UNIVERSITÀ DEGLI STUDI DI MILANO
FACOLTÀ DI SCIENZE DEL FARMACO

La ricerca chimico-farmaceutica nell'ottica della sostenibilità e dell'uguaglianza

Marco De Amici

DiSFarM Dipartimento di Scienze Farmaceutiche

Le scienze chimiche per la pace e il progresso

Dipartimento di Scienze Farmaceutiche - 09.04.2026, Aula V3

Il Codice Deontologico della Professione di Chimico e Fisico

Il **Codice Deontologico della Professione di Chimico e di Fisico** **stabilisce le norme di comportamento che i professionisti Chimici e Fisici sono tenuti a osservare** in via generale e, specificatamente, nei rapporti con il cliente, con la controparte, con i colleghi e con altri professionisti [in particolare: **Articolo 2** (ambito di applicazione), **Articolo 3** (principi e doveri generali), **Articolo 4** (obblighi nei confronti della professione)].

Il Codice Deontologico è stato approvato dalla Federazione Nazionale degli Ordini dei Chimici e dei Fisici nella riunione di Consiglio dell'11 ottobre 2018, così come previsto dal Capo III, art. 7 comma 3 della Legge 11 gennaio 2018, n. 3 "Delega al Governo in materia di sperimentazione clinica dei medicinali nonché disposizioni per il riordino delle professioni sanitarie e per la dirigenza del Ministro della Salute", che qualifica la professione del Chimico e del Fisico come professione sanitaria.

Il Codice Deontologico viene recepito con delibera dai Consigli direttivi degli Ordini territoriali ed è rivolto a tutti gli iscritti all'Albo che sono pertanto tenuti all'osservanza dello stesso.

FEDERAZIONE NAZIONALE DEGLI ORDINI DEI CHIMICI E DEI FISICI

Il Codice Etico della Società Chimica Italiana

La **SCI** (fondata nel 1909) è una società scientifica, alla quale aderiscono più di seimila Soci, il cui operato si ripropone di:

- favorire ed **incrementare la ricerca scientifica** in tutti i campi della Chimica;
- divulgare **la conoscenza della Chimica** e l'importanza delle sue applicazioni nel quadro del progresso e del benessere dell'umanità;
- promuovere **lo studio della Chimica** nelle Università e nelle scuole di ogni ordine e grado;
- favorire in ogni campo **lo sviluppo delle scienze**.

I Soci svolgono la loro attività nelle Università e negli Enti di Ricerca, nelle scuole, nelle industrie, nei laboratori pubblici e privati di ricerca e controllo, nella libera professione. Contribuiscono, così, alla crescita culturale ed economica della comunità nazionale, al miglioramento della qualità della vita dell'uomo e alla tutela dell'ambiente. La SCI ha adottato un **Codice Etico** **che costituisce una carta dei diritti e dei doveri morali per i propri membri e collaboratori**. Il codice è parte integrante del Modello di Organizzazione, Gestione e Controllo adottato dalla SCI ai sensi del DL 231/01.

Società Chimica Italiana

The Chemical Professional's Code of Conduct of ACS

The **American Chemical Society (ACS)** expects its members to adhere to the highest ethical and safety standards. Indeed, the Federal Charter of the Society (1937) explicitly lists among its objectives **"the improvement of the qualifications and usefulness of chemists through high standards of professional ethics, education and attainments….."** The chemical professional endeavors to advance the broader chemistry enterprise and its practitioners for the **benefit of Earth and its people, and has obligations to the public, to colleagues, and to science**.

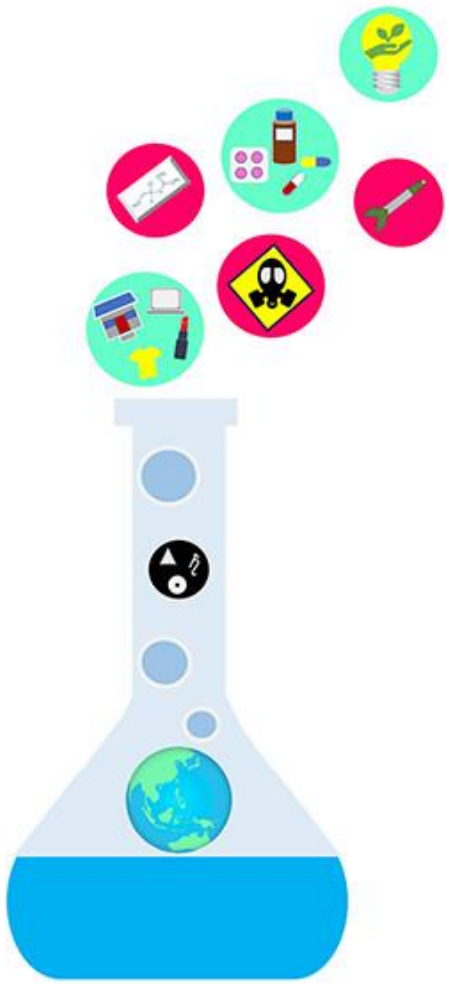
"The Chemist's Creed," was approved by the ACS Council in 1965. The principles of "The Chemist's Code of Conduct" were prepared by the Council Committee on Professional Relations, approved by the Council (March 16, 1994), and replaced "The Chemist's Creed". They were adopted by the Board of Directors (June 3, 1994) for the guidance of Society members in various professional dealings, especially those involving conflicts of interest. **The Chemist's Code of Conduct was updated and replaced by The Chemical Professional's Code of Conduct** to better reflect the changing times and current trends of the Society in 2007, and subsequently updated in 2012, 2016 and 2019.

ACS Chemistry for Life®

SCI e CNC contro le Armi Chimiche nel 2015

"L'infausta ricorrenza del 22 aprile 2015, **il centesimo anniversario del primo massiccio impiego delle Armi Chimiche** durante il conflitto mondiale della Guerra 1914-18, può e deve essere utilizzata per alimentare la ricerca e consolidare la riflessione sull'etica della scienza come portatrice di sviluppo e benessere sempre più al servizio dell'uomo e delle cause umanitarie". La **Società Chimica Italiana e il Consiglio Nazionale dei Chimici si impegnano a non far restare parole mute quelle spese contro gli armamenti chimici, unendosi alle altre istituzioni ed associazioni di tutto il mondo, nel ricordare quel tragico evento ai propri soci e più in generale alla opinione pubblica del Paese**. Non dimenticare insomma e più ancora investire sul progresso per ribaltare concezioni e accadimenti storici: le prime, quelle che associano la chimica alle armi di distruzione, i secondi che la categoria vuole impegnarsi a controbilanciare promuovendo idee ed azioni di valorizzazione della pace. In particolare, SCI e CNC danno la propria convinta adesione alle **cerimonie commemorative che si svolgeranno ad Ypres in Belgio il 22 aprile** da parte dell'**Organizzazione per la Proibizione delle Armi Chimiche (OPCW)**. A tale cerimonia, in rappresentanza dei chimici europei e per testimoniare il convinto impegno contro le armi chimiche, sarà presente una delegazione dell'**EuCheMS** (European Association for Chemical and Molecular Sciences), guidata dal suo Presidente Prof. David Cole-Hamilton.

Of War and Peace, and Chemistry



The accessibility of chemicals provides comfort and improves human daily lives. But chemistry, which is very much intertwined with the development of human civilization, has a dual persona. Its ability to metamorphosize from friend to foe, from peaceful compounds to weaponries simply by breaking and forming chemical bonds, keep us wary of its power. Understanding the **dual nature of chemistry** and its related scientific discoveries and emerging technologies is central to the effective implementation of the Chemical Weapons Convention. Human history spans thousands of years of chemical misuse in warfare, making chemicals a constant threat to human health and safety, particularly in conflict areas. **The need to continuously assess and review new scientific research output and emerging technologies, both for the opportunities and the risks that they can provide**, is essential in ensuring that sound and apolitical science advice is provided for policy-making related to chemical disarmament.

I. S. Martinez, G. Povoden *ACS Chem. Health Saf.* **2025**, *32*, 223-227 - doi: 10.1021/acs.chas.5c00044

Of War and Peace, of Chemistry and Sustainability

The constant monitoring of new scientific discoveries and technologies ensures that policies pertaining to the Chemical Weapons Convention remain pertinent to the times and are well in line with sound and apolitical scientific advice. State-of-the-art equipment and technologies for detection and analyses of CWA, use of chemical forensics, and advanced personnel protective equipment for chemical safety, among others, will not only allow the effective implementation of the Convention but will, more than anything else, help save lives. **Nowadays, whispers and traces of chemical misuse, here and there, in conflict areas cannot be ignored. The peaceful use of chemistry is a phrase that requires not only vigilance to be constantly implemented but generations and generations of developing a chemical conscience in each new chemical practitioner and chemical disarmament policy maker**, through science advice, communication, and education. And so, the fight continues ….. for a world free of chemical weapons.

I. S. Martinez, G. Povoden, *ACS Chem. Health Saf.* **2025**, *32*, 223-227.

Beyond economic and utility considerations, progress in chemistry must now be measured by its environmental acceptability. The discovery and manufacture of new chemical goods must align with sustainability principles, ensuring that economic feasibility does not come at the cost of environmental degradation. Chemistry's impact on war is a nuanced and multifaceted phenomenon that encompasses both positive contributions and negative implications. As a powerful **tool with the potential for both creation and destruction, chemistry demands responsible and ethical use**. The challenges and dilemmas associated with chemical warfare necessitate a collective commitment to promoting peaceful and beneficial applications, ensuring the well-being of humanity and the planet. Balancing progress, responsibility, and ethics in the realm of chemistry is crucial for **shaping a future where scientific advancements contribute to peace, sustainability, and the betterment of society**. V. Khilnani, *IRJAEM* **2024**, *2*, 2752-2756.

Sustainable Development Goals (United Nations 2030 Agenda)

In 2015, the United Nations officially launched the **Sustainable Development Goals** (**SDGs**) as "the blueprint to achieve a better and more sustainable future for all". They address the global challenges we face, including those related to poverty, inequality, climate change, environmental degradation, peace and justice. The **17 goals** are all interconnected and, **to leave no one behind, it is important that we achieve them all by 2030**. **Medicinal chemistry** (**MEDCHEM**) **is a key player to achieve** SDGs, since it can and must contribute to a sustainable future and a better world with an improved quality of life for all. The authors of this study have taken a critical look at each of the SDGs, which are divided into **Priority** and **Foundational**, and analyzed how **MEDCHEM** may impact on each of them. Although much has been done, scientists should be determined to make further progress in this area.

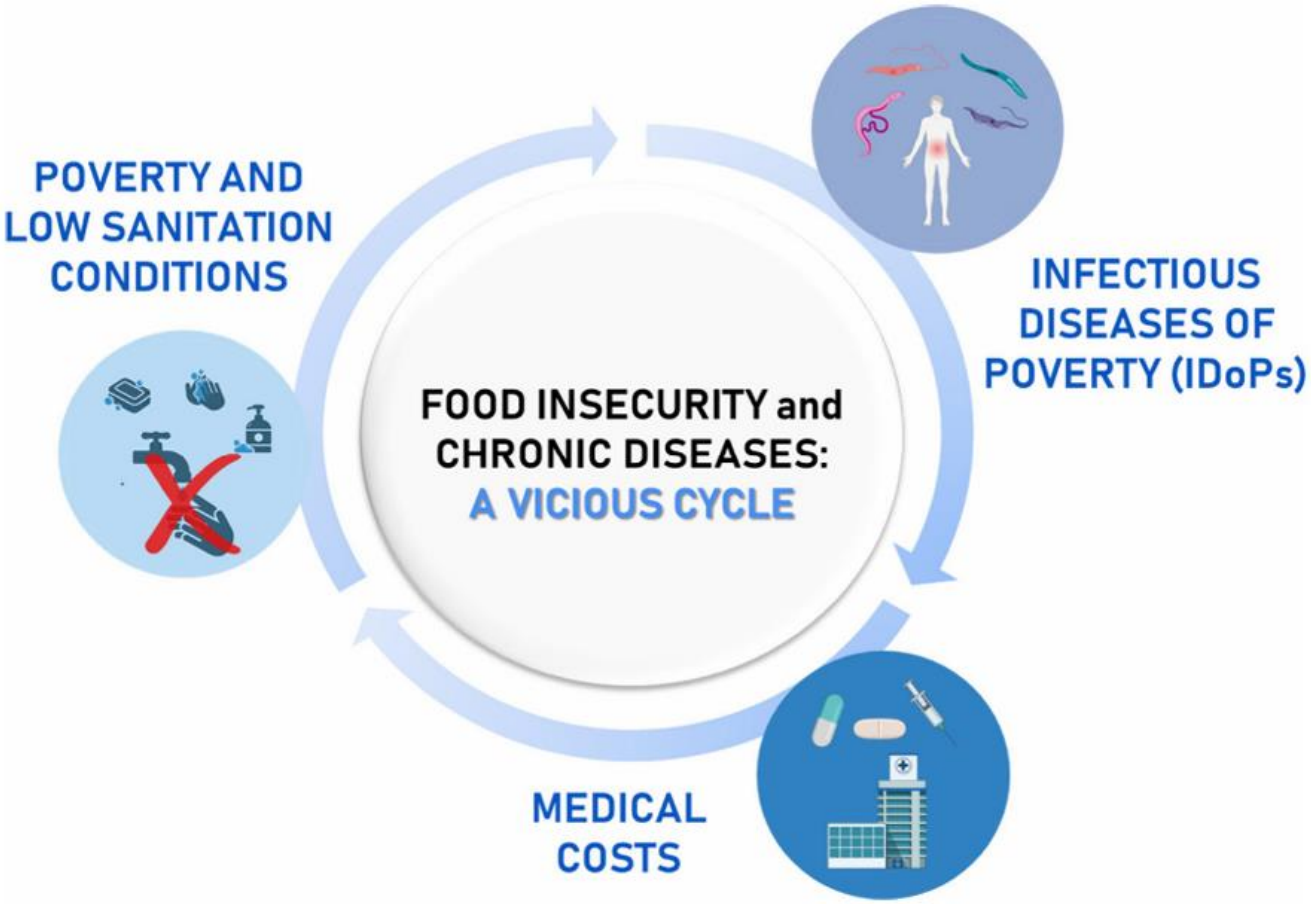
B. Martinengo, M. L. Bolognesi et al. *J. Med. Chem.* **2025**, *68*, 6916-6931 - doi: 10.1021/acs.jmedchem.4c03016

How the 17 SDGs have been defined and their classification

Medicinal chemistry is increasingly aligned with these general sustainability principles, since global health challenges must ensure environmental protection and promote sustainable industrial practices. **The integration of green and sustainable chemistry principles is crucial in this context, aiming to minimize environmental impact and enhance the efficiency of chemical processes and products.**

