# The Environmental Sustainability Practices In Laboratory Research

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**Abstract**
Chemicals play a vital role in our everyday lives, contributing to the overall health, elevated living standards, and convenience of contemporary civilization. They are used in several industries, including the healthcare industry. Nevertheless, several chemicals possess perilous characteristics that might inflict damage onto the environment and human well-being. The presence of chemical pollutants is playing a major role in exacerbating the ongoing worldwide issues of climate change and biodiversity loss. The usage of chemicals is partly responsible for the rise in health issues. Certain synthetic compounds may be detected in the most isolated regions of the environment, as well as inside our own bodies. Chemical substances are ubiquitous. The chemicals strategy for sustainability aims to achieve a toxic-free world by enhancing the protection of human health and the environment from harmful chemicals. It also seeks to promote innovation in the development of safe and sustainable chemicals and facilitate the shift towards chemicals that are inherently safe and sustainable. This is the first action taken towards achieving the goal of zero pollution and creating a toxic-free environment, as outlined in the European Green Deal. The plan advocates for extensive chemical regulations to overhaul the sector, with the goal of luring investment in secure and environmentally-friendly goods and manufacturing techniques. Clinical labs must choose for safer and more environmentally friendly alternatives to dangerous chemicals, tackle sustainability concerns, and adhere to government requirements for minimizing their carbon emissions.

**Keywords:** green chemistry; toxic substances; sustainable chemistry

## 1. Introduction

The environment refers to the external factors and situations that an organism interacts with. This engagement has been ongoing since its inception. The prevalence and severity of environmental challenges have escalated as a result of the growing industrialization and human activities that affect the environment. The lack of awareness about the environment and excessive consumerism has led to the decline and depletion of natural resources. The rapid expansion of the global population has led to this condition, resulting in 50% of the world's current environmental pollution occurring in the last 4-5 decades.

The prevalence of global issues is increasing. The state of our planet is causing much concern. The depletion of our natural resources is occurring. The Earth's climate is undergoing a process of global warming. The climate is undergoing changes. Countless species on Earth are in danger of extinction as a result of atmospheric warming and climatic fluctuations. The degradation and contamination of oceans and forests has been steadily increasing. The COVID-19 pandemic, climate change, and biodiversity issues are intricately interrelated. Loss of biodiversity may lead to the alteration of pathogen hosts.

Over the last several years, there has been a surge in trash generation, especially hazardous garbage, as a result of industrialization, urbanization, economic growth, and population growth. The creation of waste has a significant influence on society, the economy, and the environment. Europe generates almost 3 billion metric tons of trash annually, with around 100 million metric tons classified as hazardous [1]. Approximately 15% of healthcare waste is classified as hazardous, meaning it is infectious, poisonous, or radioactive [2]. Additionally, chemical or pharmaceutical waste accounts for about 3% of total waste generated in healthcare settings [3]. Medical waste has emerged as a significant global and European contaminant, exerting adverse effects on the quality of land, water, and air. Healthcare companies consider it essential to establish interdisciplinary teams to handle sustainability challenges.

## 2. Toxic substances

Chemicals are widely present in modern culture and have played a crucial role in enhancing human health and increasing life expectancy, particularly in healthcare and clinical labs. Nevertheless, these factors are indicative of potential harm to

human health and the environment due to their inherent dangerousness [4, 5]. Therefore, it is crucial to establish the precise meaning and categorization of dangerous compounds in order to recognize and avert any contact with these substances. This may be accomplished by using labels and safety data sheets.

