

Overview

Pharmaceutical sector:

Priority actions towards a nature-positive future

March 2025

Introduction

Nature is critical to human health and well-being, providing us with air, water, food and the raw materials necessary to manufacture medicines and medicinal compounds. The pharmaceutical sector, which exists to improve human health and quality of life, also relies on nature for many of its operations and innovations, such as water for the production of biological medical products like vaccines.

However, negative impacts from many human activities are driving significant environmental changes, including increases in invasive species, changes in land and sea use, climate change, pollution and the direct exploitation of natural resources. All of these collectively contribute to nature and biodiversity loss.[1] This loss, in turn, endangers the health of people and the planet, potentially affecting everyone and everything. The World Health Organization (WHO) estimates that nearly 14 million people die each year from environmental health risks, highlighting the interconnection between human health and environmental well-being.[2]

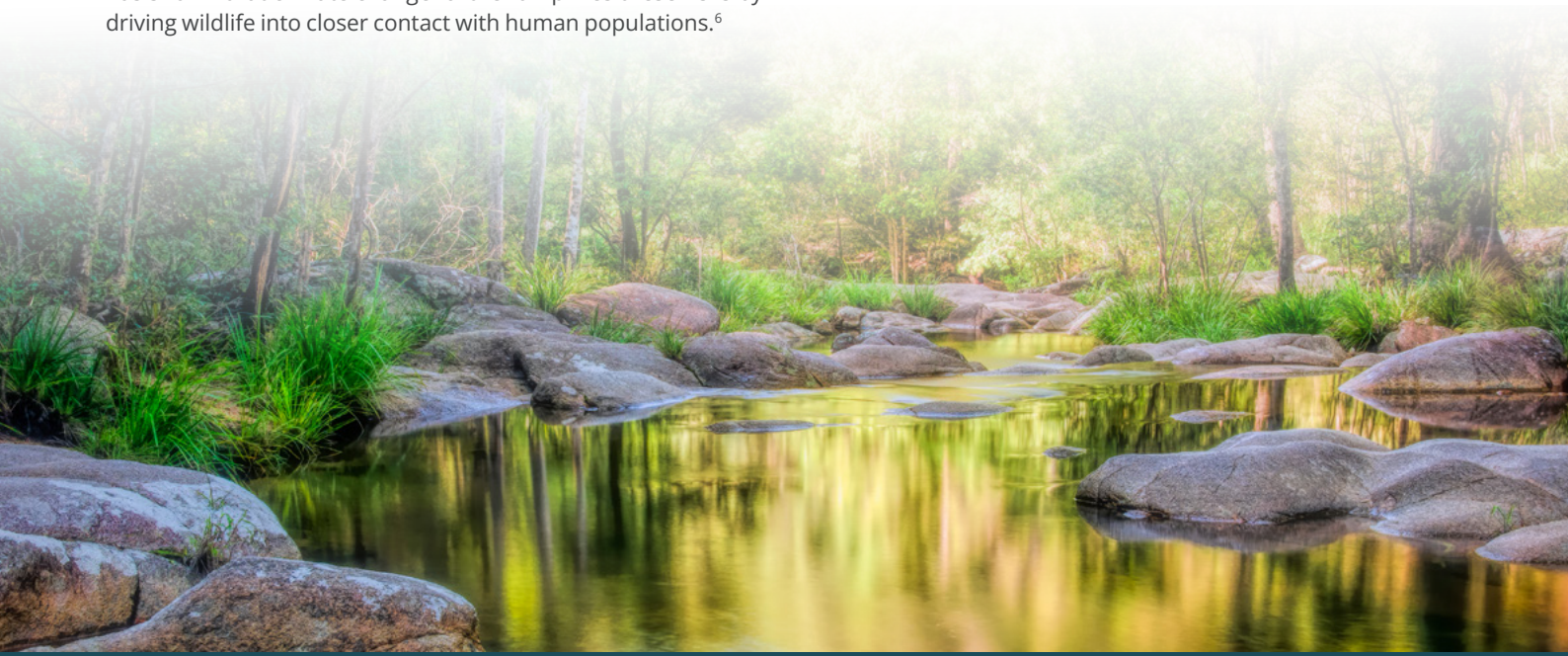
The healthcare sector, while focused on improving human health, is also a contributor to environmental impacts. For example, the sector is responsible for around 5% of global GHG emissions, accentuating the industry's impact on the natural environment.[3] While the continuing advancement of medical technology has contributed to the extension of global life expectancy from 46.5 years in 1950 to 71.2 years in 2023,[4] the process involved in developing, manufacturing and delivering medicines also contributes to climate change and nature loss.