B. Martinengo, M. L. Bolognesi et al. *J. Med. Chem.* **2025**, *68*, 6916-6931 - doi: 10.1021/acs.jmedchem.4c03016

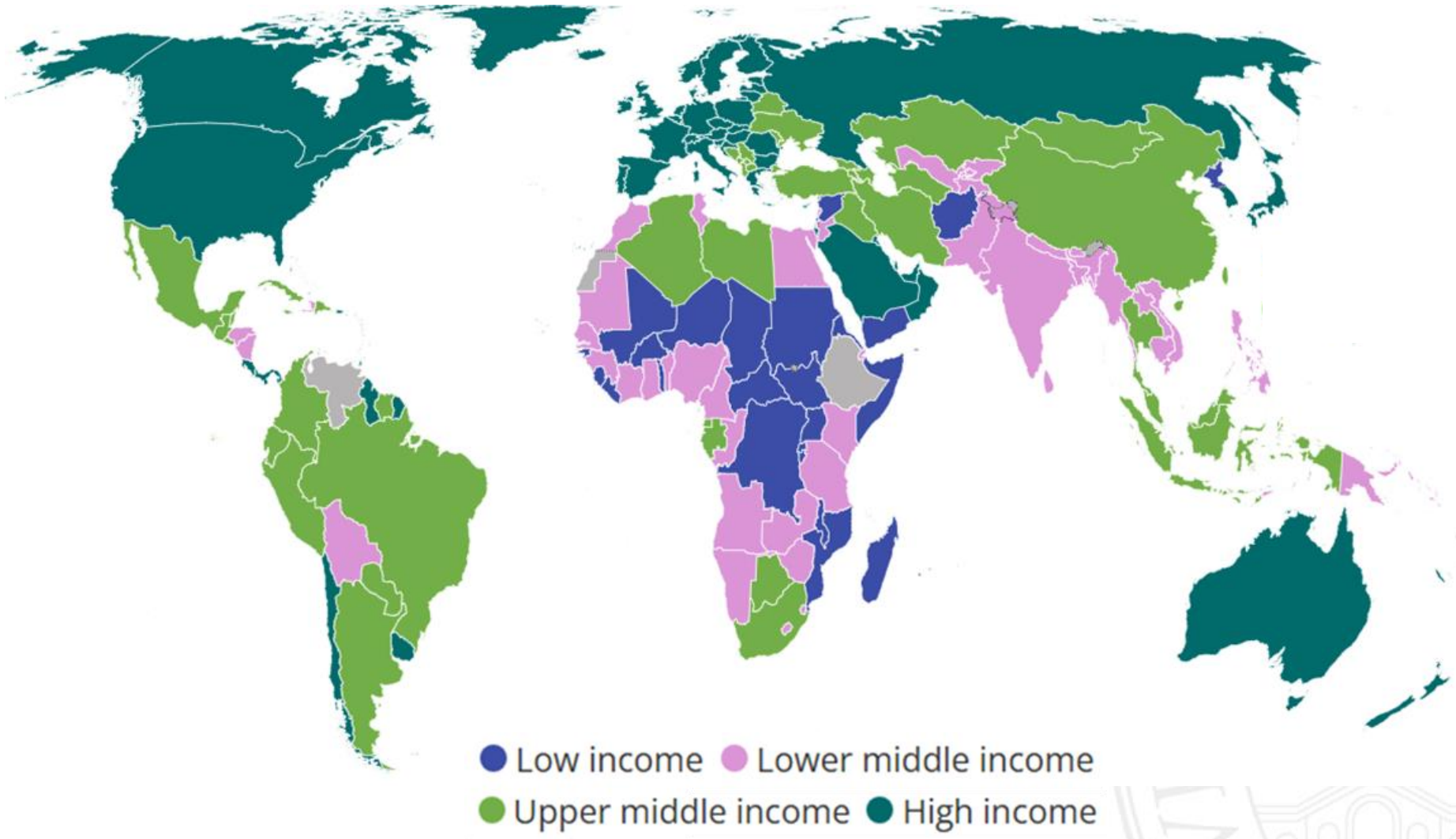
Consequences of poverty-related infectious diseases



The eradication of extreme poverty is a pivotal goal of the 2030 Agenda. Back in 1990, a positive trend was seen with more than one billion people that escaped poverty; however, the COVID-19 pandemic reversed it, forcing a million people below the extreme-poverty line. **IDoPs, including Neglected Tropical Diseases (NTDs)**, impose disproportionate human, social, and economic burden. This is driven by the widespread presence of infectious agents with transmission heavily influenced by socioeconomic and environmental factors. **Besides the inadequacy of sanitation conditions and food insecurity, the lack of safe, effective, and affordable medicines is also identified as a key factor that may hinder the achievement of this target.** The overall situation creates a vicious cycle of poverty, loss of productivity, chronic illness, disability, and social stigma. Nevertheless, coordinated global initiatives could and have played a relevant role, and examples of notable successes include the near elimination of **dracunculiasis, lymphatic filariasis, and trachoma in several countries, as well as the reduction of human African trypanosomiasis (HAT) cases**.

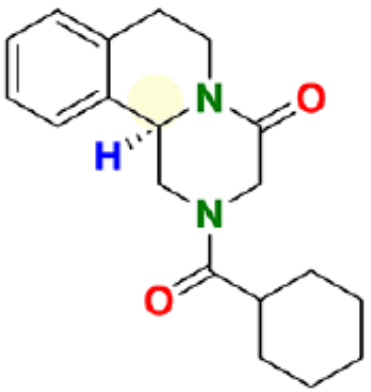
B. Martinengo, M. L. Bolognesi et al. *J. Med. Chem.* **2025**, *68*, 6916-6931 - doi: 10.1021/acs.jmedchem.4c03016

The world by income (2024)

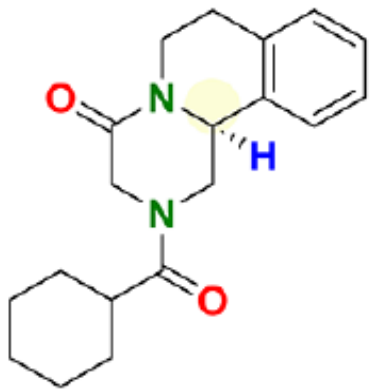


The World Bank classifies economies for analytical purposes into four income groups: **low**, **lower-middle**, **upper-middle**, and **high** income. It uses gross national income (GNI) per capita data in U.S. dollars, converted from local currency using the World Bank Atlas method, which is applied to smooth exchange rate fluctuations. Estimates of GNI derive from economists in World Bank country units who rely primarily on official data published by the countries.

Eradication of Schistosomiasis: efficacy of a chiral drug



(R)-(–)PZQ



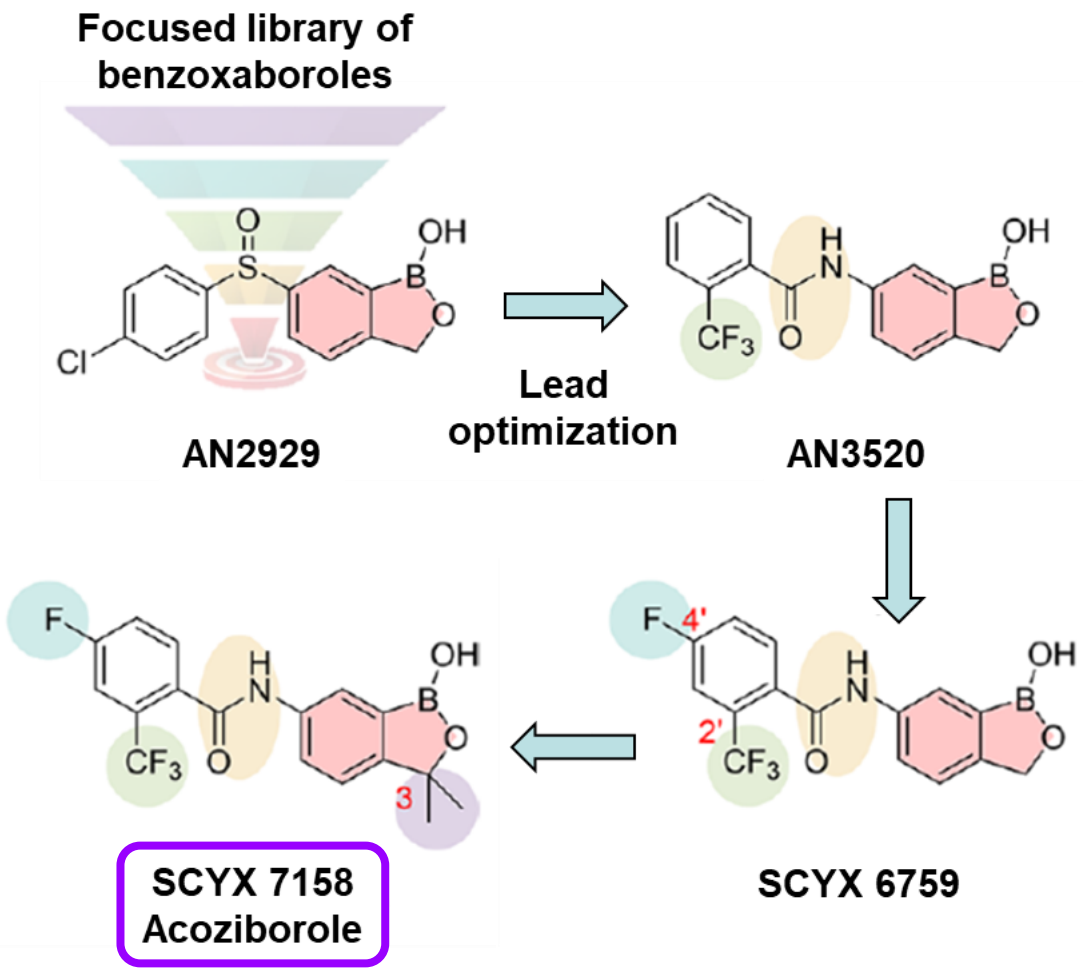
(S)-(+)PZQ

*(R)-PZQ causes rapid **paralysis** of schistosome worms*

The available **Praziquantel (PZQ)** formulation exist as 500 mg or 600 mg tablets, that are unsuitable for preschool-aged children, and the bitter taste counteracts administration leading to low compliance. Moreover, the various drug-related adverse effects due to praziquantel are common, particularly in the younger than 6 years age groups. Therefore, developing a new drug formulation which would be palatable and easier to administer is important. Of the two enantiomers, **(*R*)-PZQ** is a vermicide agent with low toxicity, whereas **(*S*)-PZQ has little anthelmintic activity plus an unpleasant smell, bitter taste, and worse side-effects**. Efforts to produce pure **(*R*)-PZQ** rather than the racemic mixture for preschool-aged children have been successful by reducing the tablet size, suppressing the offensive taste and odor, and reducing side-effects, but the manufacture is expensive due to the difficulty of achieving enantiomeric purity. The need for a formulation of pediatric Praziquantel has led to establishment of the **Pediatric Praziquantel Consortium**, which has developed an ***orodispersible tablet*** containing **(*R*)-PZQ**. However, despite the large global demand of **(*R*)-PZQ** for preschool-aged children, this enantiomer has not been adopted yet in schistosomiasis control programs.

G. J. Yang, X. N. Zhou *Lancet Infect. Dis.* **2023**, *23*, 774-776 - doi: 10.1016/S1473-3099(23)00059-2

Acoziborole against Human African Trypanosomiasis (HAT)



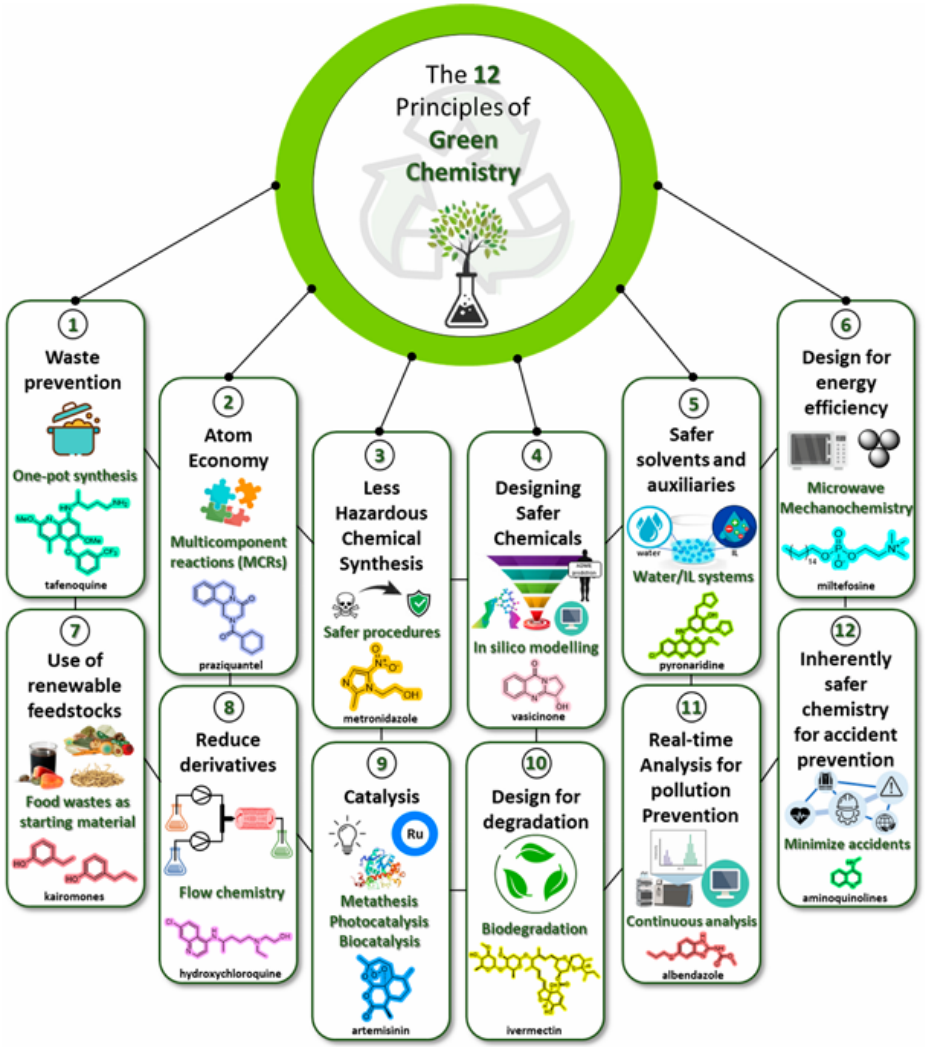
Another disease that has been recognized as potentially impacting the achievement of the 2030 Agenda is **HAT (also known as sleeping sickness), caused by different *Trypanosoma brucei* species**. It is a NTD that, by affecting both people and livestock, straddles the ground between human health, livestock health, agricultural production, and rural development in Africa. The disease, fatal if left untreated, progresses through two distinct stages: an initial **acute stage (stage 1)** where the parasitic infection is restricted to the hemolymphatic system and a **second stage (stage 2)** where parasites have migrated across the blood-brain barrier (BBB). This latter stage is particularly difficult to treat because the only available drugs, melarsoprol and eflornithine, have limited ability to cross the BBB, are toxic, and their activity depends on complex parenteral administration, which is a barrier to treatment.

