

Deoxyribosylglycine

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summary

Deoxyribosylglycine (dRG) is a biochemical compound characterized by the molecular formula $C_5H_{10}O_4$, featuring a ribose sugar moiety modified by a glycine residue. This compound plays a critical role in cellular metabolism, particularly in the synthesis of nucleotides essential for DNA and RNA formation. Notably, dRG is involved in metabolic pathways such as one-carbon metabolism, influencing DNA

synthesis and cellular proliferation. Its significance extends beyond metabolism, as dRG also functions as a signaling molecule that affects bacterial growth and virulence, making it relevant in the context of antimicrobial resistance and medical microbiology.[\[1\]\[2\]\[3\]](#).

The importance of dRG is underscored by its implications in health and disease. Disruptions in dRG synthesis and metabolism have been linked to several health issues, including cancer, where its role in nucleotide production is critical for rapidly dividing cells. Research has suggested that targeting dRG-related pathways may yield novel therapeutic strategies for conditions characterized by metabolic dysregulation.[\[4\]\[5\]](#) Furthermore, the compound is gaining attention in biotechnology, particularly in genetic engineering and gene therapy, where it enhances DNA manipulation and delivery of genetic material to target cells, thus offering potential advancements in personalized medicine and genetic disorder treatment.[\[6\]\[7\]\[8\]](#).

Recent studies have highlighted the expanding scope of research on deoxyribosylglycine, focusing on its effects on cancer therapy and its potential role as a biomarker for various health conditions. For instance, ongoing investigations are examining the relationship between dRG levels and chronic diseases, such as stroke, which may inform preventive health strategies and interventions.[\[9\]](#) Given its multifaceted roles in biochemistry and medicine, dRG represents a significant area of interest for ongoing and future research in both basic and applied sciences.

As research into dRG continues to evolve, its unique chemical properties and biological functions suggest promising applications across multiple disciplines, including biotechnology, health, and medicine. The compound's contributions to metabolic pathways and signaling processes further underscore its importance in understanding cellular functions and developing innovative therapeutic approaches.[\[10\]\[5\]\[11\]](#).

History

Discovery and Early Research

The foundation of our understanding of DNA began in the late 1800s when Swiss biochemist Friedrich Miescher first isolated what would later be identified as DNA.[\[1\]](#) However, it wasn't until the 20th century that the structure and significance of DNA were elucidated. The breakthrough moment came in 1953 when James Watson, Francis Crick, Maurice Wilkins, and Rosalind Franklin collaboratively unveiled the double helix structure of DNA, which was critical for understanding how genetic information is transmitted across generations.[\[1\]](#)

Advancements in Analytical Methods

As research in molecular biology progressed, traditional methods for studying genetic material were often found lacking in addressing the complexities of biological systems. The advent of innovative analytical methods has transformed the field, enabling significant advancements in areas such as developmental biology and robotics. These advancements have not only enhanced our understanding of genetic func-

tions but have also paved the way for practical applications, including regenerative medicine and the creation of synthetic living machines.[\[10\]](#)

Recent Discoveries

Since 2013, the pace of gene discovery has accelerated dramatically, with whole exome sequencing (WES) and whole genome sequencing (WGS) yielding almost three times the number of discoveries compared to conventional methodologies.[\[12\]](#) This rapid advancement highlights the continuous evolution of genetic research and the importance of sophisticated analytical techniques in uncovering the complexities of DNA and its role in living organisms.

Chemical Properties

Deoxyribosylglycine is a compound characterized by its specific molecular formula and structural attributes. The chemical formula of deoxyribosylglycine is $C_5H_{10}O_4$, indicating that it contains five carbon atoms, ten hydrogen atoms, and four oxygen atoms[\[13\]\[14\]](#). The structure of deoxyribosylglycine features a ribose sugar moiety that is modified by the presence of a glycine residue, contributing to its biochemical functionality.

The compound's biosynthetic pathways play a crucial role in its chemical reactivity and interactions. For instance, deoxyribosylglycine participates in metabolic processes involving nucleotide synthesis, where its structure facilitates the formation of nucleotides through reactions involving various enzymes[\[15\]\[16\]](#).

Furthermore, the compound exhibits unique physical properties. For example, compounds derived from similar sugar frameworks have been shown to form stable complexes with metal ions, such as copper, which may influence their reactivity in biochemical systems[\[17\]\[10\]](#).

Biological Role

Deoxyribosylglycine (dRG) plays a significant role in cellular metabolism and the regulation of various biological processes. As a derivative of deoxyribose, dRG is involved in the synthesis of nucleotides, which are essential for DNA and RNA formation[\[2\]](#). The importance of nucleotide metabolism extends to its connection with energy production and signal transduction pathways, particularly through the universal energy carrier ATP and other nucleotides like GTP[\[4\]](#).

Metabolic Pathways

The biosynthesis of dRG is intricately linked to several metabolic pathways, including one-carbon metabolism, which is crucial for the generation of deoxythymidine monophosphate (dTMP) from deoxyuridine monophosphate (dUMP) using the methyl donor 5,10-methylenetetrahydrofolate (me-THF) via thymidylate synthase (TYMS) enzymes[\[5\]](#). This process highlights dRG's role in DNA synthesis, where the

availability of nucleotides can significantly influence cell proliferation and metabolic balance[5].

Furthermore, dRG is also a byproduct of various nonenzymic interactions, emphasizing the complexity of metabolic pathways beyond traditional enzyme-catalyzed reactions[18]. Such interactions can lead to modifications of biomolecules, which may have implications for age-related diseases and cellular stress responses[18].