Environmental changes are also impacting human health, particularly, but not only, among marginalized populations who are most vulnerable to the effects of climate change. The interconnectedness of ecosystems means that disruptions in nature and climate change often lead to a range of adverse consequences for human health, for example:

- **Emergence of zoonotic diseases:** As habitat loss brings society in closer proximity to nature, including the role of invasive species, there is an increasing emergence of new zoonotic diseases. Land-use change has contributed to the emergence of more than 30% of new diseases reported since 1960.[5] Research has shown that climate change further amplifies these risks by driving wildlife into closer contact with human populations.[6]
- **Changes in vector-borne, waterborne and non-communicable diseases:** Climate change and biodiversity loss are driving shifts in disease patterns. Rising temperatures and altered ecosystems are expanding the range of vector-borne diseases like malaria and dengue into previously unaffected regions. Factors such as flooding and poor sanitation exacerbate waterborne illnesses, while higher temperatures and air pollution contribute to the increase in and changing pattern of non-communicable diseases such as respiratory and cardiovascular conditions.
- **Climate change and migration:** Extreme weather events, rising sea levels and prolonged droughts are displacing millions of people annually. This forced migration increases the spread of infectious diseases, strains healthcare systems and worsens living conditions in overcrowded areas.
- **Mental health impacts:** The compounding effects of natural disasters, such as wildfires, floods and hurricanes, are leading to significant mental health challenges. These impacts can contribute to increased rates of anxiety, depression and trauma among individuals vulnerable to the effects of nature loss and climate change.[7]

The pharmaceutical sector's complex value chain brings unique challenges in identifying and managing nature-related impacts and dependencies. Nature impacts are particularly difficult to address when they occur deep in the value chain, such as sourcing raw materials (both organic and inorganic) and managing the disposal and end-of-life treatment of pharmaceutical products. In these areas, the traceability and management of nature-related impacts and dependencies can be difficult to achieve.

Additionally, to maintain the highest medical efficacy and safety standards, companies manufacture medicines in energy and water-intensive facilities and single-use items are prevalent. As companies identify innovative solutions to minimize environmental impacts, making changes to products and processes requires time and partnerships with regulators to ensure patient safety.



Efforts to protect and restore nature must involve local communities and stakeholders, as emphasized in the Kunming-Montreal Global Biodiversity Framework (GBF). Target 19 highlights the need for inclusive, participatory action to create locally adapted solutions, ensuring effective conservation that enhances resilience and livelihoods. Target 13 focuses on sharing benefits from genetic resources, including digital sequence information (DSI), and contributing to the GBF's successful implementation by recognizing the role played by those who protect biodiversity and preserve traditional knowledge.

The Convention on Biological Diversity (CBD) decision on the fair and equitable sharing of benefits from the use of DSI on genetic resources established a voluntary fund to enable companies to share the benefits arising from their use. Known as the Cali Fund, the indicative contribution rates are under review – along with several other elements – as part of ongoing intergovernmental discussions to refine benefit-sharing mechanisms. In alignment with international frameworks, the pharmaceutical sector engages with access- and benefit-sharing processes as required by the Nagoya Protocol and the CBD, supporting efforts to ensure fair and transparent contributions to biodiversity conservation.[I]

To complement ongoing sustainability initiatives, businesses across the sector should use the Nature Strategy Handbook – which draws on the **A**ssess, **C**ommit, **T**ransform, and **D**isclose framework (ACT-D high-level business actions on nature) – to help them understand their relationship with nature and develop a credible nature strategy. The Handbook forms the basis of It's Now for Nature, a global campaign to rally all businesses to act on nature. It helps companies acknowledge the value of nature to their business; identify, assess and measure their impacts and dependencies on nature; set transparent, time-bound, science-based targets; take actions to address their key impacts and dependencies and transform their businesses; and publicly disclose performance and other relevant nature-related information.