The story reported on the left half of the slide summarizes a medicinal chemistry series of optimization steps, culminating in **Acoziborole (SCYX 7158)**, showing the installation of substituents at the C(3) position of the benzoxaborole scaffold, that **provided the best balance of potency and pharmacokinetic profile**. On this lead compound, a phase 1 clinical trial was successfully completed in 2015, and **a phase 2/3 trial was initiated by the DNDi (Drugs for Neglected Diseases initiative)**, indicating that **Acoziborole** holds promise in the efforts to reach the WHO goal of interrupting HAT transmission by 2030.

D. Ding, J. J. Plattner et al. *ACS Med. Chem. Lett.* **2010**, *1*, 165-169 - doi: 10.1021/ml100013s

V. K. Betu Kumeso, A. Tarral et al. *Lancet Infect. Dis.* **2023**, *23*, 463-470 - doi: 10.1016/S1473-3099(22)00660-0

The 12 principles of Green Chemistry



The term **Green Chemistry**, introduced by the US Environmental Protection Agency (EPA) in the early 1990s, defines "**the design of chemical products using (preferably renewable) raw materials and processes to reduce or eliminate the use and generation of toxic and/or hazardous reagents and solvents in the manufacture and application of chemical products**". Building on such a holistic view, **One Health** encourages collaboration among diverse disciplines, promoting unified efforts expected to provide more sustainable knowledge, experiences, and a better constituency in health policy. **The upcoming WHO VBPD (Vector-Borne Parasitic Disease) roadmap for 2021-2030 underscores the necessity of a One Health approach for achieving its ambitious control and elimination targets**.

B. Martinengo, M. L. Bolognesi et al. *ACS Infect. Dis.* **2024**, *10*, 1856-1870 - doi: 10.1021/acsinfectdis.4c00172

The One Health definition and principles

OHHLEP (One Health High-Level Expert Panel)

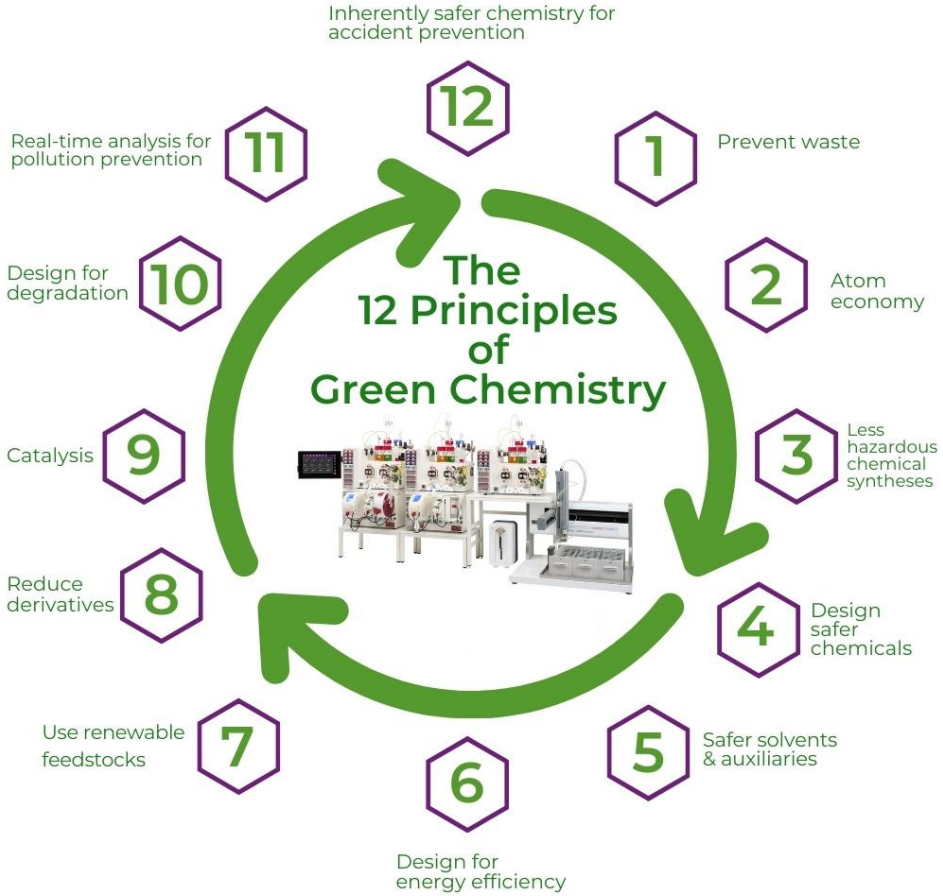
DEFINITION

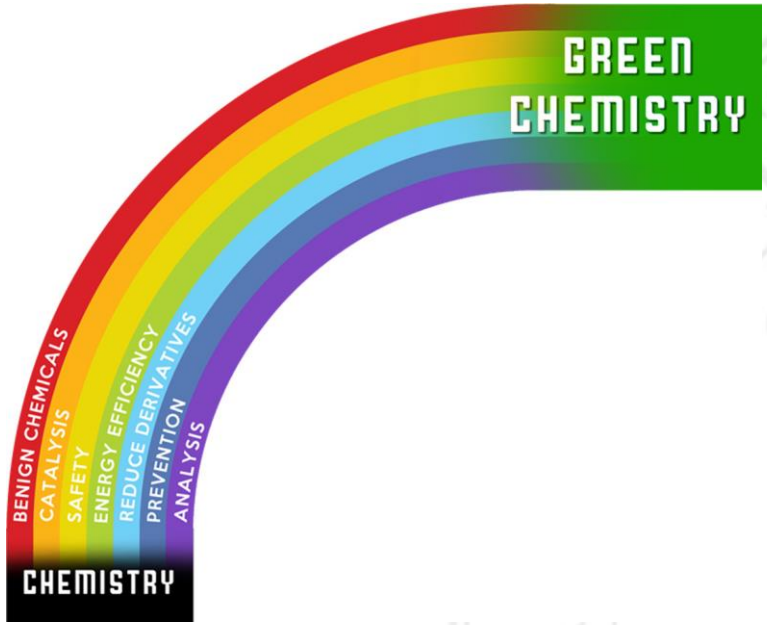
- **One Health is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems.**
- It recognizes the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and inter-dependent.
- **The approach mobilizes multiple sectors, disciplines and communities at varying levels of society to work together to foster well-being and tackle threats to health and ecosystems, while addressing the collective need for clean water, energy and air, safe and nutritious food, acting on climate change and contributing to sustainable development.**

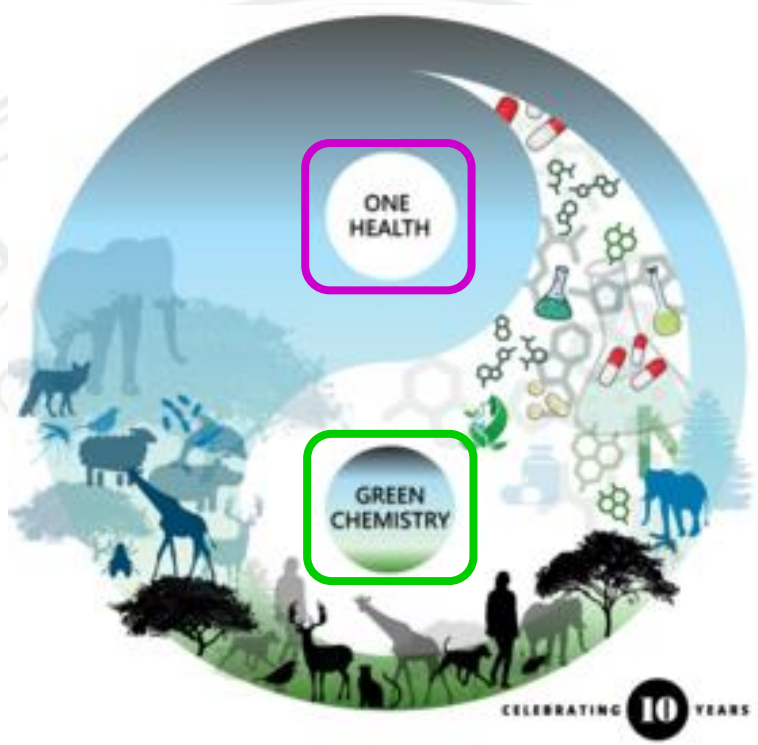
KEY UNDERLYING PRINCIPLES

- Equity between sectors and disciplines.
- **Socio-political and multicultural parity (the doctrine that all people are equal and deserve equal rights and opportunities) and inclusion and engagement of communities and marginalized voices**;
- Socioecological equilibrium that seeks a harmonious balance between human-animal environment interaction and acknowledging the importance of biodiversity, access to sufficient natural space and resources, and the intrinsic value of all living things within the ecosystem;
- Stewardship and the responsibility of humans to change behavior and adopt sustainable solutions that recognize the importance of animal welfare and the integrity of the whole ecosystem, thus securing the well-being of current and future generations;
- **Transdisciplinary and multisectoral collaboration, which includes all relevant disciplines, both modern and traditional forms of knowledge and a broad representative array of perspectives**.

An integrated, sustainable development model

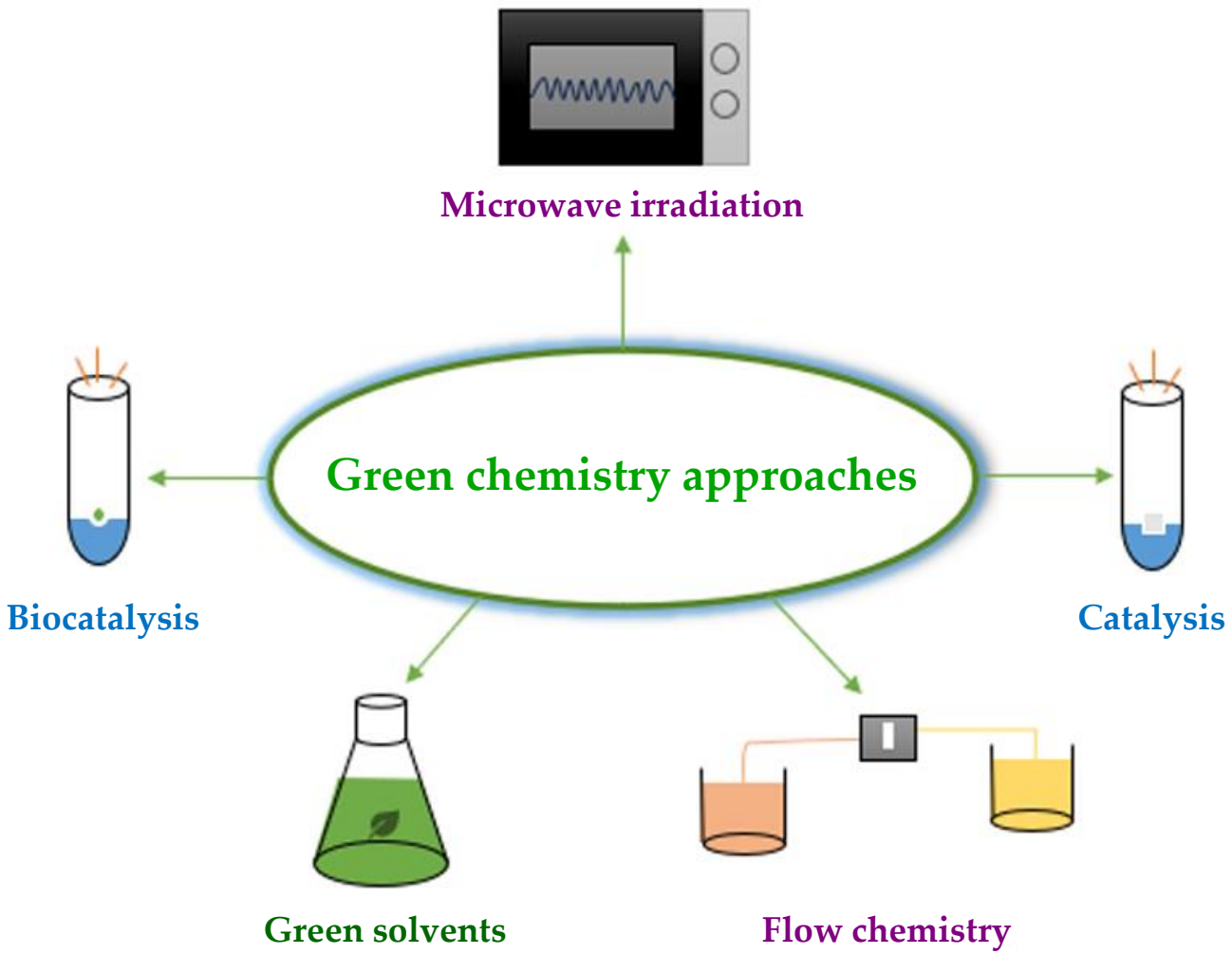






Am. J. Infect. Dis.
vol 10, issue 6, 2014

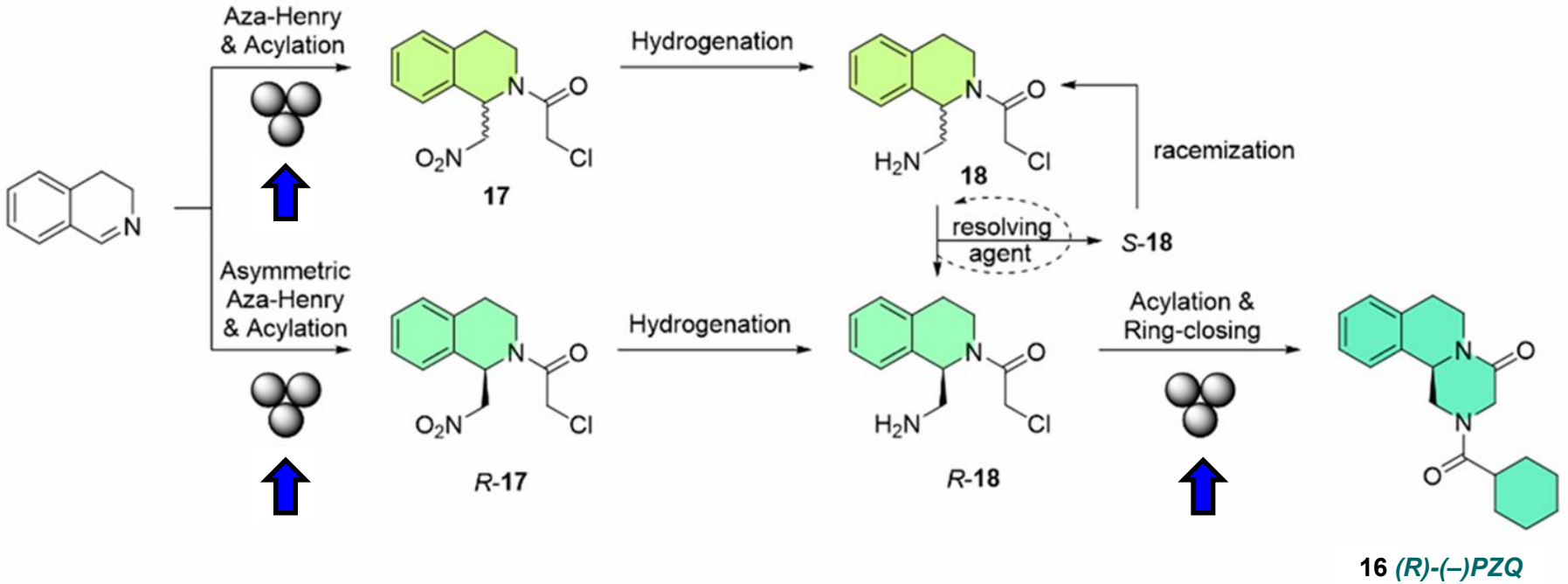
Green chemistry tools applied to pharmaceutical synthesis