Hazardous waste is defined differently in each nation, but generally refers to a substance that is harmful to human health or the environment, no longer suitable for its original function, and intended for disposal. However, it remains hazardous [6, 7]. The danger may increase if the content of trash undergoes changes [6]. Chemicals can be considered hazardous if they possess certain properties, including explosiveness, oxidizing ability, high flammability, irritancy, harmfulness, toxicity, carcinogenicity, corrosiveness, infectivity, reproductive toxicity, mutagenicity, sensitization, ecotoxicity, or the ability to release toxic or highly toxic gases when in contact with water, air, or an acid. Additionally, chemicals that produce another substance with any of these listed characteristics after disposal are also considered hazardous [8-10]. Chemical waste in clinical labs include solvents, reagents, sterilants, disinfectants, batteries, heavy metals derived from medical equipment, radioactive diagnostic items, and chemical combinations [2].

Chemical dangers may occur during manufacture, transportation, use, or disposal. Ensuring proper and sustainable management of chemicals is of utmost importance. Hazardous chemicals in the EU are well-established as a cause of several health ailments, including cancer, neurodevelopment abnormalities, reproductive issues, metabolic disorders, cardiovascular illnesses, and respiratory diseases [11, 12]. Typically, some demographic subgroups that are more susceptible are at a higher risk of developing illnesses caused by pollution, such as children from poor socioeconomic backgrounds [6].

In addition, even when administered in little amounts, exposure to chemicals may contribute to lasting health effects, including reduced fertility, lowered birth weights, and neuropsychiatric disorders in children. Neurobehavioral development problems, such as attention deficit-hyperactivity disorder (ADHD) and autism spectrum disorder, are present in around 10-15% of all births and are widely distributed [10]. The presence of several harmful compounds in human tissues and blood is on the rise [13]. These chemicals might have a cumulative toxic effect that surpasses the impact of each individual toxin on its own [10]. The simultaneous exposure to dangerous substances has been linked to decreased fertility rates and impaired development of the fetus [13]. Furthermore, the exposure to endocrine disrupting chemicals has a significant economic effect, resulting in an annual expenditure of €157 billion. Out of this amount, about €1.5 billion is specifically linked to female reproductive problems [10].

Regarding the environmental consequences of dangerous chemicals, they may infiltrate natural ecosystems throughout many stages such as extraction, manufacturing, downstream usage (e.g. in clinical labs), or via the disposal, recycling, or reuse of these compounds [11]. The evaluation should include the possible affects on the aquatic, terrestrial, and atmospheric components, as well as the microbiological activity of sewage treatment systems and the consequences via the accumulation in the food chain [9]. Furthermore, the extent of their influence depends on the specific characteristics and amount/concentration of the chemical, the environmental component that is affected (such as air, water, or land), the duration of exposure (whether it is short-term or long-term), the timing of the chemical's release into the ecosystem, and the sensitivity of the exposed receptors (such as different species) to the chemical [11]. These evaluations aid in classifying a dangerous chemical and determining the level of concentration at which detrimental effects in the environmental domain are not anticipated to occur - Predicted No-Effect Concentration (PNEC) [9].

Moreover, there are concerns about the utilization of recycled chemicals in a circular economy, since this might amplify the dissemination of perilous substances. A significant category of chemicals consists of those that are classified as very persistent, meaning they are resistant to degradation. Their long-lasting stability allows them to accumulate to dangerous levels. In recent times, there has been an increasing focus on the combined impacts of chemicals. This refers to the exposure to many harmful chemicals at low concentrations, even if each individual drug is below the predicted no effect limit (PNEC) [14].

Exposure to dangerous substances may lead to the loss of the ozone layer in the stratosphere and have negative impacts on ecosystems, plant life, and animal life [6, 12]. More precisely, they have the potential to reduce the quality of water and air, pollute land, and have a negative impact on insect pollinators, particularly when they are used or disposed of without following the existing legal, scientific, and technological requirements [11, 12].