This overview provides a sector-level summary of potential key impacts and dependencies on nature. Importantly, it also sets out the priority actions that leading businesses in the sector should take now to **transform** and ensure the pharmaceutical sector plays its part in meeting the global goal to halt and reverse nature loss by 2030 – the mission at the heart of the GBF.

Scope of this overview

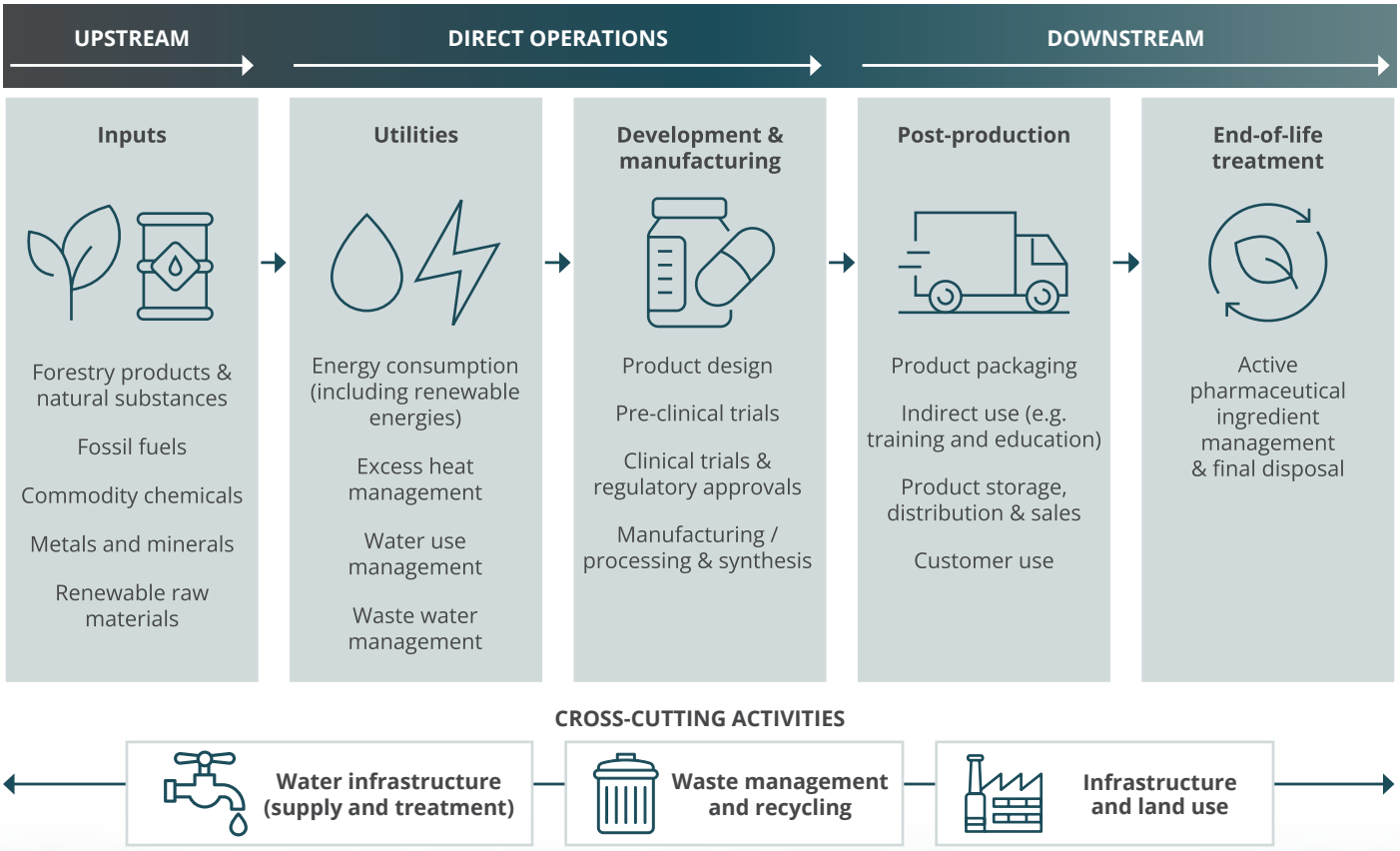
This overview covers the full value chain of the pharmaceutical sector (SICS CODE: HC-BP), from inputs such as raw material production to the manufacturing, processing and distribution of pharmaceutical products, as well as patient use and end-of-life disposal.[II]