Employing energy-efficient processes, such as microwave- or ultrasound-assisted syntheses reduces energy consumption in manufacturing. **Flow chemistry**, also known as continuous flow chemistry, is the practice of carrying out chemical reactions in a continually flowing stream rather than by the conventional batch approach. Continuous flow synthetic techniques can also be integrated easily with other enabling technologies, such as **microwave irradiation (MW)**, supported reagents or catalysts, inductive heating, photochemistry, electrochemistry, novel solvent systems or microreactor technology. These combinations may enable the development of fully automated processes that are more efficient and, often, more sustainable. Implementing **catalytic processes** aims at enhancing reaction rates, selectivity, and efficiency while avoiding to utilize hazardous reagents. Choosing **green solvents** or, better, water as a solvent reduces the environmental impact of pharmaceutical processes.

A. Stefanache et al. *AppliedChem* **2025**, *5*, 13 - doi.org/10.3390/appliedchem5020013

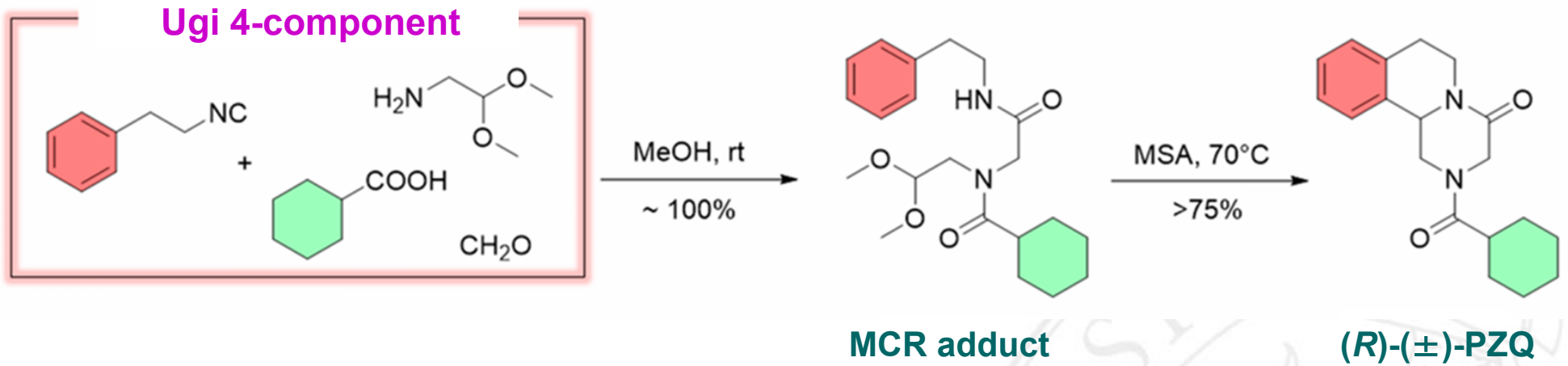
Environmentally friendly access to *levo*-Praziquantel (*R*-PZQ)



Mechanochemistry, like **MW, aligns with principles #5 and #6 of Green Chemistry** by prioritizing energy efficiency and waste reduction. Particularly, in mechanochemistry, chemical reactions are initiated by mechanical energy at room temperature, and the use of solvents is minimized. In essence, mechanochemistry reactions not only are predominantly solvent-free but also exhibit energy-savings, high productivity, and room-temperature characteristics compared to conventional solution-based methods. The key intermediate **(*R*)-1-aminomethyltetrahydroisoquinoline (*R*-18)** was obtained either by the resolution of the racemic material or by an enantioselective synthetic procedure. A scaled-up experiment showed that the efficiency of the multi-millimolar (50 mM) reaction was not significantly compromised. Notably, in a circular fashion, **racemization of (*S*-18)** is also achieved by using safe, cheap, and recyclable D-tartaric acid.

H. Shou et al. *Org. Biomol. Chem.* **2021**, *19*, 4507-4514 - doi: 10.1039/d1ob00453k

MCR: a green "atom economy" approach to racemic PZQ

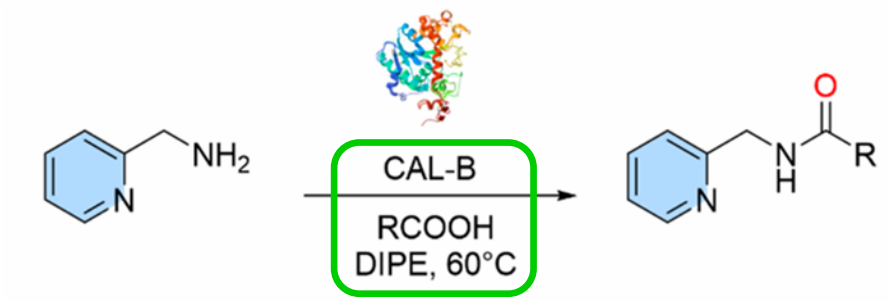


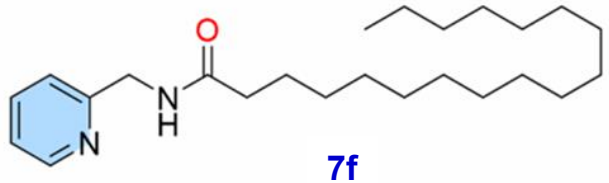
The **Ugi four-component reaction (U-4CR)**, a widely used **MultiComponent Reaction (MCR)**, is a condensation among an amine, an oxo compound, a carboxylic acid, and an isocyanide. **Praziquantel (PZQ)** is one of the 12 drugs of the WHO list of essential medicines, and it is currently the drug of choice for the treatment of both veterinary and human trematode and cestode infections, including human schistosomiasis. At variance with the original five-step synthesis, a convergent synthesis that affords **PZQ** with an overall yield of 45% in just three-step synthesis has been reported. The first two steps are the preparation of the (2-isocyanoethyl) benzene used in the classical Ugi MCR to react with paraformaldehyde, cyclohexanecarboxylic acid, and 2,2-dimethoxy ethylamine to yield the **MCR adduct** quantitatively. Then, a Pictet-Spengler reaction in the presence of methanesulfonic acid (MSA) and under solvent-free conditions released the desired racemic **PZQ**. This improvement positively affects not only the cost of goods, but also allows for the synthesis of many analogues, which may serve as backup drugs in case of resistance emergence.

H. Cao, H. Liu, A. Dömling *Chem. Eur. J.* **2010**, *16*, 12296-12298 - doi: 10.1002/chem.201002046

Lipase-catalyzed synthesis of antiproliferative agents

F. F. García et al. *ACS Med. Chem. Lett.* **2023,** *14*, 59-65
doi: 10.1021/acsmedchemlett.2c00425





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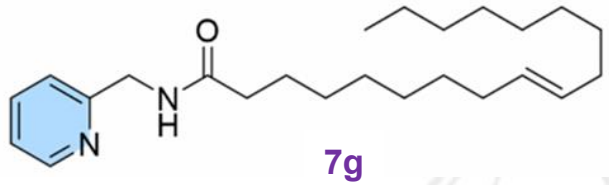
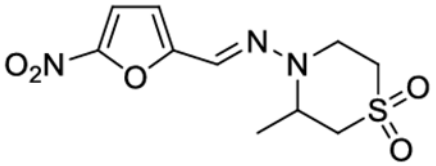
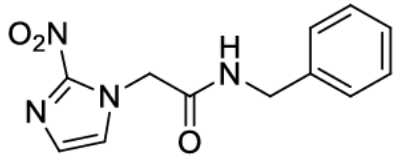


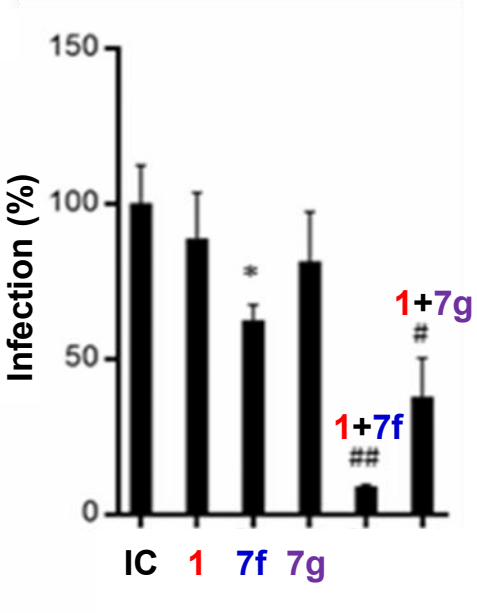
7g

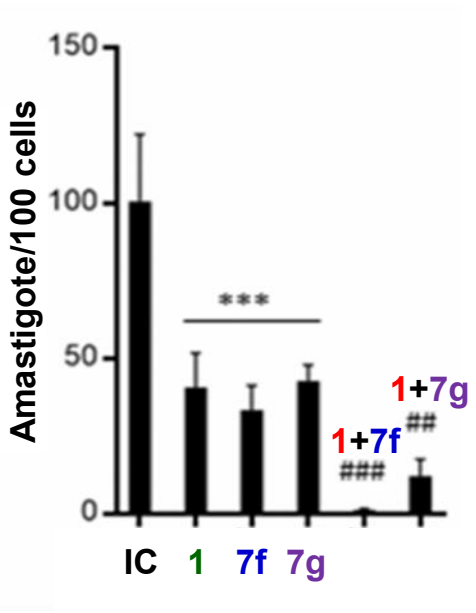


1: Nifurtimox



2: Benznidazole



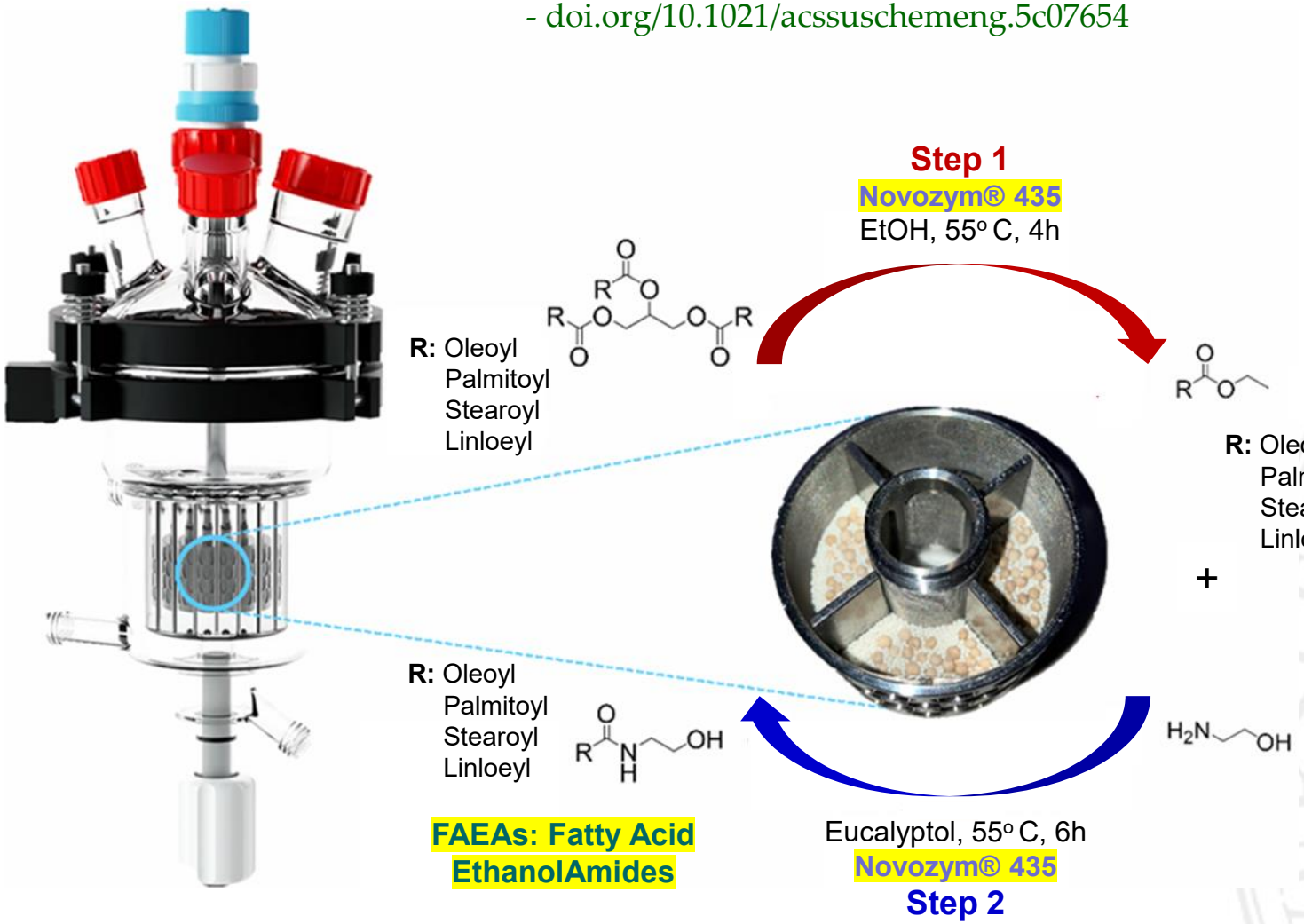


7f: IC_{50} (*T. cruzi* amastigotes) = 16.35 ± 4.41 μM
7g: IC_{50} (*T. cruzi* amastigotes) = 47.65 ± 1.39 μM

Amide derivatives of 2-methylaminopyridine with stearic acid (**7f**) and elaidic acid (**7g**), saturated and *E* isomer monounsaturated C18 fatty acids, respectively, were shown to be very effective inhibitors of *T. cruzi* intracellular proliferation exhibiting an efficacy comparable to that of **Nifurtimox 1**. In addition, a strong synergism between **Nifurtimox 1** and **7f** was observed, almost completely inhibiting the proliferation of amastigotes. **This result is of great interest since the combination of compounds would allow the use of lower concentrations of the drug**. Furthermore, since **7f** has cytotoxicity comparable to that of **1** and that **7g** is less cytotoxic than **1**, these compounds offer excellent prospects as potential drugs for chemotherapy of American trypanosomiasis.

