EMERGING TRENDS IN DRUG DELIVERY

TRACKING TODAY'S INNOVATIONS TO FIND TOMORROW'S OPPORTUNITIES

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The field of drug delivery is highly diverse and continues to evolve as new technologies enhance both the effectiveness of treatments and the patient experience. Ongoing efforts to minimize adverse effects, reduce dosage requirements, and support more personalized, patient-friendly dosing schedules or routes of administration are driving a wealth of exciting advances.

Sized at $1.2 billion USD in 2018, the drug delivery systems market is expected to nearly double over the next 10 years[1]. Already, sustained growth in the volume of drug delivery system research and intellectual property (IP) published over the past decade demonstrates an expansive range of technologies that are being used to support an increasing number of therapeutic agents and applications. Several technologies have experienced particular growth in recent years and are expected to be key innovation areas over the coming decade. In this whitepaper, we highlight emerging trends in this dynamic field, as identified from the CAS Content Collection™, a scientist-curated information resource covering published scientific literature and patents globally.

Figure 1. Patent volume by nanoscale category
Source: CAS Content Collection™

Monitoring market trends highlights areas of commercial opportunity

Key growth areas

Targeted nanoscale drug delivery systems

Targeted drug delivery systems, designed to maximize the therapeutic impact of drugs on a localized area, have been the focus of significant research attention for decades. However, as developers increasingly look to reduce the harmful side effects associated with potent active ingredients, recent years have seen a substantial increase in research output for these technologies. Among the most widespread applications of targeted systems are the delivery of oncology drugs, where minimizing systemic exposure to cytotoxic agents is important to reduce the risk of adverse effects.

Targeted drug delivery systems draw on a broad range of technologies, with systems based on both covalent and non-covalent attachment of the drug to the carrier available. Nanocarriers based on liposomes, polymer micelles, and nanoparticle systems are widely used for targeted drug delivery applications[2,3], and recent advances in polymer and nanoscale science have seen the types of materials used for these applications expand. For example, polymer–drug conjugates based on a wide variety of polymeric materials have been reported, including systems based on polyethylene glycol, N-(2-hydroxypropyl) methacrylamide as well as natural, biodegradable polymers such as polyglutamic acid[2]. Amid continued demand for more environmentally sustainable materials, the use of such polymers in novel delivery systems may become increasingly important[4]. Developing approaches to make biopolymers more stable for industrial processing applications remains at the forefront of research, and this field is likely to be a source of new patents in the years to come.

Figure 1 highlights the volume of IP for nanoscale systems by patent classification as revealed by the CAS Content Collection. Micelles represent the largest proportion of nanoscale drug delivery IP, followed by nanoemulsions and nanocapsules. While micelles and nanocapsules have long made up a large proportion of nanoscale drug delivery systems, Figure 2 highlights that the volume of patents for nanoemulsions has grown considerably in recent years. Interestingly, IP for controlled-release nanoparticles and nanospheres have fallen out of the top five categories of nanoscale technology over the course of the last decade, although both fields remain important sources of new technology.