[I] *As global discussions on benefit-sharing continue to evolve, it will be important to refine mechanisms to ensure that they do not hinder innovation while recognizing the contributions of countries and communities that provide access to these resources. Strengthening collaboration among researchers, industry, and stakeholders will be critical to fostering the sustainable and responsible use of genetic materials, ensuring alignment with international biodiversity frameworks and equitable development goals.*

[II] *The pharmaceutical value chain does not include specific considerations for veterinary medicine. However, some of the impacts and priority actions in this document may be of use to actors in that industry.*

Pharmaceutical sector value chain (as covered in this overview)





Nature-related impacts

To protect and enhance ecosystems, businesses in the pharmaceutical sector should direct their efforts toward addressing the most significant impacts that their operations and value chains have on nature, namely:[III]

- **GHG emissions:** Manufacturing processes, which require specific ambient conditions such as humidity, temperature and sterility, along with company vehicles and purchased energy, all contribute to direct operational GHG emissions. The extent of these emissions depends on the energy sources used to meet these requirements. Additionally, sourcing inputs, product distribution, transport and product use significantly contribute to value chain emissions.[8]

- **Land-use change:** The pharmaceutical sector can lead to some changes in land use, particularly in the upstream value chain, through the sourcing of raw materials and intermediary products. For example, pharmaceutical companies often derive the compounds used in manufacturing processes from agricultural or forestry-based feedstocks, such as palm oil, soy or sugarcane. This can contribute to deforestation, habitat loss and altered land-use patterns. Additionally, forestry products like paper and cardboard used in packaging may indirectly impact land use. While smaller in scale, land-use change also results from the construction or expansion of manufacturing sites and office facilities. Such activities can lead to ecosystem destruction or fragmentation, reducing biodiversity, impairing vital ecosystem connectivity and diminishing resilience to stressors such as climate change.

- **Solid waste:** Generated across the pharmaceutical value chain, solid waste includes materials that may have been in contact with active pharmaceutical ingredients (APIs) or biological or genetically modified materials – requiring additional considerations for treatment and disposal. Examples of solid waste include raw material containers for chemicals and solvents, components such as tubes, filters and single-use processing systems, as well as product packaging and distribution devices such as syringes, insulin cartridges, injectors and asthma inhalers. Waste classified as hazardous or clinical presents unique challenges for effective and compliant disposal or re-processing. The incorrect disposal of unused medicines by patients poses unnecessary risks to the environment and waste handlers and can potentially contribute to the presence of APIs in the environment.[9]

- **Water use:** Companies use both groundwater and surface freshwater as an ingredient in medicines, production processes, the cultivation or extraction of raw materials, and for cleaning and sterilization. Consumers and patients also use them at the point of product use.[10] The production of both specialist and commodity agricultural crops used in the sector, along with the upstream manufacturing of APIs, excipients and precursor chemicals, can be highly water-intensive.

- **Water pollution:** The release of APIs (including antibiotics), harmful chemicals and other substances can occur due to activities across the pharmaceutical value chain, including following patient use, improper disposal of unused medicines and post-use excretion by users.[11] Tight regulations and controls aim to prevent the release of APIs in waterways, such as the EU Water Framework Directive,[12] Environmental Quality Standards[13] and the USA's Clean Water Act.[14] However, some discharges into water can occur in the manufacturing process.[15]



[III] *The list of nature-related impacts represents the top five identified across the sector. We have not ranked them by order of priority. We have based the list of impacts on stakeholder survey results from engagement with WBCSD's pharmaceutical working group and the highest ENCORE (Exploring Natural Capital Opportunities, Risks and Exposure) materiality ratings. While this provides a starting point to help companies identify potential material impacts in their value chains, it is a generalized assessment. Companies may identify additional priorities based on their specific business models and resulting materiality, and should conduct further risk and opportunity evaluations before using the list to inform priority actions and targets.*