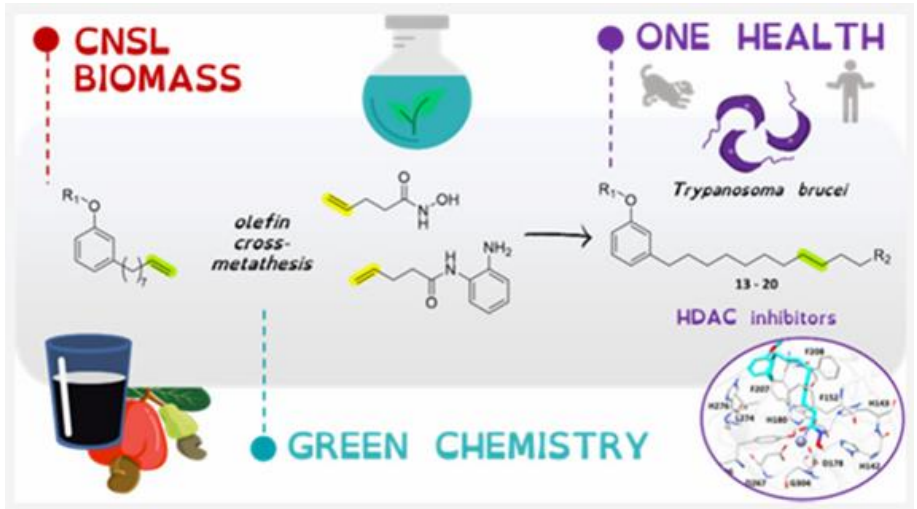
Lipase-catalyzed synthesis of bioactive fatty acid amides

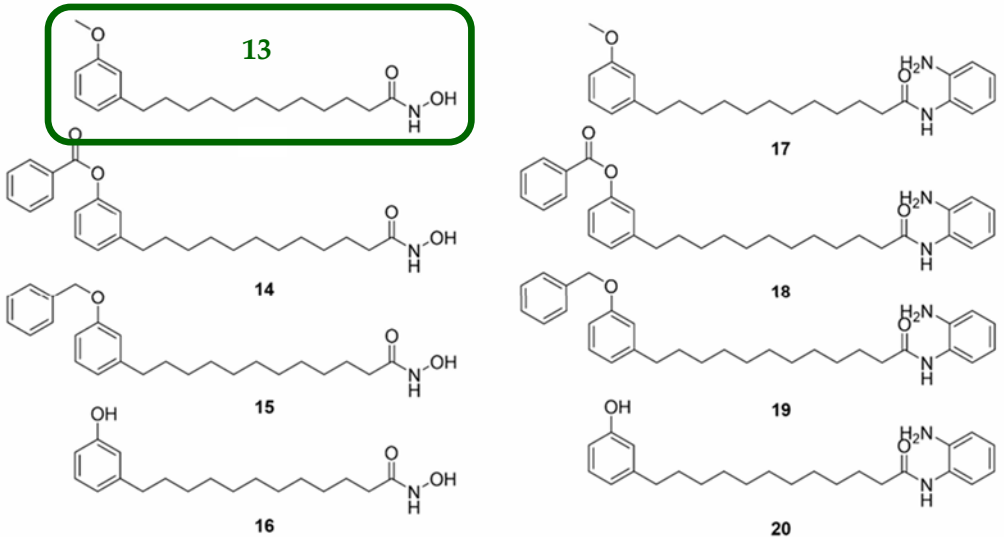
M. L. Contente et al. *ACS Sustainable Chem. Eng.* **2025**, *13*, 18214−18222
- doi.org/10.1021/acssuschemeng.5c07654

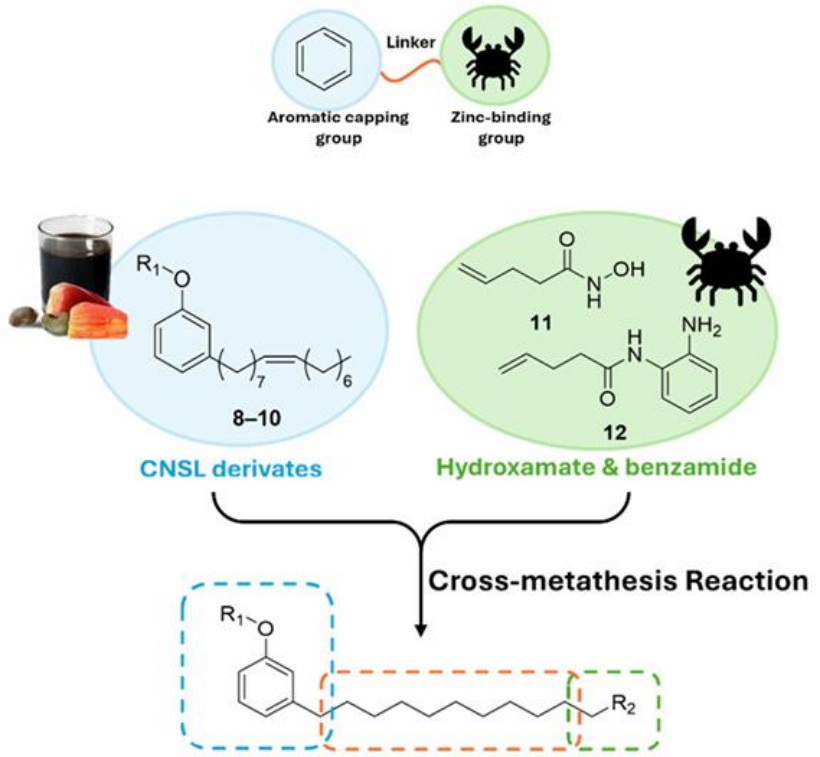


Fatty acid ethanolamides (FAEAs) are bioactive lipids involved in inflammation, pain modulation, and energy homeostasis, gaining interest in the pharmaceutical, nutraceutical, and cosmetic sectors. Starting from microbial lipids extracted from *Cutaneotrichosporon oleaginosus*, cultivated on whey permeate, a major dairy by product, a two-step enzymatic cascade was applied. Transesterification of triacylglycerols into ethyl esters followed by aminolysis with ethanolamine were catalyzed by **Novozym 435 (immobilized Candida antarctica lipase B)** in green solvents. Whereas ethanol has been used for the first step, eucalyptol proved particularly effective in aminolysis reaction with > 99% conversion and complete selectivity. **Process intensification *via* a Spin Chemrotating bed reactor led to a 5-fold reduction in reaction time (48 to 10h), a 5- to 7-times increase in space-time yield and quantitative yields for both steps**. By transforming low-value residues into bioactive molecules with nutraceutical and therapeutic potential, this platform not only enhances productivity and environmental performance, but also exemplifies the principles of circular economy and sustainable manufacturing since target compounds were obtained with clean and scalable technologies.

Benign-by-design antiparasitic compounds







An example of sustainable chemistry (see **principles #7 and #9 of Green Chemistry**) is illustrated, that allowed to synthesize the group of derivatives **13-20** through a metathesis approach. The compounds were assessed for their potential against major human and animal vector-borne parasitic diseases (VBPDs).

Compound **13** emerged as a green hit against the trypomastigote forms of *T. b. brucei*. In silico studies showed that the *T. b. brucei* HDAC (TbDAC) catalytic pocket could be occupied with a similar binding mode by both SAHA and **13**, suggesting a putative explanation for its antiparasitic mechanism of action (**13**, EC_{50}= 0.7 ± 0.2 μM).

M. Rossi, M. L. Bolognesi et al. *ACS Med. Chem. Lett.* **2024**, *15*, 1506-1515 - doi: 10.1021/acsmedchemlett.4c00242

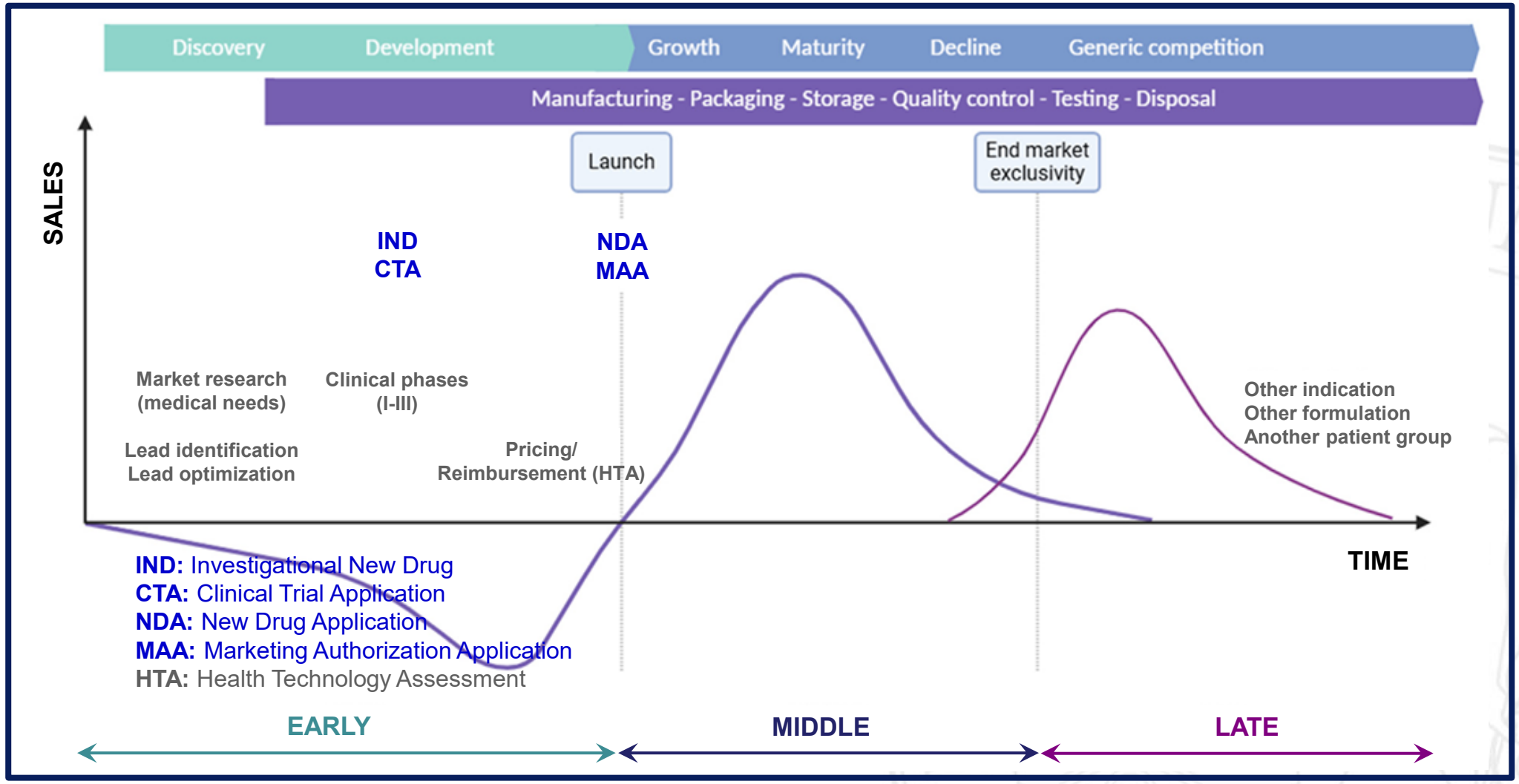
Principles for sustainability in drug discovery

1	Ecological-environmental impact (benign-by-design)
2	Medical needs
3	Green chemistry
4	Artificial intelligence and big data
5	Root cause of illness
6	Risk and decision-taking models
7	Biomarkers and bioinformatics to support precision medicine
8	Cost-effective
9	Lean discovery process
10	Responsible research and innovation