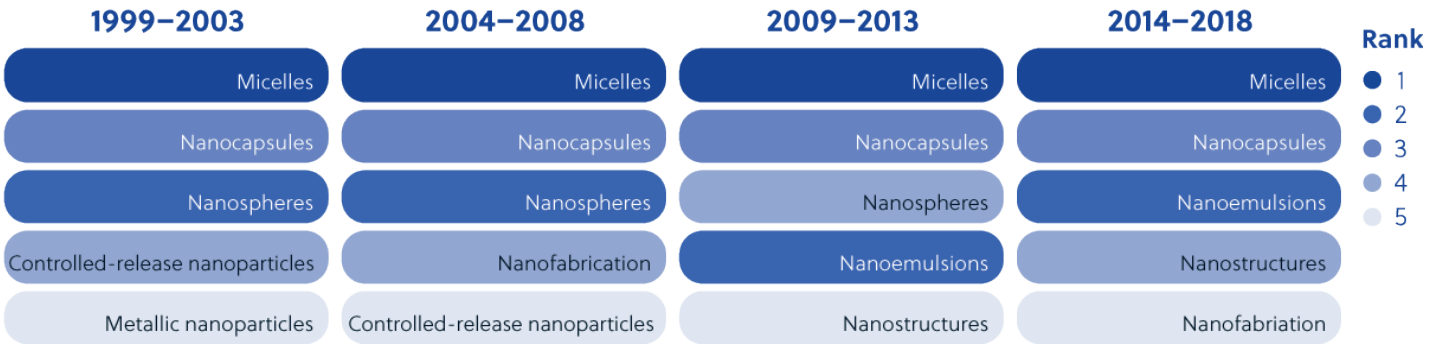
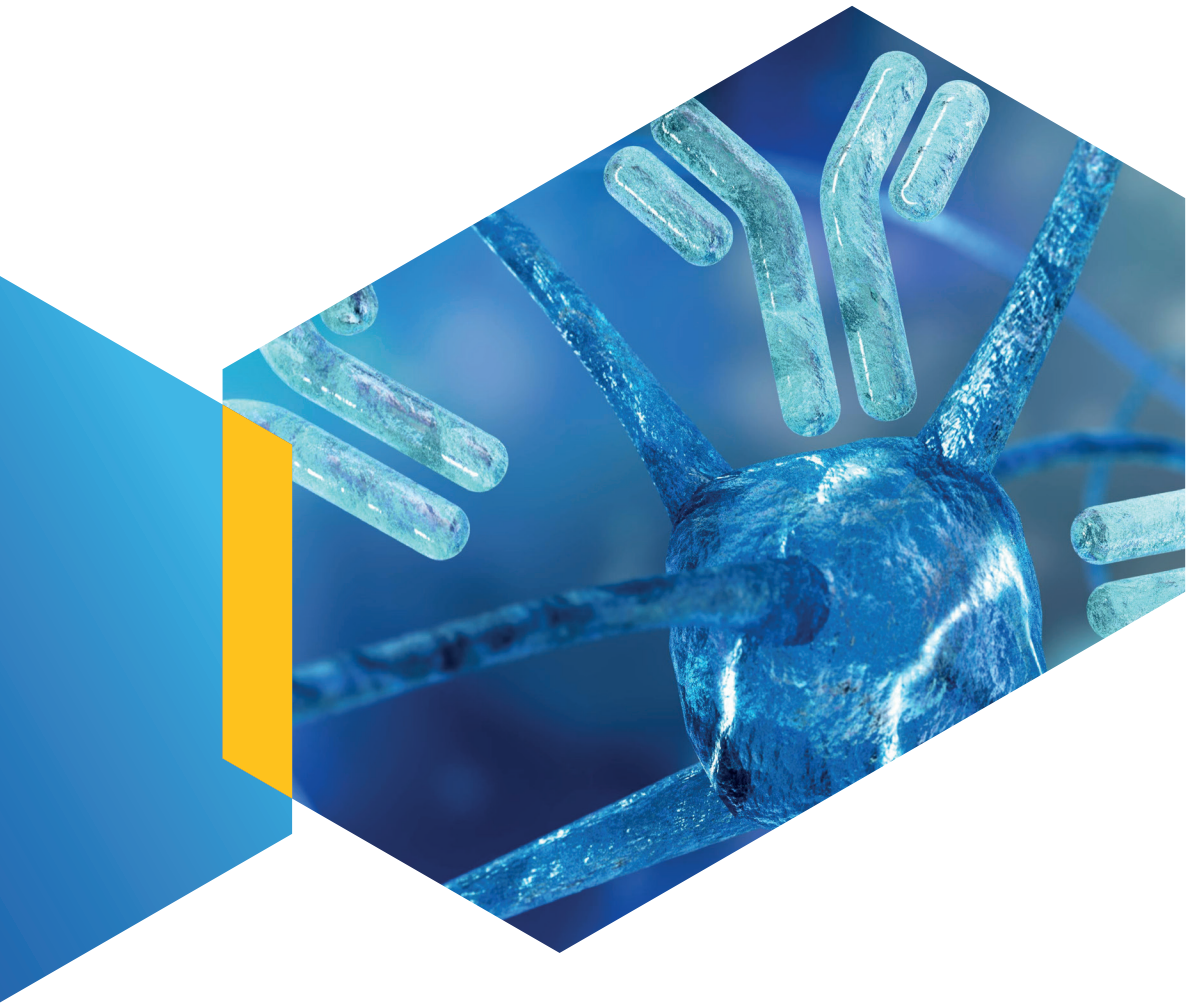