Nature-related dependencies

Like many sectors, the pharmaceutical sector depends on a number of ecosystem services and assets to operate. Businesses in the pharmaceutical sector mainly rely on:[IV]

- **Water supply:** Pharmaceutical manufacturing processes and the use of water as an ingredient for products – such as water for injection – depend on a consistent, pure and plentiful freshwater supply. Climate change impacts on precipitation patterns and surface water evaporation, along with increased water consumption due to human activities, can contribute to disrupted and depleted water supplies.
- **Water purification:** The pharmaceutical sector is increasingly facing regulation focusing on water pollution. Companies adhere to strict systems and protocols to minimize APIs, harmful substances and other pollutants. However, due to technical limitations, they also rely on the bioremediation and filtration capacity of local ecosystems to manage the effects of the smaller volumes of pollutants released into the environment.[16] Natural physical and biological processes (such as microbial decomposition) help remediate these pollutants and improperly disposed of waste materials from agricultural, industrial and domestic sources.[17]
- **Climate regulation:** The pharmaceutical value chain depends on a stable climate as hazards can disrupt crop growing, the mining of key metals and any transportation of products by air, rail, road and sea. Climate regulation is necessary to prevent manufacturing operation outages and downstream product delivery. Climatic variability and extremes can also impact health due to associations with extreme temperatures, food insecurity and malnutrition. Additionally, climate change may exacerbate the transmission and spread of certain diseases, such as malaria, by altering the habitat ranges of Anopheles mosquitoes.[18]
- **Genetic material research:** R&D departments can use research models and genetic information from non-human organisms and pathogens to improve the scientific understanding of disease. This can lead to insights and innovations that contribute to the development of new medications and vaccines, and improved biotechnology processes.[V]
- **Bio-based products:**[VI] The pharmaceutical sector increasingly relies on biomass inputs for products, production processes and energy generation. For instance, limulus amoebocyte lysate (LAL), derived from the blood of horseshoe crabs, is a critical bio-based product used to test for endotoxins[VII] in pharmaceutical products, ensuring patient safety. Regulatory authorities in certain jurisdictions mandate its use. Similarly, many pharmaceutical products rely on agricultural products such as pharmaceutical-grade starch from crops like corn or potatoes. This starch functions as an excipient in drug formulations, aiding in tablet binding, disintegration and the stabilization of capsules and liquid medications.[19] Additionally, pharmaceutical packaging frequently uses bio-based materials like wood fiber for paper production. This growing reliance underscores the importance of sustainable biomass resources in advancing pharmaceutical innovation and safety.



[IV] *The list of nature-related dependencies represents the top five identified across the sector. We have not ranked them by order of priority. We have based the list of impacts on stakeholder survey results from engagement with WBCSD's pharmaceutical working group and the highest ENCORE (Exploring Natural Capital Opportunities, Risks and Exposure) materiality ratings. While this provides a starting point to help companies identify potential material impacts in their value chains, it is a generalized assessment. Companies may identify additional priorities based on their specific business models and resulting materiality, and should conduct further risk and opportunity evaluations before using the list to inform priority actions and targets.*

[V] *As pharmaceutical research uses these genetic and biological resources, Target 13 of the GBF covers their fair use, procurement and management of genetic resources. This target aims to ensure equitable access to genetic and biological resources, promoting benefit sharing to support both scientific progress and biodiversity conservation.*

[VI] *Bio-based products refer to materials, chemicals and energy derived from biological resources, including wild species (e.g., horseshoe crabs and shark liver) and agricultural products (e.g., biofuels, bioplastics).*

[VII] *Endotoxins are harmful substances found in the outer membrane of certain bacteria. When these bacteria break apart, they release endotoxins into the body. If they enter the bloodstream, they can be harmful.*

Priority actions and opportunities

The pharmaceutical sector has a key role to play in the transition to a nature-positive economy, particularly in connection with the identified priority impacts and dependencies on nature. Actors in the pharmaceutical sector can reduce their negative nature-related impacts, protect nature and promote restoration by prioritizing five key actions. In doing so, companies can simultaneously mitigate operational risk, unlock commercial opportunities and realize co-benefits for society, people and health. To effectively avoid and reduce negative impacts while promoting restoration and regeneration, companies should consider the following:

