensal bacteria can influence and control the host's metabolic system and immune response. The most abundant metabolites in the stool of patients suffering from inflammatory bowel diseases such as ulcerative colitis and Crohn's disease are ceramides, sphingomyelins and sphingosines (C18:1) produced by the host, while the amount of sphingolipids produced by bacteria and sphingolipids originating from Bacteroides is significantly reduced [3].

A study of SPT-sufficient or SPT-deficient Bacteroides thetaiotaomicron-adopted mice showed that commensal bacteria are a source of ceramides and attenuate excessive intestinal inflammation by breaking the barrier and activating the innate/adaptive immune system, excessive "Renaissance" of commensal bacteria can also cause activation of the host's immune system, especially humoral immunity, with

the production of antibodies and sphingosines that counteract potential sources of danger, ultimately preventing microflora disruption and preparing a healthy host defense system. Bacterial pathogens try to neutralize the body's defense system and then bind to the host's epithelial cells and/or release bacterial molecules (e.g., toxins) that stimulate the accumulation of ceramides and block the production of sphingosines, facilitating the colonization of these bacteria [3].

Sphingolipids can affect the short life of neutrophils. Increased ceramide content may modulate neutrophil function in terms of cell migration, reactive oxygen species generation, neutrophil trapping, and bactericidal activity, and increased sphingomyelin content in neutrophils may be associated with neutrophil infiltration and phagocytic activity [3].

Conclusions. The chemical structure of sphingolipids determines the amphiphilic properties, polarity or nonpolarity of these substances, which determines the location and role of a particular sphingolipid in cells and tissues. The stability of the cell membrane structure is caused by the presence of sphingolipids in lipid rafts, which interact with receptors outside the cell, carbohydrates on the same cell surface, control the location, change the conformation and activity of proteins in the cell membrane. The barrier function of the plasma membrane depends on the length of the hydrocarbon residue of fatty acids that make up sphingolipids. Sphingolipids are partially responsible for its permeability, functioning as regulators of calcium mobilization, primary or secondary messengers, and affecting the lifespan of neutrophils and their functions: phagocytosis and degranulation. Sphingolipids are recognized by bacteria, bacterial toxins and viruses, which directly affects the vital functions of the cell and the body as a whole.

References

1. Nelson, David L., Michael M. Cox. (2017). *Lehninger Principles of Biochemistry*. 7th ed., W.H. Freeman. [1011-1012; 3202]. https://archive.org/details/david-l.-nelson-michael-m.-cox-lehninger-principles-of-biochemistry-w.-h.-freeman-2017-kopyasi/page/n1010/mode/1up
2. Sphingolipids [Internet]. (2022). *Physics LibreTexts*. https://phys.libretexts.org/@go/page/1977
3. Lee, M., Lee, S.Y. & Bae, YS. (2023). Functional roles of sphingolipids in immunity and their implication in disease. *Exp Mol Med*, 55, 1110–1130. https://doi.org/10.1038/s12276-023-01018-9.
4. Quinville, B. M., Deschenes, N. M., Ryckman, A. E., & Walia, J. S. (2021). A Comprehensive Review: Sphingolipid Metabolism and Implications of Disruption in Sphingolipid Homeostasis. *International Journal of Molecular Sciences*, *22*(11), 5793. https://doi.org/10.3390/ijms22115793
5. Muralidharan, Sneha et al. (2021). A reference map of sphingolipids in murine tissues. *Cell Reports*, 35(11), 109250. doi: 10.1016/j.celrep.2021.109250.
6. Johnson, E.L., Heaver, S.L., Waters, J.L. *et al.* (2020). Sphingolipids produced by gut bacteria enter host metabolic pathways impacting ceramide levels. *Nat Commun*, 11, 2471. https://doi.org/10.1038/s41467-020-16274-w.