

# Applications of Lead Compounds in Daily Life

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**Abstract.** Lead compounds are crucial in the early stages of drug discovery and development and play a pivotal role in pharmaceutical advancements. In addition to drug development, lead compounds have a myriad of other applications in daily life. This article reviews the extensive applications of lead compounds across various fields and explores their potential uses. First, this paper introduced the concept, characteristics, and research significance of lead compounds. Next, we discuss in detail the application of lead compounds in fields such as medicine, agriculture, food engineering, and material science, exploring their importance and potential trends in these areas. In the medical field, lead compounds provide a foundation for new drug development. Through the drug development process, compounds with potential therapeutic effects have been discovered and optimized, offering new avenues for disease treatment. In agriculture, lead compounds play a significant role in the development of pesticides and plant protection, helping to enhance crop yield, resilience, and quality and promoting sustainable agricultural practices. In the food industry, lead compounds are widely used in the development of food additives, functional foods, and food preservation technologies, enhancing the nutritional value and safety of food products. In the realm of material science, the application of lead compounds has spurred the research and development of new materials, improved material performance and functionality, and broadened their application fields. However, with continuous advancements in science and technology and evolving societal needs, research on lead compounds still faces many challenges and opportunities. Thus, strengthening the research and broader application of lead compounds will become a critical direction for future scientific endeavors.

**Keywords:** Lead compounds, Applications, Daily Life.

## 1. Introduction

Lead compounds[1] are compounds with unique structures and pharmacological or biological activities that serve as the starting point for modern drug research. Their molecular architectures can be strategically refined to enhance therapeutic efficacy, selectivity, and pharmacokinetic attributes. Newly identified lead compounds often present certain limitations, including suboptimal activity, chemical instability, significant toxicity, inadequate selectivity, and substandard pharmacokinetic profiles, necessitating sophisticated chemical modifications. These modifications increase the pharmacological potential of these compounds to levels amenable for advanced biological or clinical evaluation. Subsequent refinements transform these molecules into optimal therapeutic agents, a process termed lead compound optimization. The research significance of lead compounds is multifaceted: as pivotal initiators of drug discovery and development, their systematic research and meticulous optimization facilitate the identification of more potent and selective drug candidates. Moreover, compared to the de

novo synthesis of novel entities, the exploration and refinement of lead compounds can substantially reduce both the timeline and financial burden associated with drug development. Furthermore, investigations into lead compounds have contributed to the expansion of the medicinal chemistry landscape, uncovering novel drug scaffolds and elucidating underlying pharmacological mechanisms, thereby broadening the therapeutic possibilities for diverse pathologies.

Many lead compounds initially originate from natural sources such as plants, microorganisms, or animals. Natural products have significant advantages over traditionally synthesized small-molecule drugs in terms of chemical novelty, structural complexity, functional diversity, biocompatibility, and pharmacokinetic properties. [3] For instance, active compounds discovered in the effective ingredients extracted from herbal medicines or metabolic products of microorganisms often become candidate substances for new drug research.

## **2. The methods to find lead compound**

HTS is a mature method for determining the starting point of lead compounds in the drug discovery process. [4] The large-scale evaluation of the biological activity of compounds involves identifying compounds with specific biological activities.

With the development of computational chemistry and bioinformatics, computational simulation has become a common method for acquiring lead compounds. Computer-aided design is a technique that utilizes computer simulation technologies to predict and optimize the structure and properties of compounds. Through molecular modeling, pharmacophore analysis, and molecular docking, compounds with potential biological activity can be rapidly screened, reducing the time and financial costs associated with the discovery process and designing lead compounds with enhanced activity and selectivity.

In addition to extraction from nature, many lead compounds are also obtained through chemical synthesis. Synthetic chemical methods are crucial for preparing lead compounds, allowing for the design of compounds with specific structures and activities to optimize their performance and pharmacological effects. This provides greater flexibility and controllability for drug development.

Some lead compounds are derived by modifying the structure of known active compounds. Structural modification can alter a molecule's structure, properties, and activity, enhancing the pharmacological effectiveness and selectivity of the compound and thus yielding lead compounds with greater activity and stability.