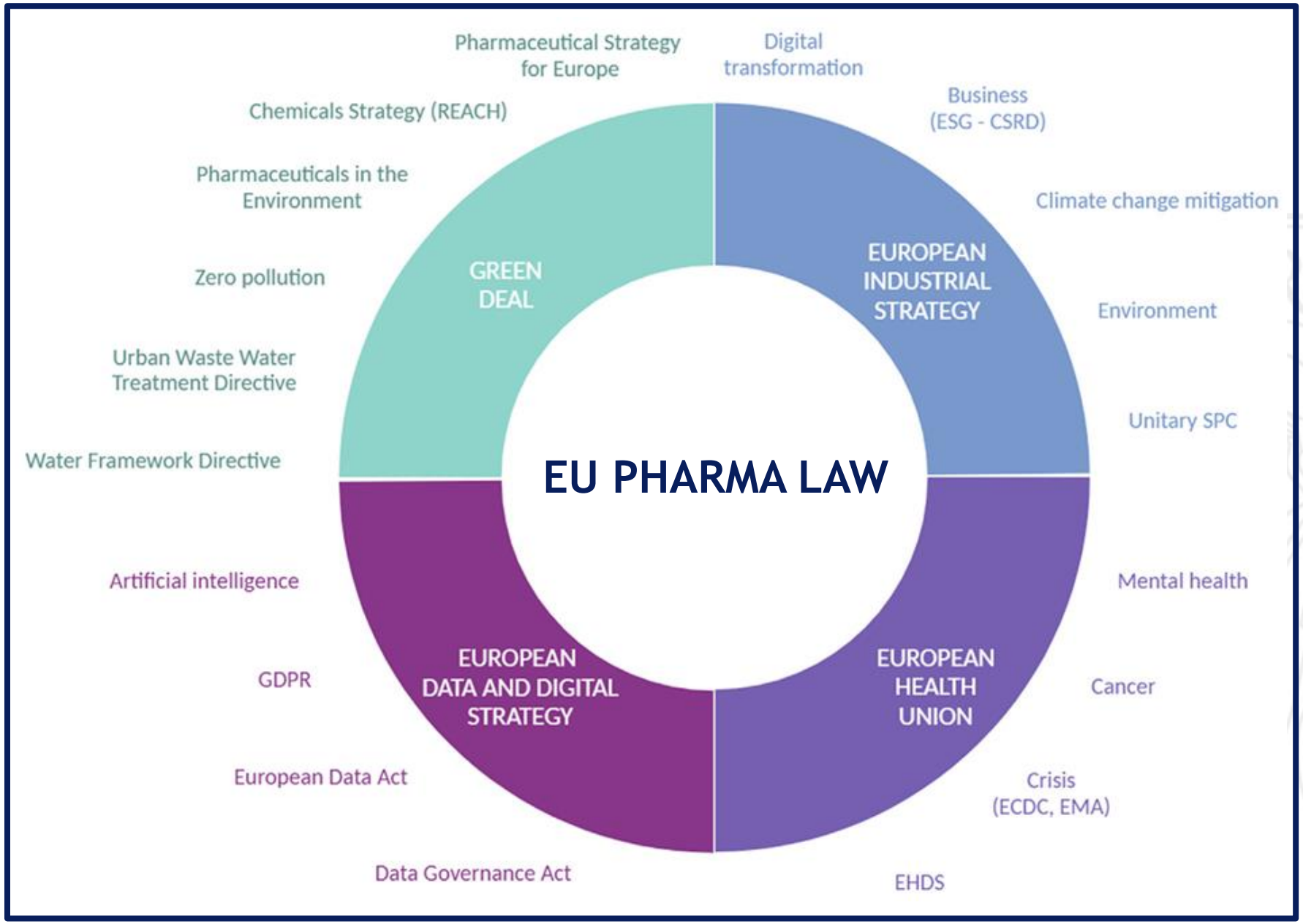
Due to the expanding and ageing world population, the importance and use of medicines is expected to increase. However, this will lead to a greater impact on the ecosystem and our health in the long term. **The concept of sustainability is rather slowly gaining traction and is currently still fragmented in the pharmaceutical field**. A consortium of researchers from five European universities therefore advocates a global, systematic approach and places the emphasis on sustainability already in early stages of drug development, i.e., drug discovery. **According to these researchers, the competent authorities, universities, research institutions and industrial organizations all need to take sustainability more into account**.

E. Wynendaele et al. *Med. Drug Disc.* **2021**, *12*, 100107 - doi: 10.1016/j.medidd.2021.100107

Main stages in the life cycle of a medicine

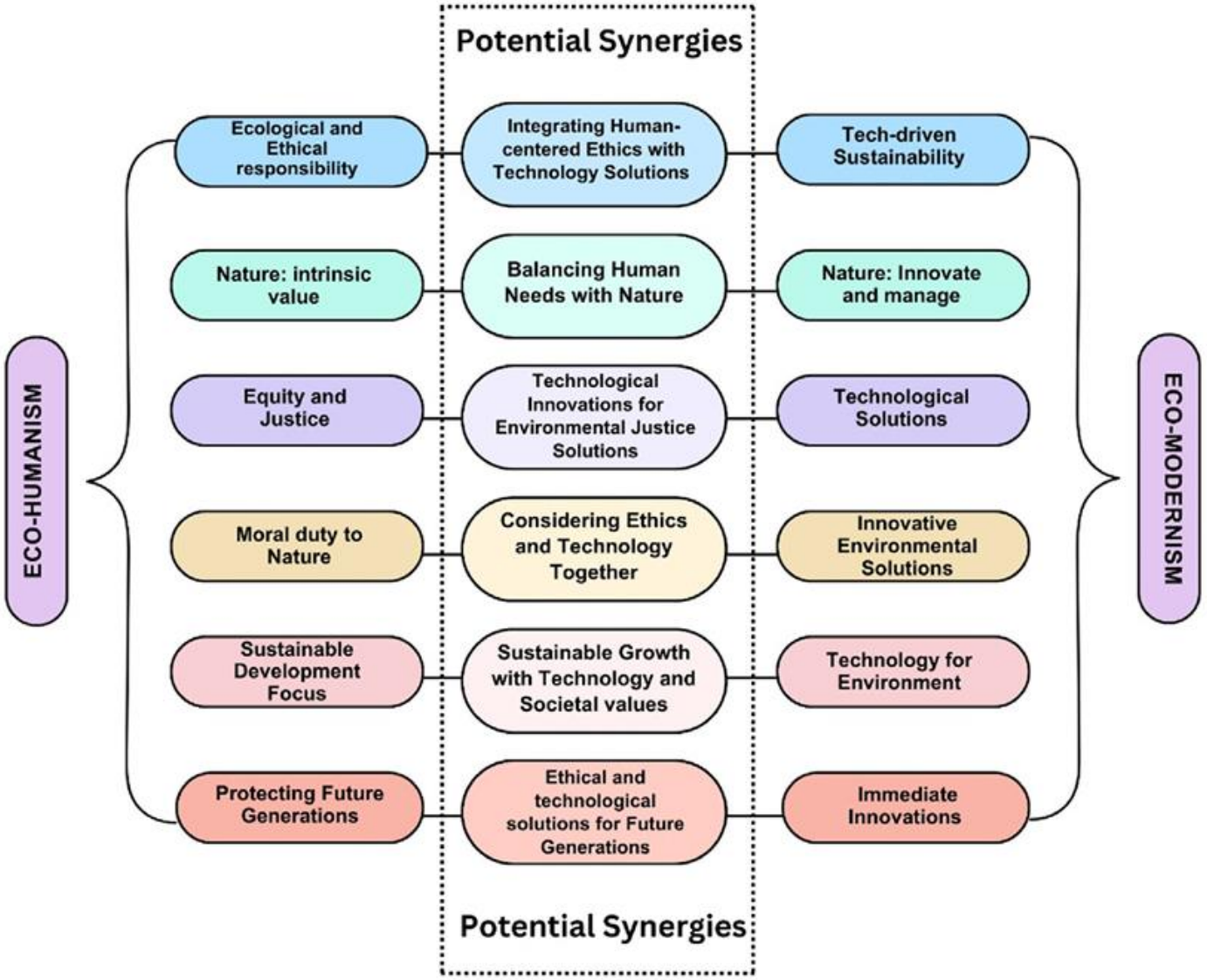


B. De Spiegeleer, E. Wynendaele *Curr. Opin. Green Sustain. Chem.* **2025**, *53*, 101028 - doi.org/10.1016/j.cogsc.2025.101028



B. De Spiegeleer, E. Wynendaele *Curr. Opin. Green Sustain. Chem.* **2025**, *53*, 101028 - doi.org/10.1016/j.cogsc.2025.101028

Intersections between eco-humanism and eco-modernism



Sustainable development requires a balanced approach between **eco-humanism** and **eco-modernism**. Each ideology has strengths that prove instrumental in finding environmental solutions. Harmonizing human-centered ethics with technological advancements can produce inclusive and effective solutions for future generations. We can work towards a future that honors both humanity and the natural world by committing to this holistic approach. Based on these premises, the human relationships with the environment and their contribution to the technological progress of green and sustainable chemistry are worthy of examination, looking at how humans, technology and nature interact. Future studies should investigate hybrid models in which eco-humanist ethics could coexist with eco-modernist technological innovations. **Investments in ethical AI, responsible resource management and circular economy models should be prioritized** to align corporate sustainability objectives with broader social and environmental problems.

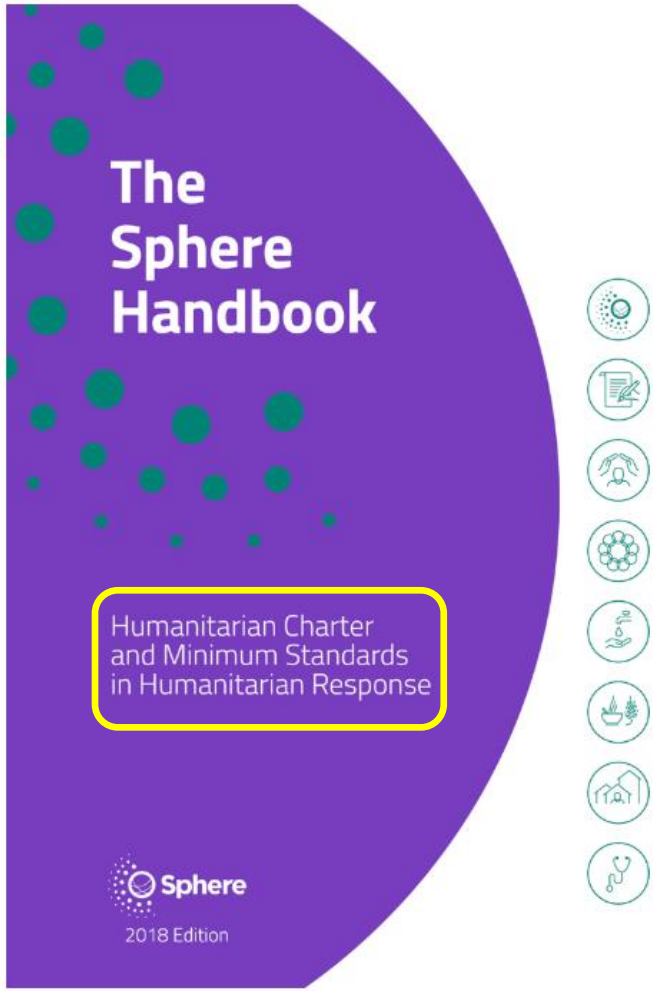
M. H. Javed et al. *Curr. Opin. Green Sustain. Chem.* **2025**, *53*, 101018

WHO global research priorities for AMR in human health

The WHO research agenda for **antimicrobial resistance (AMR) in human health has identified 40 research priorities to be addressed by the year 2030**. These priorities focus on bacterial and fungal pathogens of crucial importance in addressing AMR, **including drug-resistant pathogens causing tuberculosis**. These research priorities encompass **the entire people-centered journey, covering prevention, diagnosis, and treatment of antimicrobial-resistant infections, in addition to addressing the most relevant knowledge gaps in AMR epidemiology, burden and drivers, policies and regulations, and awareness and education.** The research priorities were identified through a multistage process, starting with a comprehensive scoping review of knowledge gaps, with expert inputs gathered through a survey and open call. The priority setting involved a rigorous modified Child Health and Nutrition Research Initiative approach, ensuring global representation and applicability of the findings. The goal of this research agenda is to encourage research and investment in the generation of evidence to better understand AMR dynamics and facilitate policy translation for reducing the burden and consequences of AMR. **The 40 priorities should invigorate research efforts, generate evidence to improve existing treatment and diagnostic approaches, bolster the implementation of evidence-based national action plans for AMR, and ensure the feasibility of AMR interventions in low-resource settings**. The research priorities reflect the most crucial knowledge gaps on AMR in human health that need to be addressed in the medium-to-long-term future (i.e., by the year 2030) and aim to guide and encourage scientific interest and investment, generate evidence-based interventions to inform global and national health policies, and ultimately counteract the rise of AMR and its associated morbidity and mortality.

S. Bertagnolio, K. Van Weezenbeeck et al. *Lancet Microbe* **2024**, *5*, 100902 - doi: 10.1016/S2666-5247(24)00134-4

https://handbook.spherestandards.org/en/sphere/#ch001



The Sphere Handbook is marking its 20th anniversary with the publication of this fourth edition. It is the result of an intense year-long mobilization of humanitarian actors around the globe and reflects two decades of experience using the standards in front-line operations, policy development and advocacy to uphold principled quality and accountability.

With a clear, rights-based framework, the Handbook builds on the legal and ethical foundations of humanitarianism with pragmatic guidance, global good practice and compiled evidence to support humanitarian staff wherever they work.

Sphere holds a unique place in the sector and in the constantly evolving humanitarian landscape. This edition was clearly informed by the **international commitments made at the first World Humanitarian Summit in 2016, the 2030 Agenda for Sustainable Development and other global initiatives.**

However, even as the policy landscape continues to evolve, we know that the immediate survival needs of people in conflict and disasters remain largely the same wherever crisis strikes. Sphere supports and contributes to global and local policy processes by recalling the fundamental necessity to provide accountable assistance to help people survive, recover and rebuild their lives with dignity.

Sphere's strength and global reach lie in the fact that it belongs to all. This sense of ownership is renewed every few years, when the **standards are reviewed and revised by the users themselves. It is a moment when we collectively restate our commitments and agree on improved action to make sure that practitioners have the best information available to them wherever they may work.** This makes Sphere a core reference and a reminder of the fundamental importance of human dignity and the right of people to participate fully in decisions that affect them.

Sphere is one of the foundations of humanitarian work. It is the starting point for new humanitarian actors and a standing reference for experienced staff, providing guidance on priority actions and where to find more detailed technical information. Our standards partners provide even more support in specific sectors beyond Sphere to help people recover and thrive.

This edition benefits from the input of thousands of people working with more than 450 organizations in at least 65 countries around the world. The global reach reflects experience from diverse contexts, extraordinary challenges and different types of actors. These standards would not exist without the unwavering commitment of so many of you. You have the thanks of our sector for your contributions during the revision and, indeed, over the past two decades.

Global Tuberculosis Report (WHO 2025)

Dr Tedros Adhanom Ghebreyesus
Director-General
World Health Organization

This is a crucial period. Even as we must strive to meet the commitments from the second United Nations high-level meeting on TB, we have entered a new period of scarcity. WHO is committed to working with donors, partners and affected countries to mitigate the impact of funding cuts, find innovative solutions, and mobilize the political and financial commitments needed to End TB.