Figure 2. Five leading categories of nanotechnology IP, 1999-2018
Source: CAS content collection



Immunoconjugates

With the pharmaceutical industry turning to targeted strategies to drive improvements in patient treatment, the commercialization of drug delivery technologies based on immunoconjugates has been another focus of intense interest. These highly specific delivery systems, which consist of antibodies joined by a linker to a 'payload' such as a radioisotope, label, or cytotoxic drug, have experienced sustained growth over the past decade, largely driven by their formidable potential as anticancer treatments. The market for antibody–drug conjugates (ADCs) is yet to fully mature, with four such drugs having been approved by the U.S. Food and Drug Administration as of 2018, and at least 60 more in clinical trials[5].

Recent years have seen a wealth of advances in antibody, linker, and cytotoxin technologies. Fundamental to the specificity of ADCs is the use of antibodies and a wide range of approaches have been developed. Patents for conditionally-active antibodies, masked proproteins, and non-internalizing ADCs have received significant attention[6,7]. The latter is thought to hold particular promise for oncology as they may be used to deliver potent anticancer drugs without the need to be internalized into tumor cells, potentially enhancing the efficacy of treatments[8].

Ongoing advances in ADC linker technologies have resulted in a range of designs to support enhanced drug release[8]. Improved conjugation strategies that increase the yield of ADCs carrying drugs in order to improve drug efficacy have been applied, while linkers that offer greater stability towards cleavage in the bloodstream, for example, are being developed to ensure drugs better reach their target. Similarly, cleavage mechanisms that give greater control over drug release (such as by plasma enzymes or conditions within the tumor) have been the focus of much research. In addition, the number of patents for ADC payloads continues to expand, with various benzodiazepine, duocarmycin, and tubulysin drugs, among others, published in recent years[8].

Dosage form trends

New drug formulations are being continually developed to enhance the stability and efficacy of medicines, improve patient compliance with treatment regimen, and comply with changing regulatory requirements. Furthermore, the trend towards more personalized medicine and greater patient choice has led to active pharmaceutical ingredients being formulated using multiple drug delivery systems and dosage forms to customize offerings for the needs of different patient populations. The continued expansion in IP reflects ongoing innovation in this area.

Oral, topical, and parenteral drug delivery systems have long dominated the IP landscape due to their importance across a wide range of sectors, including pharmaceutical, biotechnology, and cosmetics, as well as the food and nutraceutical industry. Our analysis of the leading patented technologies over the past 15 years, obtained using insight from the CAS Content Collection, highlights the key trends (Figure 3). Perhaps unsurprisingly, patents for oral administration, including tablets and capsules, are the most common within the pharmaceutical and food (including nutraceuticals) sectors, while topical delivery systems are the leading category of drug administration route within the cosmetics industry.

However, beyond these dominant classes, it is interesting to note the more subtle changes in the leading types of delivery route and dosage forms being patented. The biotechnology sector, in particular, has experienced several changes over this period, with pastes and powders entering the top five most patented dosage forms in the last five years. This trend stems from drug developers looking towards delivery systems that offer greater patient convenience and ease of use. Within the cosmetics sector, oil-in-water emulsions have recently taken over from powders as one of the top categories of dosage form technology, reflecting increased interest in these formulations for applications such as sunscreen, lotion, and makeup. Other sectors have remained more consistent. However, it is notable that intraperitoneal injections have emerged as a leading drug delivery route within the pharmaceutical and food sectors, potentially due to their importance for cancer treatment.