1. **Reduce water use** – Reduce manufacturing water use through improved efficiency during product development, water recycling, closed-loop systems and altering hard infrastructure, such as insulating cooling towers for reaction chambers (consider potential trade-offs relating to energy consumption). Increase the understanding of dependencies on water supply across the value chain and prioritize mitigation in areas of high-water stress or drought risk. Take a basin-level approach[VIII] to water management, reducing the strain on local water resources that communities and ecosystems rely on and ensuring sustainable freshwater withdrawal. Enhance traceability and engage with suppliers and contract development and manufacturing organizations (CDMOs) to understand their water risks and increase water use efficiency, thereby minimizing water stress impacts. Participate in river basin restoration and replenishment activities, prioritizing nature-based solutions (NbS). Locate resources near manufacturing sites while considering societal, climate and biodiversity impacts. Engage with local communities, hydrologists and other stakeholders, especially in water-stressed regions and areas critical for biodiversity, to ensure sustainable and responsible water use.

2. **Reduce pollution risk from APIs** – Minimize the release of APIs, chemicals and other substances from pharmaceutical manufacturing processes and ensure you meet and exceeded requirements and regulations for specific production sites where possible. Incorporate environmental considerations into pharmaceutical R&D, including the persistence, mobility, bioaccumulation and ecotoxicity of APIs, to advance the development of greener, benign-by-design APIs, while accounting for the lead time needed for research, development and testing before patient availability.[20] Mitigate the environmental impacts of antibiotics released in wastewater discharge by obtaining certification from standards such as the British Standards Institute (BSI) Antibiotic Manufacturing Standard. Work collaboratively to identify the most material effluents from manufacturing processes based on their ecotoxicity and how common their use is across the sector. Share end-of-life solutions with users through educational campaigns on responsible product use and disposal, as a significant portion of the impact from APIs and antibiotics often occurs downstream in the value chain, such as during product use and disposal.[21]

   For hazardous chemicals that are not APIs or antibiotics, transition to circular models in the sourcing of reagents, solvents, buffers and other feedstocks and in the design and manufacturing of products. Implement downstream solutions in the value chain for chemicals and by-products while mitigating negative impacts. Take-back schemes for used devices, primary packaging and unused medicines offer a valuable opportunity to enhance circularity, reduce water pollution and mitigate environmental impacts. Additionally, working collaboratively with regional and municipal wastewater treatment plants ensures that their systems can adequately support the removal of ecotoxic chemicals and their decomposition techniques can mitigate downstream accumulation.

   Additionally, address the advancement of antimicrobial resistance in the environment by prioritizing measures to mitigate antibiotic pollution. This includes actions such as implementing robust waste management systems and ensuring responsible antibiotic use along with storage, disposal and treatment practices.

3. **Avoid and reduce the release of GHG emissions across the entire value chain** – Establish a science-based emissions reduction target, such as through the Science Based Targets initiative, and encourage suppliers and CDMOs to follow suit. Use product-level life-cycle assessment (LCA) data to identify priority areas and actions to minimize GHG emissions. Engage with suppliers and CDMOs on energy use and efficiency, promoting the adoption of clean, renewable energy sources. Increase the efficiency of product manufacturing, for example by adopting green chemistry principles, and the efficiency of production, storage and distribution facilities and processes. Consider opportunities for emissions reductions related to product manufacturing, storage and distribution, such as energy-efficient cooling and refrigeration systems, to reduce patient travel to access pharmaceutical products. Consider trade-offs, such as the land-use impacts of expanded renewable energy generation infrastructure, in decision making.



[VIII] *UNESCO's World Water Assessment Programme describes a basin-level approach as the following: "A basin-level [approach], defined by geographical and hydrological characteristics, facilitates the practical integration of downstream and upstream as well as basin-wide issues, and the incorporation of quantity and quality aspects of the basin's available surface and groundwater resources." IRMW Guidelines at River Basin Level Vol. 1 (UNESCO).*



4. **Source responsibly, improve supply chain traceability and transparency, and accelerate the use of alternative lower impact materials** – Identify the key chemical and agricultural inputs used and understand their natural source. Handle this work individually or in collaboration with the Pharmaceutical Environment Group (PEG) and the Pharmaceutical Supply Chain Initiative (PSCI). Assess the environmental impacts and risks associated with key commodities used in production processes, such as palm oil or petrochemicals, supported by pharmaceutical product LCAs and other tools to locate these impacts and risks in the value chain.