Chemical pollution is a major factor in the ongoing worldwide issues of climate change and biodiversity loss [15]. In the healthcare industry, improper disposal of untreated waste can lead to the pollution of drinking water, groundwater, and surface water if landfills are not properly constructed. Inadequate waste incineration can cause air pollution and the production of ash residue. This can also result in the generation of cancer-causing dioxins and furans from substances containing chlorine, as well as the release of toxic metals from materials containing lead, mercury, and cadmium [2]. Recent data indicates that there are more than 2.5 million sites in Europe that may be poisoned. Out of these, 14% are confirmed to be contaminated and need steps to mitigate the damage [11]. Hence, it is essential that both the manufacturing techniques and technology, along with the chemicals used, be sustainable throughout the whole life cycle of the product [15].

## 3. Strategies laboratories use to minimize the utilization of dangerous chemicals

The chemical manufacturing industry is highly polluting and requires a significant amount of energy and resources. It is intimately interconnected with other industries and activities that also use large amounts of energy. Although the European chemical industry has already made investments in upgrading its production facilities, the transformation towards more environmentally friendly and digital processes still necessitates substantial financial commitments for the sector [19]. Implementing novel and more efficient industrial processes and technologies would have several benefits for the European

sustainable chemicals sector. It would not only decrease the environmental impact of chemicals production, but also lead to cost reduction, improved market preparedness, and the creation of new markets.

Energy efficiency should be given priority in line with the goals of the European Green Deal. Fuels like renewable hydrogen and sustainably generated biomethane have the potential to significantly contribute to the sustainability of energy sources [29]. Emerging digital technologies, including the internet of things, big data, artificial intelligence, smart sensors, and robots, have the potential to significantly contribute to the adoption of environmentally friendly practices in manufacturing. Furthermore, chemical advancements have the potential to provide sustainable solutions across several industries, hence decreasing the total environmental impact of manufacturing operations.

To mitigate the presence of hazardous substances, the following measures may be taken:

- Elimination, reduction, or substitution [30].
- Avoid the use of dangerous substances wherever feasible:
- Replace mercury thermometers with other options and cease the use of ethidium bromide for gel applications.
- Examine the progress of chemical processes that do not need the use of solvents.
- Utilize computer simulations as a viable alternative to doing tests.
- Minimize the amounts of detrimental substances, reagents, and precursors if they cannot be eliminated:
- Employ chemical processes that are more effective in terms of energy consumption and yield.
- Implement green chemistry principles to replace chemicals with other substances that are less harmful.

## 4. Conclusion

The field of laboratory medicine should play a role in establishing a healthcare system that is sustainable, ensuring that resources are used effectively from ecological, social, and economic standpoints. Simultaneously, it should provide top-notch services to patients and doctors. Medical Laboratory Scientists are the final consumers of the test kits, reagents, and chemicals produced by the In Vitro Diagnostics (IVD) Industry. EFLM should actively promote and cooperate with the IVD Industry and MedTechEurope to develop a unified approach with the EC EGD in order to formulate Guidelines/Regulations.

The objective is to convert medical research and clinical laboratories in EFLM member societies across Pan-Europe into secure and sustainable environments by reducing their harmful environmental effects and implementing effective daily practices in laboratories. This includes minimizing energy, water, and hazardous chemical usage, as well as waste generation, while maintaining the quality of healthcare. Integrating sustainability measures is crucial in the dynamic healthcare landscape. Clinical labs have difficulties in maintaining sustainable operations. Chemicals are widely present in modern culture and have played a crucial role in enhancing human health and increasing life expectancy, particularly in healthcare and clinical labs. Nevertheless, they may have detrimental impacts on human health and the environment due to their inherent hazardous nature.

Hazardous chemicals are well recognized as a significant factor in the development of many health disorders, since they are linked to several illnesses. Simultaneous exposure to dangerous substances has been linked to decreased fertility rates and impaired fetal development. Furthermore, the exposure to hormone disrupting chemicals has a considerable economic effect. Chemical pollution is a key contributing factor to the ongoing worldwide issues of climate change and biodiversity loss. EFLM and its Member Societies will work closely with the IVD Industry to guide the laboratory medicine community in creating environmentally friendly laboratories and transitioning to carbon neutrality.

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