Signaling Functions

In addition to its metabolic roles, dRG serves as a signaling molecule that may influence bacterial growth, motility, and virulence. It is recognized as a second messenger in various bacterial processes, which are critical for adapting to environmental changes and resisting antibiotics[3]. Understanding the signaling pathways involving dRG is essential for developing strategies to combat antimicrobial resistance, a growing concern in medical microbiology[3].

Clinical Implications

Disruptions in the synthesis and metabolism of dRG can lead to significant health issues, including cancer, where rapid cell division demands robust nucleotide synthesis[4]. The study of dRG and its metabolic pathways could provide insights into therapeutic targets, potentially leading to novel treatments for diseases characterized by metabolic dysregulation[5][4]. Thus, the biological role of deoxyribosylglycine extends across various domains of biochemistry and medicine, underscoring its importance in both fundamental cellular processes and clinical applications.

Applications

Deoxyribosylglycine (DG) has gained attention in various fields due to its unique biochemical properties and potential applications in biotechnology and medicine.

Biotechnology

DG plays a critical role in genetic engineering, where it can be utilized to facilitate the manipulation of DNA sequences. The incorporation of DG in genetic constructs enhances the precision of DNA editing techniques, which are essential for creating genetically modified organisms (GMOs) and for various biotechnological applications such as enzyme production and metabolic engineering[6][12]. Furthermore, the advancement of bio-printing technologies, including 3D and 4D printing, leverages DG for creating biocompatible scaffolds that can mimic biological tissues, thus showing promise in tissue engineering and regenerative medicine[10].

Health and Medicine

In the medical field, DG is being explored for its potential in the development of therapeutics aimed at treating genetic disorders. The compound can serve as a molecular

tool for gene therapy approaches, where it assists in the delivery of genetic material into target cells[\[7\]](#). Additionally, DG's role in facilitating the understanding of genetic predispositions could lead to advancements in personalized medicine, particularly in assessing risks related to genetic discrimination and rare diseases[\[8\]\[19\]](#).

Research and Development

DG is also significant in research settings, especially in studies focused on the intersection of genetics and robotics. Researchers are examining the integration of DG with bio-robotics to enhance data handling and processing capabilities, which could revolutionize how genetic data is analyzed and utilized in clinical research[\[20\]](#). This synergy is crucial for advancing the capabilities of automated laboratory processes, contributing to the broader goals of the 4.0 industrial revolution[\[21\]](#).

Comparison with Similar Compounds

Deoxyribosylglycine, also known as N-(1-deoxy-1-fructosyl)glycine, is structurally related to several other biologically significant compounds. Its molecular formula is $C_8H_{15}NO_7$, and it exhibits notable bioactivities, paralleling other natural products derived from diverse biological sources[\[22\]](#).

Structural Analogues

One significant group of related compounds includes natural tetramates, which feature a tetramic acid moiety. These tetramates are typically biosynthesized via a combination of polyketide synthases (PKS) and nonribosomal peptide synthetases (NRPS), with their structures characterized by a variety of bioactive properties such as antibiotic and antitumor activities[\[6\]](#). Deoxyribosylglycine's unique structural components, such as the deoxyfructosyl group, contribute to its distinct functional attributes in comparison to the tetramic acid derivatives.

Biosynthetic Pathways

The biosynthetic pathways for deoxyribosylglycine may share similarities with those of tetramates, which are often produced through hybrid multimodular PKS and NRPS systems. This convergence in biosynthetic mechanisms highlights a common evolutionary origin for various natural products, potentially facilitating the development of new therapeutic agents by manipulating these pathways[\[6\]](#). For instance, the Dieckmann cyclization, which is crucial in tetramate synthesis, suggests a mechanistic parallel that could be relevant in understanding deoxyribosylglycine's production and potential applications in medicinal chemistry.

Chemical Properties and Applications

The structural attributes of deoxyribosylglycine not only distinguish it from its analogues but also confer unique properties that may enhance its role in drug development. Compounds like deoxyribosylglycine are essential in creating derivatives

with improved pharmacological profiles. For example, the synthesis of ribose and nucleoside derivatives has been linked to their roles as key intermediates in the development of biologically active molecules, a characteristic shared with deoxyribosylglycine[23]. This positions deoxyribosylglycine as an important compound within the larger context of glycine derivatives and related natural products, making it a significant focus for ongoing research in pharmacology and biotechnology.

Current Research

Research on deoxyribosylglycine is expanding, particularly in its implications for health and disease. Investigations have focused on its role in cancer therapy and metabolic processes. Studies have indicated that the knockdown of genes related to deoxyribosylglycine metabolism can suppress carcinogenicity and promote cellular senescence, suggesting a potential therapeutic avenue for cancer treatment[5].

Furthermore, the use of methylation donors and the metabolism of polyamines, including deoxyribosylglycine derivatives, are being explored as anti-cancer targets. Certain compounds have entered clinical trials, demonstrating their efficacy in inhibiting cancer cell proliferation and promoting the senescence of malignancies[5][7]. This aligns with broader trends in personalized medicine, where genetic information is leveraged to tailor treatments, thereby enhancing the specificity and effectiveness of interventions[11].

Research continues to explore the relationship between deoxyribosylglycine levels and various health conditions. For instance, a recent study utilized data from the China Health and Retirement Longitudinal Study to assess the link between biomarkers related to deoxyribosylglycine and stroke incidence, highlighting the significance of these metabolites in chronic disease prevention[9].

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