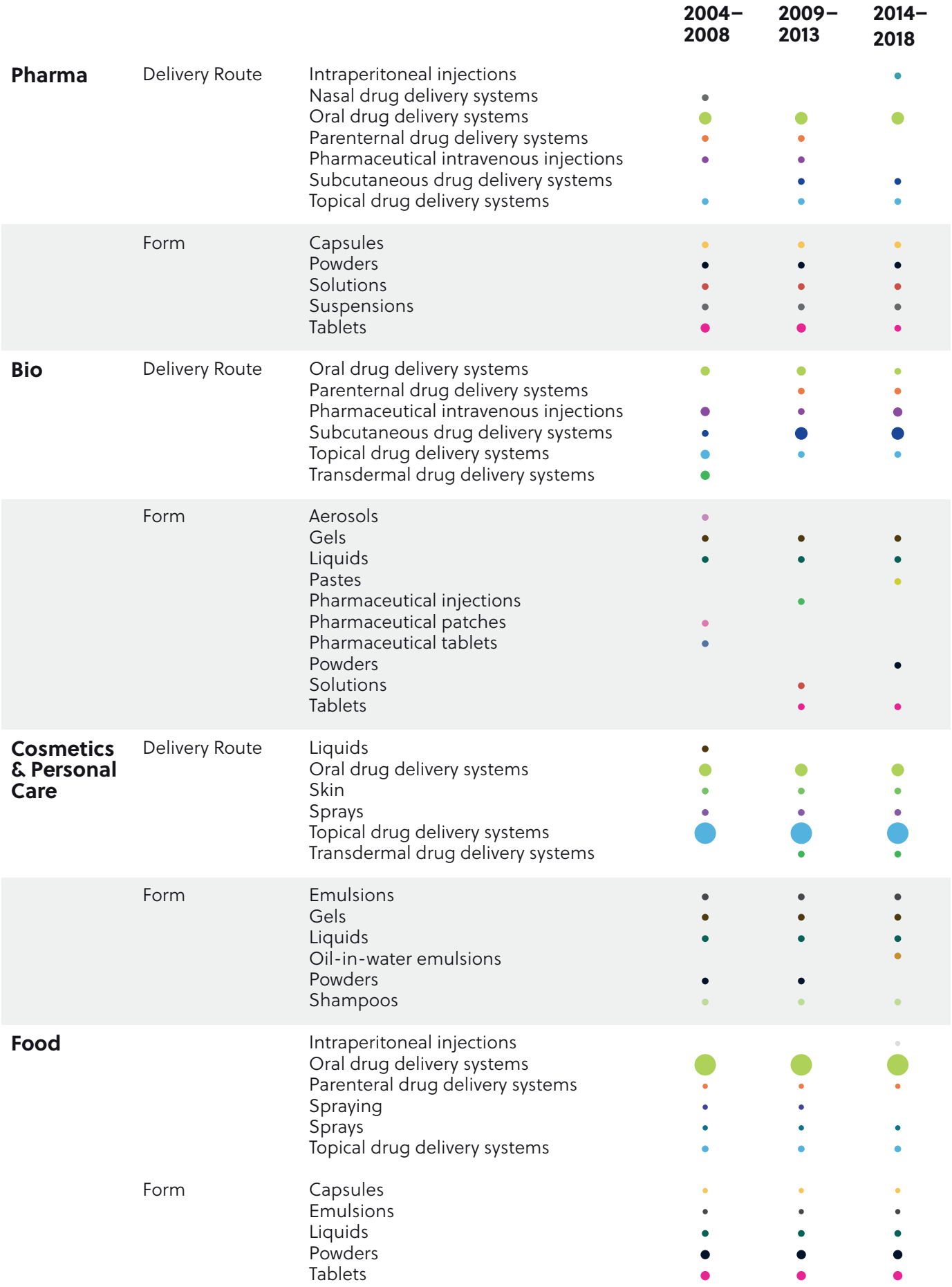


Figure 3. The five leading drug delivery routes and dosage forms by sector, 2004–2018
Source: CAS Content Collection