Dr Tereza Kasaeva
Director
Department for HIV, Tuberculosis, Hepatitis and Sexually Transmitted Infections

WHO's Global tuberculosis report 2025 *shows that progress is possible, even in the face of persistent challenges. Coverage of TB prevention, diagnosis, and care continues to expand, powered by new WHO-recommended tools, from AI-driven screening and rapid diagnostics to shorter, more effective treatments to save lives. WHO is leading the charge, providing technical expertise and driving innovation, to ensure equitable access to these innovations for everyone, everywhere.*

ISBN 978-92-4-011692-4 (*electronic version*)
ISBN 978-92-4-011693-1 (*print version*)

https://www.who.int/teams/global-programme-on-tuberculosis-and-lung-health/tb-reports/global-tuberculosis-report-2025/tb-research-and-innovation

Present key points of TC therapeutic intervention

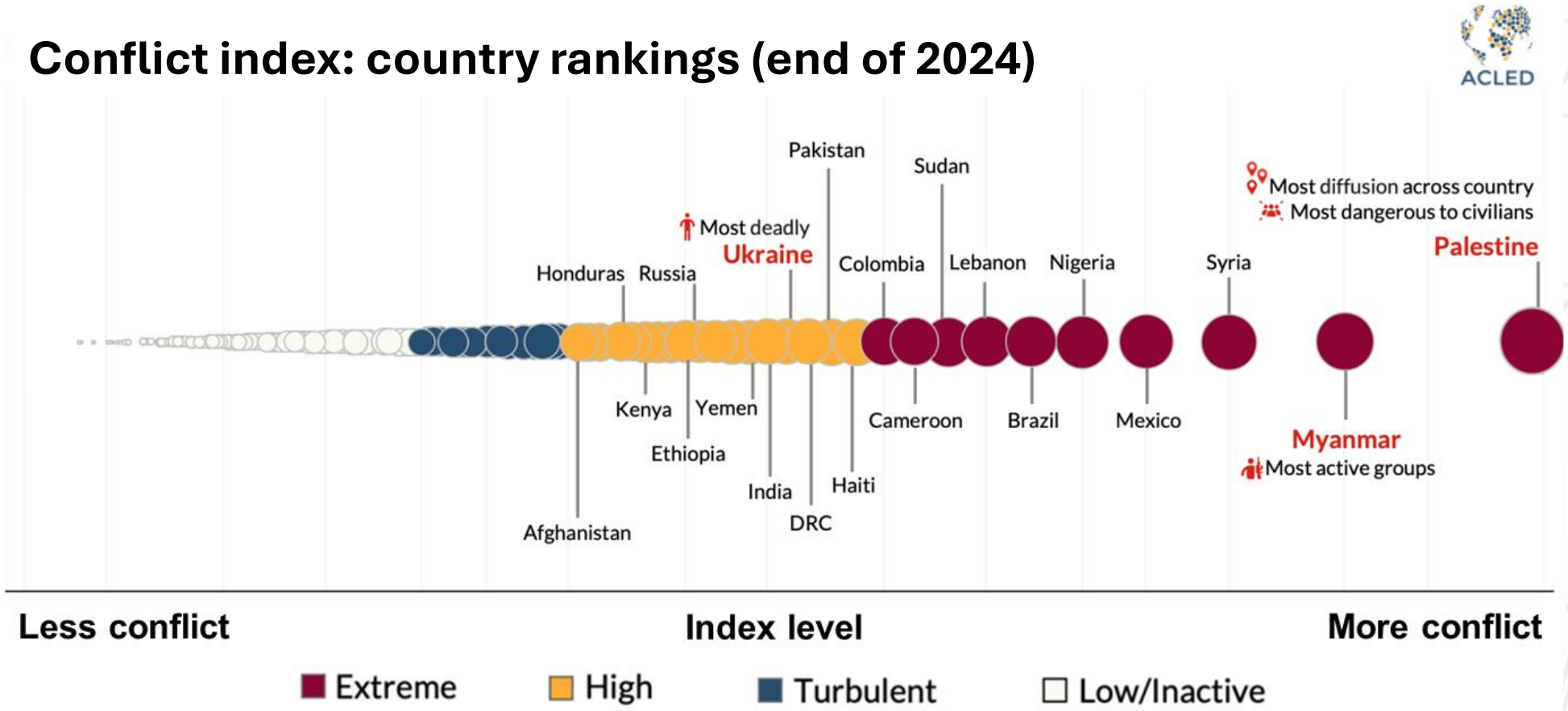
- **New drugs and repurposed agents** have transformed the treatment landscape for both drug-susceptible and drug-resistant tuberculosis.
- Recent clinical trials have successfully demonstrated the feasibility of **treatment shortening for drug-susceptible tuberculosis (TB)**, **and improved outcomes for multidrug resistant TB**, with several regimens now adopted within WHO guidelines.
- Emerging **agents are revitalizing the TB drug pipeline** and may contribute to future regimen simplification and expanded treatment options.
- Ongoing challenges include optimizing dosing strategies, managing drug-related toxicities (notably QT prolongation and linezolid-associated adverse effects), and **expanding access to novel regimens in high burden, resource-limited settings**.

Currently, the only licensed tuberculosis vaccine, Bacillus Calmette-Guérin, offers some protection for young children from severe forms of tuberculosis but provides only partial protection for adolescents and adults, who account for the majority of *M. tuberculosis* transmission. The promising vaccine candidates now in advanced clinical trials could shift the trajectory of the tuberculosis epidemic if, once approved, they will be safe and effective and will be delivered promptly and equitably at scale.

G. B. Cross *Curr. Opin. Infect. Dis.* **2025**, *38*, 512-521 - doi: 10.1097/QCO.0000000000001156

“Terza guerra mondiale combattuta a pezzi”

ACLED (Armed Conflict Location & Event Data) is an independent, impartial global monitor that collects, analyses, and maps data on conflict and protest. **ACLED provides detailed information to help identify, understand, and track patterns and trends in conflict and crisis situations around the world.**



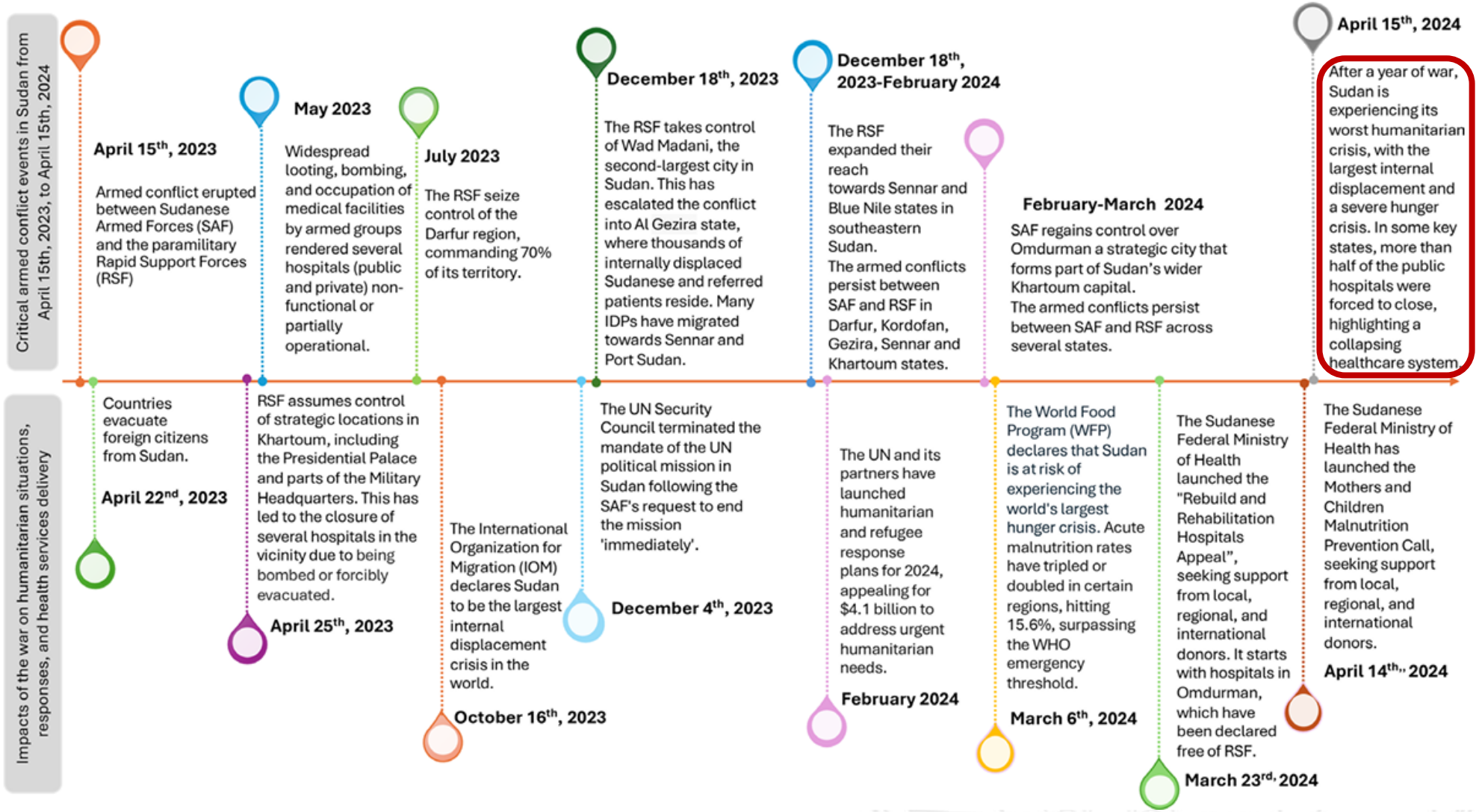
Sudan's health system amidst armed conflict

The ongoing armed conflict in Sudan has resulted in a deepening humanitarian crisis with significant **implications for the country's health system**, threatening its collapse thus causing the destruction, disruption, and disastrous consequences inflicted upon Sudan's health system.

In addition, the conflict has created a severe humanitarian crisis, displaced millions and crippled the healthcare system, leading to a **resurgence of infectious diseases such as malaria, cholera, and measles.** **The conflict has led to the severe compromise of healthcare facilities, with only one-third of hospitals in conflict zones operational.** Artillery attacks, forced militarization, power outages, and shortages of medical supplies and personnel have further crippled the health system. The exodus of health workers and escalating violence have exacerbated the crisis. Disrupted service delivery has resulted in the interruption of essential health services, including obstetric care, emergency services, and dialysis. Financial losses to the health system are estimated at $ 700 million, impacting an already underfunded sector. **We identify that in addition to restoration of peace and mobilization of urgent aid, immediate prioritization of the reconstruction of the health system is crucial to mitigate the long-term consequences of the war.** Rebuilding a resilient health system is *sine qua non* for Sudan's progress towards universal health.

E. Dafallah et al. *Confl. Health* **2023**, *17*, 43 - doi: 10.1186/s13031-023-00542-9

One-year timeline events in Sudan and their consequences



A. Elamin, S. Abdullah et al. *BMJ Glob. Health* **2024**, *9*, e016406 - doi:10.1136/bmjgh-2024-016406

The Sudan conflict and its impact on infectious diseases

The civil war (April 2023) has catalyzed the spread of infectious diseases in displaced populations

Overcrowded refugee camps with poor sanitation and limited resources have fueled outbreaks, exacerbated by disrupted immunization programs and seasonal rains. **Malaria** is spreading rapidly due to inadequate mosquito control, while **Cholera** outbreaks, linked to unsafe water and poor sanitation, have overwhelmed health facilities. **Measles** outbreaks are escalating due to low vaccination coverage, leaving vulnerable populations unprotected. The regional and global impacts are significant, as displaced populations crossing borders risk spreading diseases.

Addressing this crisis requires urgent international collaboration to a) restore healthcare services, b) improve living conditions in camps, c) resume vaccination programs, d) strengthen regional disease surveillance. Timely, coordinated responses are essential to mitigate health risks and protect global health security. **This crisis highlights the critical need for sustained efforts to safeguard public health in conflict zones.**

I. N. Hassan et al. *Int. J. Infect. Dis.* **2025**, *151*, 107326 - doi: 10.1016/j.ijid.2024.107326

Solidarity with conflict-affected communities

- Wars and armed conflicts have direct and indirect effects on public health including increased susceptibility to outbreaks, sexual- and gender-based violence, and maternal and child health problems, among others.
- Indirect health impacts of war, which often occur more frequently than the direct impacts, are primarily due to damage to civilian infrastructure and forced displacement of populations.
- **The tragedies and challenges of public health, during wars and armed conflicts are often neglected and are not getting adequate attention from the international community**
- The health workforce particularly in Africa is not well prepared and capacitated to respond to public health emergencies due to wars and armed conflicts.
- **Indeed, health professionals can play a major role in providing medical care to victims of war, documenting and performing research on the health impacts of war, educating and raising awareness, and advocating for policies and programs to prevent war and build sustainable peace**
- The global health community should therefore proactively take part in preventing conflicts and respond to public health emergencies during wars and armed conflicts.

J. Kaseya et al. *BMJ Glob. Health* **2024**, *9*, e015371 - doi: 10.1136/bmjgh-2024-015371
B. S. Levy *Front. Public Health* **2025**, *13*, 1547784 - doi: 103389/fpubh.2025.1547784

Tra le molteplici sfide di Medici Senza Frontiere …..

- **Prezzi elevati causati dai monopoli delle case farmaceutiche:** molti farmaci sono troppo costosi per consentire ai pazienti o ai governi dei Paesi in via di sviluppo di poterseli permettere. Un motivo è il monopolio ingiustificato dei brevetti, che spinge verso l'alto il prezzo dei farmaci e soffoca la concorrenza.

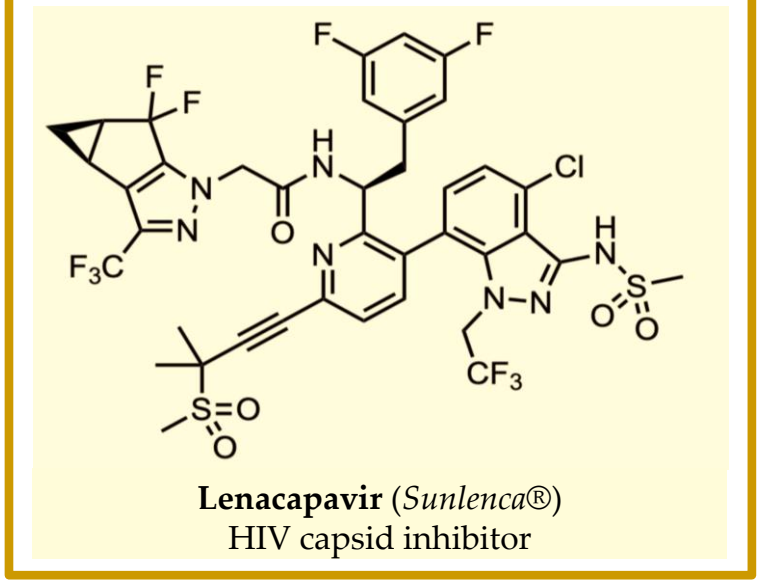
- **Ricerca e Sviluppo non hanno come obiettivo i bisogni medici:** oggi la ricerca e lo sviluppo non sono orientati verso i bisogni delle persone nei Paesi a basse risorse. I farmaci e i test diagnostici vengono sviluppati sulla base del mercato potenziale piuttosto che sui bisogni dei pazienti. **Solo l'1% dei farmaci messi sul mercato negli ultimi 30 anni sono stati sviluppati per malattie tropicali oppure per la tubercolosi**. Eppure i farmaci esistenti per queste malattie sono spesso tossici e stanno diventando sempre meno efficaci a causa delle resistenze.