   Engage with suppliers and CDMOs to enhance their sustainability performance and product traceability by establishing clear standards (including certifications) for climate and nature, while providing support to accelerate improvements where needed. Improve traceability to identify and mitigate impacts through end-to-end supply chain by identifying data gaps in product or ingredient traceability from tier 1 suppliers, ideally down to the raw material level for the most mature companies. Ensure the inclusion of social and human rights considerations for local communities in the standards.

   Accelerate the use of alternative lower-impact materials where possible and work collaboratively with the industry and regulators (e.g., the US Food and Drug Administration (FDA) and the EU European Medicines Agency (EMA)) to ensure acceptance and enable a timely transition. For instance, transitioning to synthetic LAL for pharmaceutical product testing would require a product-by-product filing process unless regulators identify and approve an alternative approach. Consider potential trade-offs relating to alternative materials.

5. **Reduce solid waste across the value chain** – Collaborate with actors across the value chain to design out waste and reduce solid waste generation. Engage with suppliers, CDMOs and other stakeholders to promote circularity and adopt waste hierarchies in management systems across the value chain. Enhance material efficiency by implementing innovative practices and technologies, such as maximizing yield, adopting continuous manufacturing techniques, and redesigning product systems to minimize waste across all stages of production and delivery.

   Review current product packaging designs to identify opportunities to reduce overall material use and increase the incorporation of recycled materials, moving away from virgin plastics and paper. Work closely with policymakers, supporting policies that reinforce circularity and reduce waste, such as collective waste gathering and alternative sustainable packaging materials.

   Reduce the downstream impacts of product use through education campaigns on responsible product use and disposal, including the appropriate handling of unused or expired medicines.

Many of the actions are relevant across the pharmaceutical value chain and require engagement with suppliers, customers or regulatory bodies. In particular, advocacy for enabling policies at local, regional, national and global levels plays a crucial role in championing sustainable change and transforming entire sectors. Importantly, the delivery of the priority actions and transforming the sector must align with a just and equitable transition, including meaningful dialogue with affected groups, such as employees, local communities, Indigenous Peoples and marginalized communities.

Resources

The following guidance and tools are available to companies in the pharmaceutical sector:

- The Nature Strategy Handbook (Business for Nature, 2023)
- Additional sector guidance Biotechnology and pharmaceuticals (Taskforce on Nature-related Financial Disclosures (TNFD), 2024)
- Roadmaps to Nature Positive: Foundations for all businesses (WBCSD, 2023)
- Accountability Framework (Accountability Framework Initiative, 2019)
- Land and Freshwater targets and technical guidance (Science Based Targets Network (SBTN), 2023)
- Sectoral Materiality Tool (SBTN, 2022)
- WHO Guidance on wastewater and solid waste management for manufacturing of antibiotics, (World Health Organization (WHO), 2024)
- ENCORE (Exploring Natural Capital Opportunities, Risks and Exposure) (United Nations Environment Programme)
- WWF Water Risk Filter Suite (World Wide Fund for Nature, 2025)
- Antibiotic Manufacturing Standard (AMR Industry Alliance, 2024)
- Science-Based PNEC Targets for Risk Assessments (AMR Industry Alliance, 2024)

The following organizations and coalitions also provide useful information for the sector:

- AMR Industry Alliance (Antimicrobial Resistance Industry Alliance)
- AWS (Alliance for Water Stewardship)
- Health Systems Task Force (Sustainable Markets Initiative)
- Pharmaceutical Supply Chain Initiative
- Pharmaceutical Environment Group
- PREMIER (Prioritization and Risk Evaluation of Medicines in the Environment)
- Circularity in Primary Pharmaceutical Packaging Accelerator

Additional sector-agnostic resources:

- Business for Nature's High-level Business Actions on Nature
- Nature and Biodiversity Peer Group
- CEO Water Mandate (UN Global Compact)
- The Natural Climate Solutions Alliance (WBCSD)

Disclaimer

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