Trends in pharmaceutical dosage forms are often linked to industry-wide shifts in therapeutic research focus. Figure 4 highlights the leading pharmaceutical activities associated with drug delivery patents

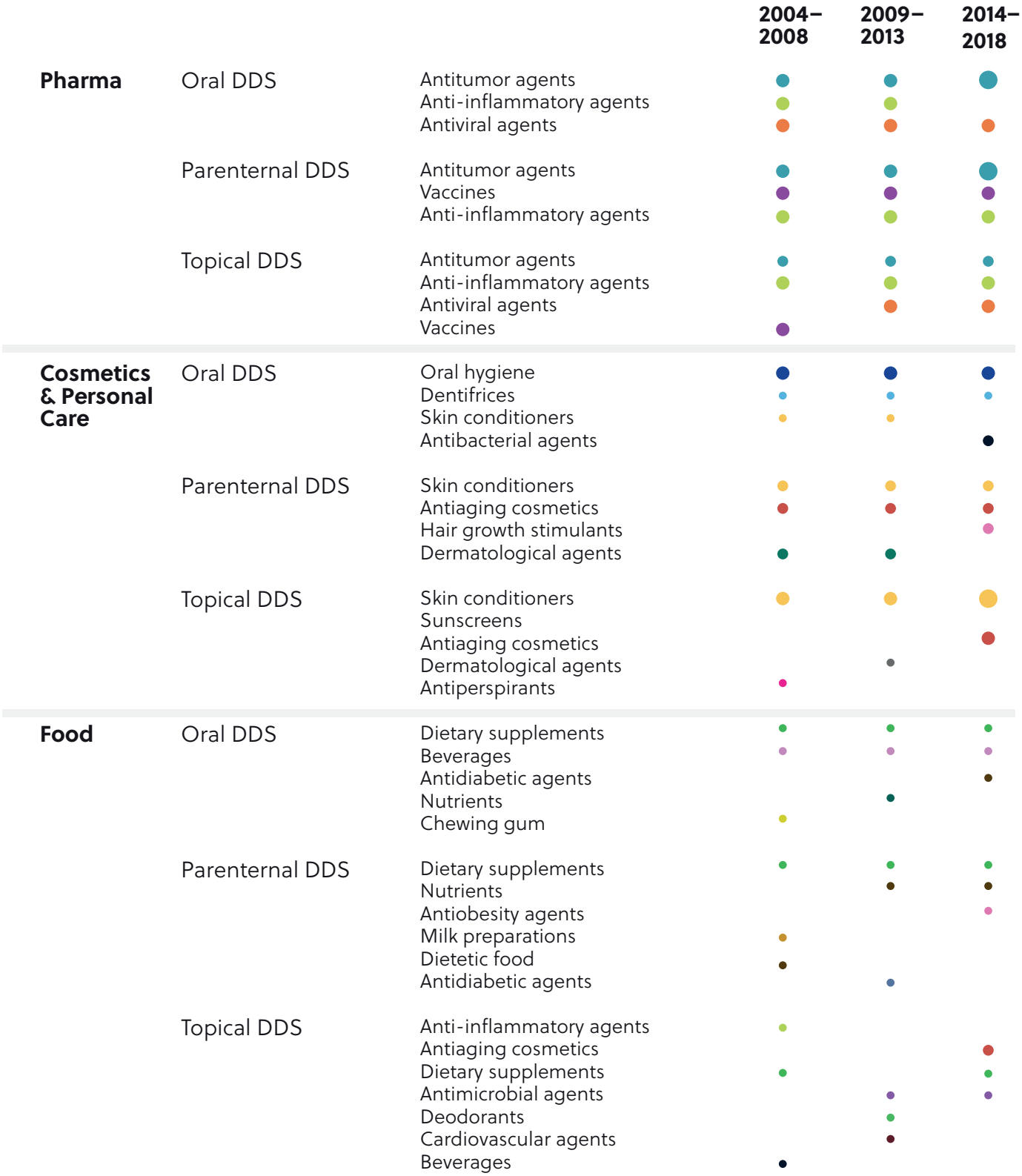


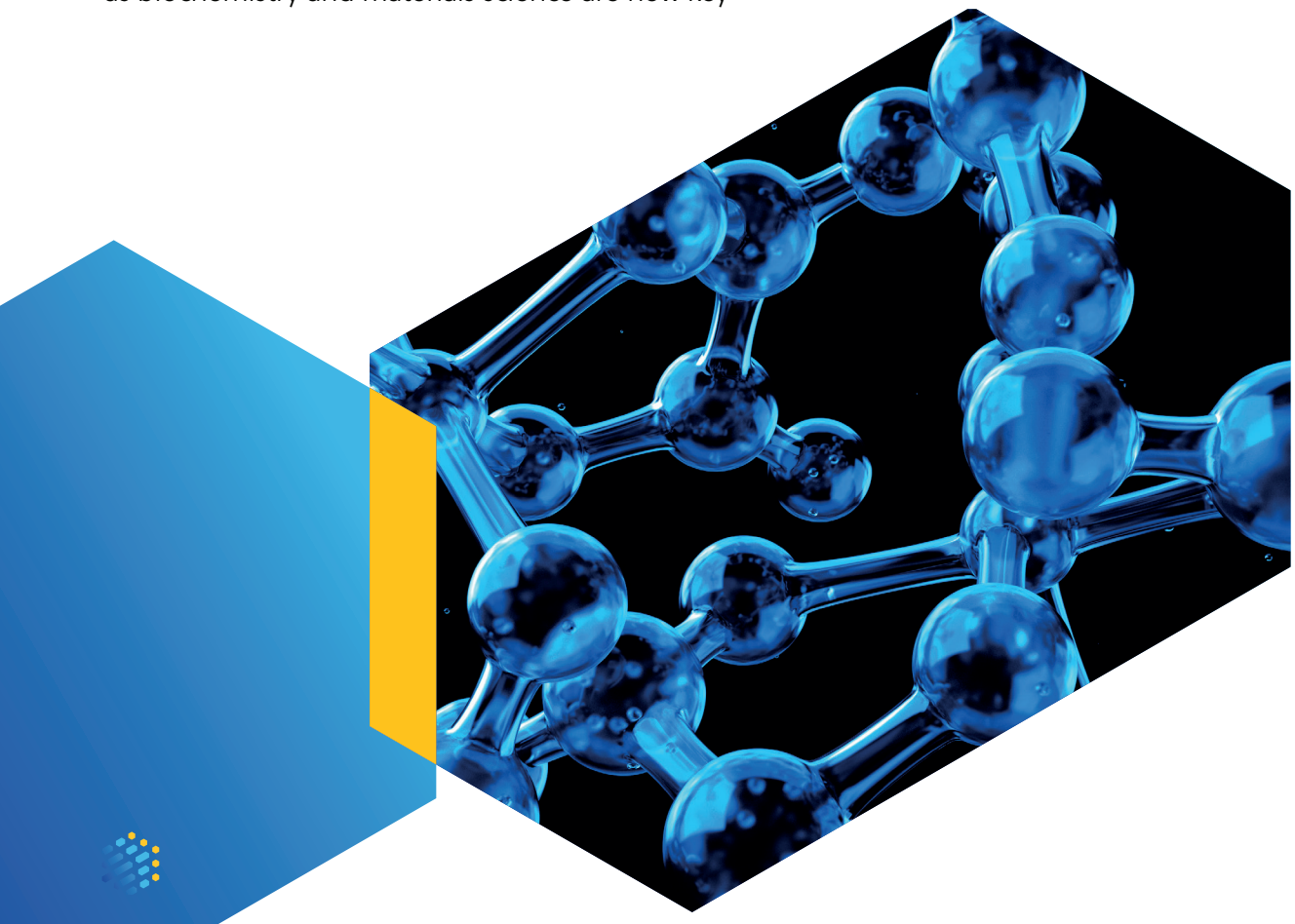
Figure 4. Leading pharmaceutical activities by drug delivery system and sector, 2004–2018
Source: CAS Content Collection