## **3. Applications of lead compounds in daily life**

### *3.1. Applications in the pharmaceutical field*

In the pharmaceutical field, lead compounds play a crucial role. They are a key component of the drug development process and play significant roles in drug therapy, molecular imaging, and biosensing.

In drug development, lead compounds are used to validate therapeutic hypotheses, determine efficacy and toxicity, and provide a basis for subsequent clinical trials. They are typically compounds with certain activities obtained from natural products or high-throughput screening[6]. Drug development teams can enhance the pharmacological effectiveness, reduce adverse effects, and increase the stability and bioavailability of these compounds in the body through the selection, optimization, and improvement of lead compounds. This increases the efficiency of the discovery process and yields safer and more effective drug candidates. These optimization processes often involve research in synthetic chemistry, pharmacokinetics, molecular simulation, and other fields, aiming to transform lead compounds into candidates with potential for clinical application.

Once lead compounds have undergone clinical trials and are proven safe and effective, they can serve as the foundation for new drugs. The development of new drugs requires stringent clinical trials to ensure their safety and efficacy in humans. These new drugs may be used to treat a variety of diseases, including cancer, cardiovascular diseases, and infectious diseases[7]. The properties and pharmacological effects

of lead compounds determine the ultimate therapeutic outcome, providing essential drug choices for clinical treatment.

In medical diagnostics, molecular imaging techniques such as CT, MRI, and PET have become routine diagnostic tools. In molecular imaging, lead compounds can be labeled with radioactive isotopes or contrast agents and used as probes to detect specific molecular processes or pathological states within the body. These probes can be used for diagnosing and monitoring diseases, such as tumor imaging and diagnosing neurological disorders. Molecular imaging allows physicians to diagnose diseases more accurately and monitor treatment effects in real time, providing a scientific basis for clinical decision-making[8].

Lead compounds are also widely used in the development of biosensors. Biosensors are devices capable of converting biological events into detectable signals and can be used to detect specific biomolecules or physiological indicators within a biological entity. The selection and optimization of lead compounds are crucial for the sensitivity and selectivity of biosensors, helping to ensure the accuracy and stability of the sensors and thus enabling rapid and convenient biomonitoring and diagnostics.

### *3.2. Applications of lead compounds in agriculture*

In the agricultural field, lead compounds also hold significant value. Their applications in agriculture range from plant protection to increasing crop yields. They provide key support for enhancing agricultural production efficiency, improving crop quality, protecting plant health, and achieving sustainable agricultural development. These compounds contribute to improving the quality and safety of food, promoting the development of the food industry, and meeting the public's demand for healthy, safe food.

In agriculture, lead compounds can be used as plant protectants to control various pests, pathogens, and weeds[9]. These compounds can protect crops from damage by altering insect behavior or affecting pathogen growth, thereby increasing crop yield and quality.

The application of lead compounds can enhance the efficiency of agricultural production and reduce production costs, thereby achieving sustainable agricultural development. For example, some lead compounds possess growth regulator properties that can affect the growth and development processes of crops. By modulating plant growth hormone levels or altering physiological processes, these compounds can promote crop growth, increase yields, and enhance crop resistance to environmental stresses. Additionally, they reduce the use of pesticides and fertilizers, diminishing the environmental impact of agriculture and realizing efficient, economical, and sustainable agricultural development.

Some lead compounds enhance the resistance of crops to various environmental stresses, such as drought, salinity, and pests [10]. These compounds can improve crop resilience by regulating plant physiological metabolic processes or strengthening the plant immune system, thereby ensuring stable crop production. For instance, certain growth regulators and plant protection compounds enhance plant adaptability to environmental stressors and improve drought, salinity, and pest resistance, thereby increasing crop growth and yield. The research and application of these compounds help to increase crop yield and quality, promote sustainable agricultural development, and reduce negative environmental impacts.

### *3.3. Applications of lead compounds in food engineering*

In the field of food engineering, lead compounds play a significant role. Their applications in food engineering primarily involve food processing, preservation, improvement, and the development of functional foods.