The leading applications for drug delivery systems within the pharmaceutical sector have remained largely unchanged over the past 15 years, with anti-inflammatories, antitumor agents, antivirals, and vaccines consistently dominating patent output. By contrast, the cosmetics and food sectors have both experienced a number of changes. Novel trends within the cosmetics sector include antibacterial agents (which are now a key focus of oral drug delivery systems), hair growth stimulants (which have emerged as an important application for parenteral delivery systems), and anti-aging creams (which have both become the focus of new patents for topical systems). The food sector has also seen its share of new trends, with antidiabetic agents a dominant focus of oral drug delivery patents, anti-obesity drugs a new focus for parenternal systems, and both dietary supplements and food-based anti-aging cosmetics the focus of topical systems.

Interdisciplinary innovation driving advances in drug delivery

The increasingly multidisciplinary nature of drug delivery means that ongoing advances in fields such as biochemistry and materials science are now key drivers of innovation in this space. Recent advances in polymer science and nanomaterials, for example, have had a considerable impact on transdermal drug delivery, while improvements in our understanding of drug bioavailability and metabolism, as well as the discovery of new targets, has led to new IP in the targeted and controlled-release drug delivery space.

The increasing complexity of drug delivery technologies is therefore making the classification of delivery systems under traditional terms much harder to define, with solutions more dependent than ever upon innovations from several different scientific disciplines. For example, innovations such as orally administered dosage forms that are capable of mechanically injecting drugs into stomach lining tissues span multiple traditional drug delivery definitions and reflect the convergence of multiple technology areas[9]. As such, it is likely that advances in polymer science, nanomaterials, biomaterials, and chemistry will have as much, if not more, influence on the future direction of drug delivery technologies than trends in active ingredients themselves.



The importance of adopting an effective monitoring strategy

The emerging trends presented here highlight the dynamic and diverse nature of the drug delivery landscape. For those looking to innovate in this evolving field, maintaining up-to date awareness of relevant discoveries is vital. Failure to do so risks investing significant amounts of time and resources repeating the work of others. Of course, regularly monitoring the literature also gives you valuable insight into emerging areas of opportunity, as well as your competitors' technology strategies, which can be used to guide your own plans.

Current awareness strategies must be supported by a high-quality, global information source and effective monitoring tools. A wide range of open-source and commercial options are available. The websites of most government patent offices, for example, allow you to look up records by search terms such as keyword, inventor and publication date, while search engines can be used to set up alerts on specific topics. However, the coverage of these types of tools is limited, and their search capabilities often lack precision and frequently do not provide all the results that are relevant to a particular subject. This is particularly true in areas such as formulations and polymers wherein precise searching for key information is challenging and time consuming without specialized solutions.

Given the potentially severe legal and financial consequences of missing key patents or publications, many innovation-focused organizations invest in high-quality specialized platforms to achieve more complete oversight of the landscape. The most sophisticated and efficient monitoring tools, such as CAS SciFinder Discovery Platform™ and STN IP Protection Suite™, provide comprehensive coverage of global publications, including human-curated content from a wealth of non-patent literature sources, as well as international patent collections. These platforms also offer powerful search functionality, such as true Markush chemical structure and specialized formulation search tools, allowing researchers and business leaders to quickly access the most relevant information while maintaining full confidence in the completeness of coverage.

As medicines continue to evolve, innovative drug delivery mechanisms will be required in order to maximize patient outcomes and realize full therapeutic effect. For the efficient development of new technologies, it's imperative that researchers and companies working in this area have easy access to published information both in scientific papers and patents. By monitoring IP literature, in addition to finding valuable data, you can gain an oversight of the competitive landscape, highlighting areas of commercial opportunity and risk.

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