In food processing, lead compounds can be used as additives such as antioxidants, preservatives, and thickeners. These compounds can extend the shelf life of food, improve its taste and texture, and preserve its nutritional content and color. Some lead compounds have antimicrobial properties and can be used for food preservation and spoilage prevention. By adding appropriate amounts of antimicrobial or antibacterial agents, the shelf life of food can be extended, food waste can be reduced, and the safety

and hygiene of the food can be ensured[11]. They can also be used to detect harmful substances or residual additives in food, ensuring the quality and safety of the food, as well as monitoring hygiene conditions during food processing to prevent food contamination and foodborne diseases.

Lead compounds can be used to enhance the nutritional content, taste, and functional properties of food. For example, the addition of nutritional enhancers, flavor enhancers[12], or taste improvers can increase the nutritional value and flavor of food, meeting diverse consumer needs.

Some lead compounds possess specific biological activities or pharmacological effects, making them suitable for developing functional foods[13]. By incorporating these compounds into food products, specific health benefits can be imparted, such as regulating blood sugar, reducing blood lipids, and enhancing immunity, thus fulfilling the demand for health-oriented foods.

### *3.4. Applications of lead compounds in materials science*

Lead compounds are commonly used in the synthesis of novel materials or the design of new material structures. These compounds often possess specific structures or functional groups that can provide the desired properties to materials, such as excellent conductivity, magnetism, and optical properties. By synthesizing lead compounds, researchers can explore the structure-property relationships of various materials, thereby guiding the targeted design and synthesis of materials. The identification of lead compounds provides an important foundation for the development of functional materials. For example, lead compounds can be used to prepare electronic materials, optical materials, magnetic materials, catalysts, etc., which have significant applications in electronic devices, optoelectronic devices, energy conversion and storage, chemical reactions, and other fields. The lead compound polyaniline, for instance, can be prepared by controlling the polymerization reaction conditions and adding different dopants, resulting in multifunctional polymer materials with conductivity, photoelectricity, and magnetism[14]. Through the synthesis and manipulation of lead compounds, precise control and optimization of the properties of functional materials can be achieved.

Lead compounds play a crucial role in the growth of crystals and the preparation of thin films. By controlling the structure and composition of lead compounds, directional control of crystal growth and improvement of crystal quality can be achieved. Additionally, lead compounds can also be used in processes such as sputtering, deposition, and laser sintering for the preparation of thin films, thereby realizing directional growth of thin film materials and interface control.

Nanomaterials possess unique physical and chemical properties and hold broad application prospects in fields such as energy, biomedicine[15], and the environment. Lead compounds play a critical role in the synthesis and preparation of nanomaterials. For example, various nanostructures, such as nanoparticles, nanowires, and nanosheets, can be synthesized using methods such as solvothermal synthesis, vapor deposition, and hydrothermal synthesis, thereby achieving precise control and modulation of nanomaterials.

## **4. Conclusion**

In the fields of medicine, agriculture, food engineering, and materials science, the extensive application of lead compounds highlights their significance across various domains. These compounds provide a solid foundation for development and innovation in each area. In the medical field, the use of lead compounds not only promotes the research and production of new drugs but also provides crucial support for improving medical devices and advancing medical technology. In agriculture, the application of lead compounds helps to enhance the quality and yield of agricultural products, increasing the efficiency and sustainability of agricultural production. In the field of food engineering, the application of lead compounds improves the quality and safety of food, fostering the innovation and development of food processing technologies. In materials science, the application of lead compounds drives the research and use of new materials, providing key support for technological advancements in fields such as electronics, optics, and magnetism.

Overall, the widespread application of lead compounds in various domains underscores their important role in scientific research and engineering applications. With the continuous development and

innovation of science and technology, the prospects for the application of lead compounds are even broader, promoting societal progress and sustainable development and injecting new vitality and momentum into the progress of human society. Through ongoing research and application, we will be better able to harness the potential of lead compounds to advance science and technology, address various challenges in real life, and achieve a brighter future for human society.

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