- **Nuovi modelli di assistenza più semplici:** anche quando diventano disponibili farmaci e test più efficaci, ci sono altri ostacoli da superare. Ad esempio, un problema chiave che rallenta l'ulteriore introduzione del trattamento dell'HIV è la carenza cronica di personale sanitario, in particolare nell'Africa meridionale. MSF lavora per fornire ricerche sul campo che possano supportare lo sviluppo di modelli di assistenza più semplificati per il trattamento, dei quali beneficerebbero sia i pazienti che gli operatori sanitari.

https://www.medicisenzafrontiere.it/cosa-facciamo/accesso-ai-farmaci/

MEDECINS SANS FRONTIERES
MEDICI SENZA FRONTIERE

Towards equity in HIV medication accessibility



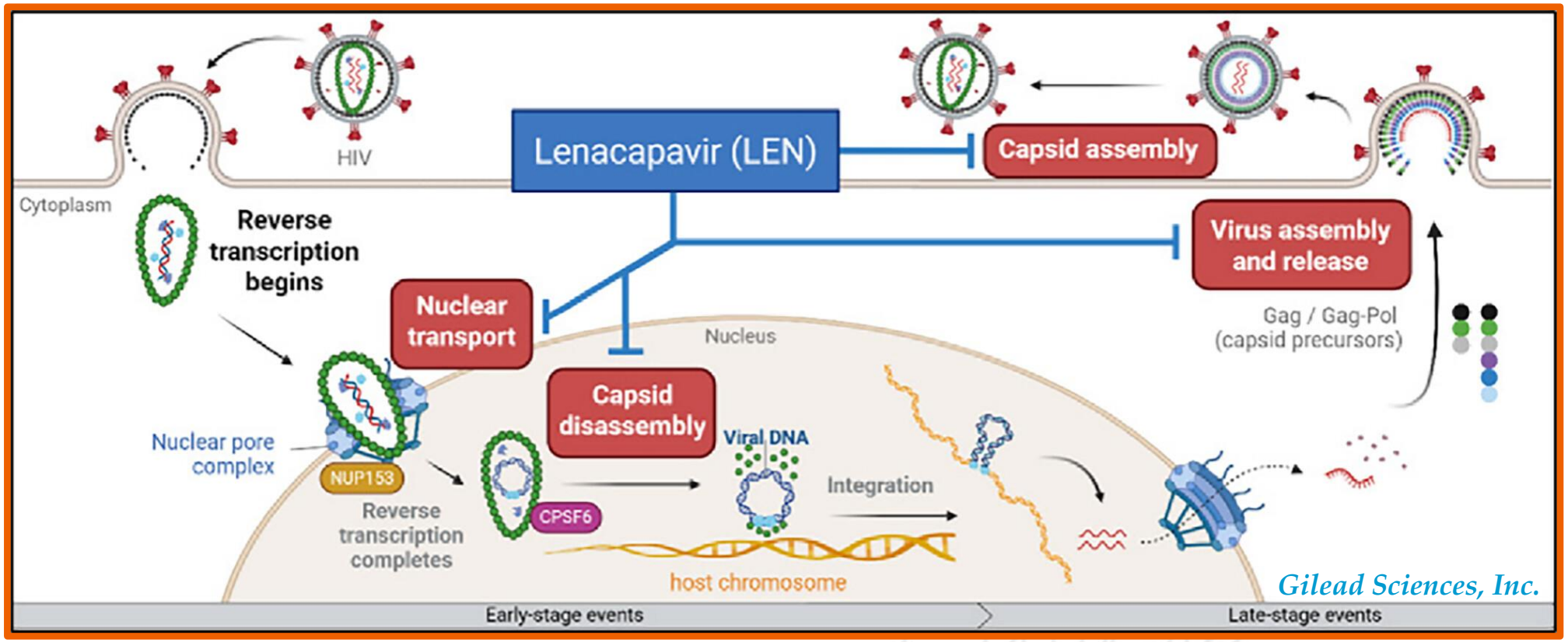
Lenacapavir (*Sunlenca*®)
HIV capsid inhibitor

The World Health Organization recognized that the trials provide "compelling evidence for the potential of **Lenacapavir** to transform HIV prevention globally, across diverse populations." Of course, such a transformation will only be possible if **Lenacapavir (a twice-yearly injectable)** becomes readily available and affordable in all countries, especially those where HIV incidence is highest. Since the trial results were made public, all eyes have been on **Gilead Sciences Inc.** - the company that makes and owns the patent on Lenacapavir - to see which steps it would take to support equitable global access. In the US, **Gilead charges around US$ 44000** per patient per year for Lenacapavir treatment, a price that is unaffordable to low- and middle-income countries. In stark contrast, **the generically manufactured drug is estimated to cost US$ 40-100** per person per year. When the Purpose-1 trial results were announced, Gilead promised to "provide a public statement regarding its planned access approach for high incidence, resource limited countries, which are primarily low and lower middle-income countries".

October 24th, 2025. South Africa has taken a decisive step towards stopping new HIV infections. The South African National AIDS Council (SANAC) and the National Department of Health, in collaboration with **UNAIDS**, convened a two-day national meeting on access to a new, and potentially groundbreaking medicine (Lenacapavir) which is set to be rolled out in South Africa in early 2026. Moreover, collaboration is going to transform affordability, since recent landmark agreements will make **generic Lenacapavir available at a cost of US$ 40** a year in 120 low- and middle-income countries starting in 2027. ***"Sustainability isn't imported, it's built"***, a concept that underlines the importance of local manufacturing and data-driven delivery.

G. Yamey et al. *BMJ* **2024**, *387*, q2254 - doi: 10.1136/bmj.q2254
https://www.unaids.org/en/resources/presscentre/featurestories/2025/october/20251024_south-africa

Lenacapavir inhibits multiple steps during HIV-1 replication



Most anti-HIV-1 drugs inhibit one stage of viral replication. In contrast, **Lenacapavir is a multistage inhibitor**, and this unusual feature may contribute to its exceptional potency. The initial biochemical screen targeted *in vitro* capsid assembly, but a further antiviral assay was able to capture all steps in the HIV lifecycle. Beyond proper capsid assembly, the authors understood that, by evaluating potency in the initial antiviral assay, they were assessing the cumulative activity of up to three steps.

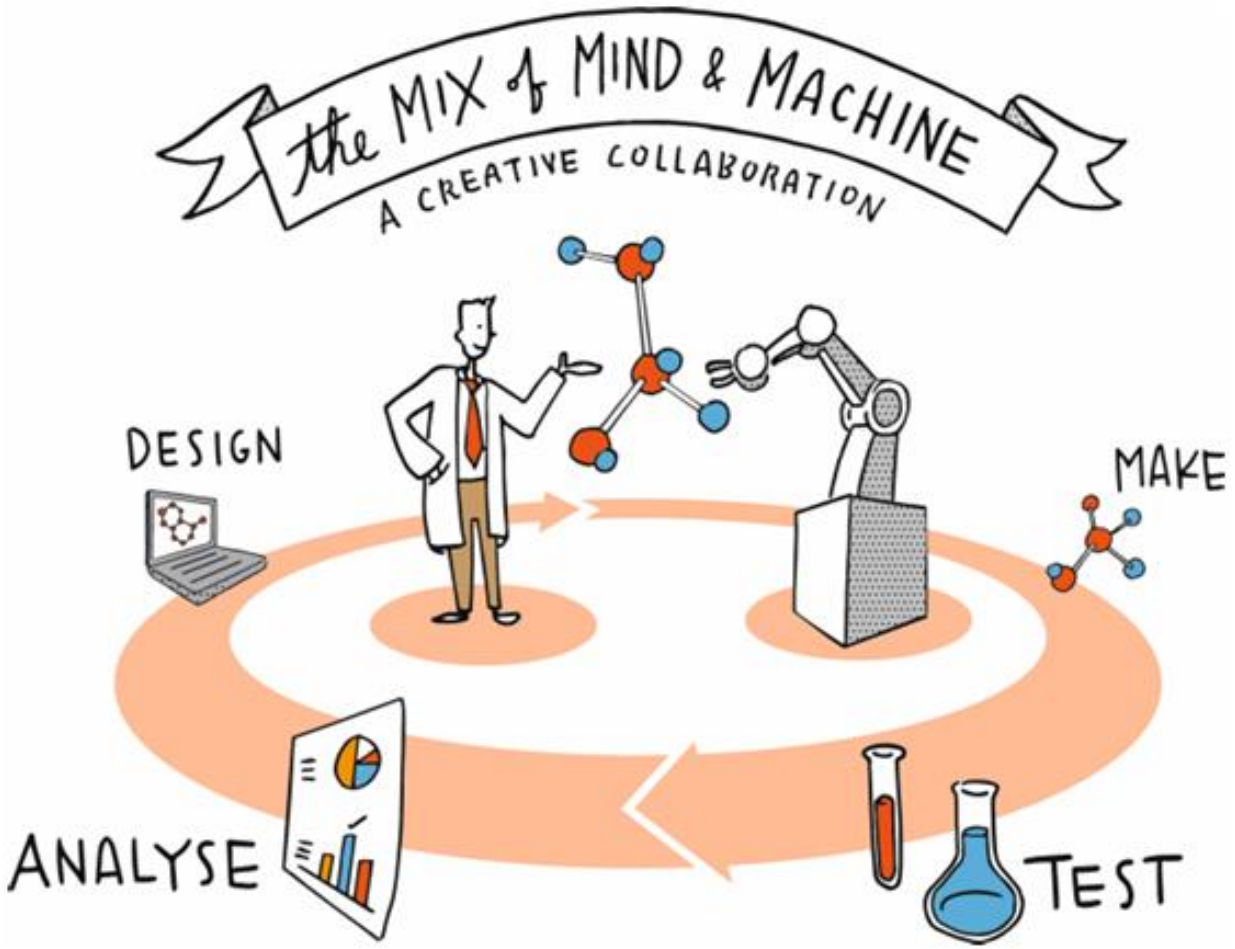
E. Canales, J. O. Link et al. *J. Med. Chem.* **2025**, *68*, 21072-21094 - doi: 10.1021/acs.jmedchem.5c01625

Lenacapavir production in South Africa (05.03.2026)

- **Lenacapavir**, a long-acting HIV prevention drug, could soon be produced in South Africa as part of a major effort to strengthen regional manufacturing and expand access to **one of the most promising new tools in HIV prevention**.
- The South African government has announced plans to pursue an agreement with Gilead Sciences that could enable local production of Lenacapavir. As part of this process, authorities have issued a call for expressions of interest **to identify pharmaceutical manufacturers within the country capable of producing the drug to international quality standards**.
- If successful, a South African manufacturer could become the seventh global licensee for generic Lenacapavir. In October 2025, Gilead granted voluntary licences to six manufacturers in Egypt, India, and Pakistan, allowing them to produce the medicine for distribution across 120 low- and middle-income countries. Establishing an additional manufacturing site in South Africa could diversify global supply **and bring production closer to regions with the highest HIV burden**.
- Regional health leaders have emphasized that local manufacturing of medicines such as Lenacapavir could play **a critical role in addressing long-standing inequities in access to life-saving treatments**. By producing innovative HIV prevention tools within Africa, countries may be better positioned to respond to regional health priorities while strengthening pharmaceutical capacity. If the initiative succeeds, it could represent an important milestone in efforts to improve access to next-generation HIV prevention technologies and support broader ambitions to end HIV as a public health threat.

https://www.emjreviews.com/microbiology-infectious-diseases/news/south-africa-moves-to-produce-lenacapavir-locally/

Integrating mind and machine in "drug discovery"



Artificial intelligence (AI) tools are increasingly being applied in drug discovery. While some protagonists point to vast opportunities potentially offered by such tools, others remain skeptical, waiting for a clear impact to be shown in drug discovery projects. The reality is probably somewhere in-between these extremes, yet AI is providing new challenges not only for the scientists involved but also for the biopharma industry and its established processes for discovering and developing new medicines. **AI and laboratory automation could augment human decision-making, chemical synthesis and biological testing in design make-test-analyze cycles involved in drug discovery**. It is anticipated that this collaborative intelligence emerging from the combination of "mind and machine" will enable better decision-making. A key opportunity to encourage the uptake of AI approaches is to identify areas in which AI can augment and support (rather than replace) chemists and drug designers to make their processes more productive, while concomitantly increasing the quality of the data and the acceptance of AI.

P. Schneider, G. Schneider et al. *Nat. Rev. Drug Discov.* **2020**, *19*, 353-364 - doi: 10.1038/s41573-019-0050-3

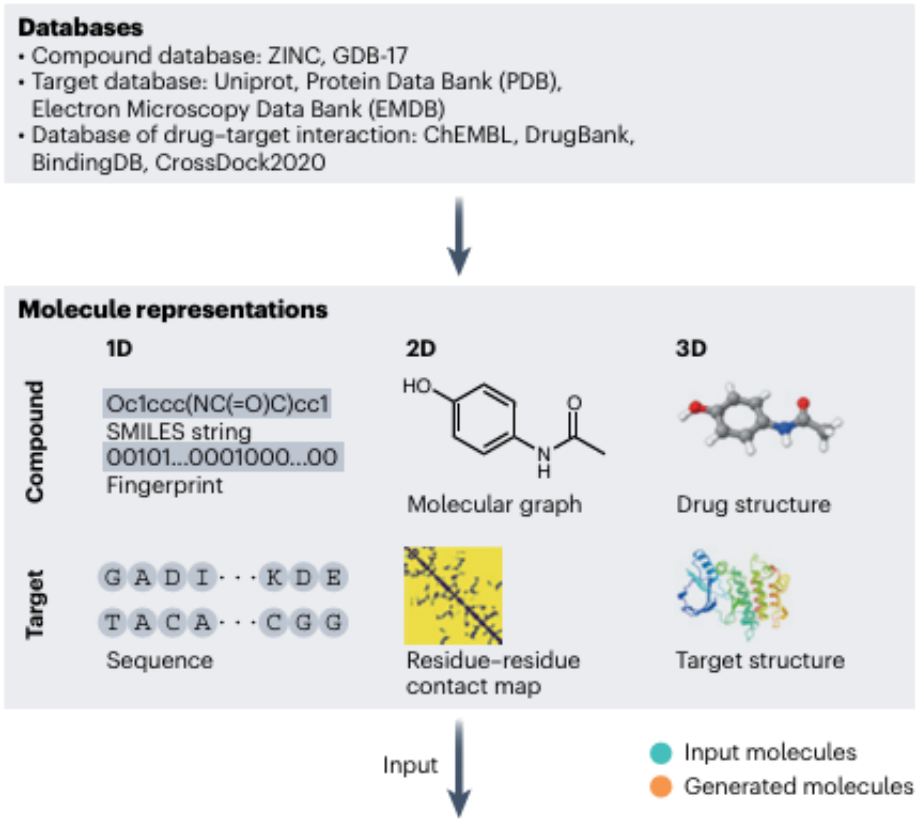
Has AI reshaped "drug discovery" or is there a long way to go?

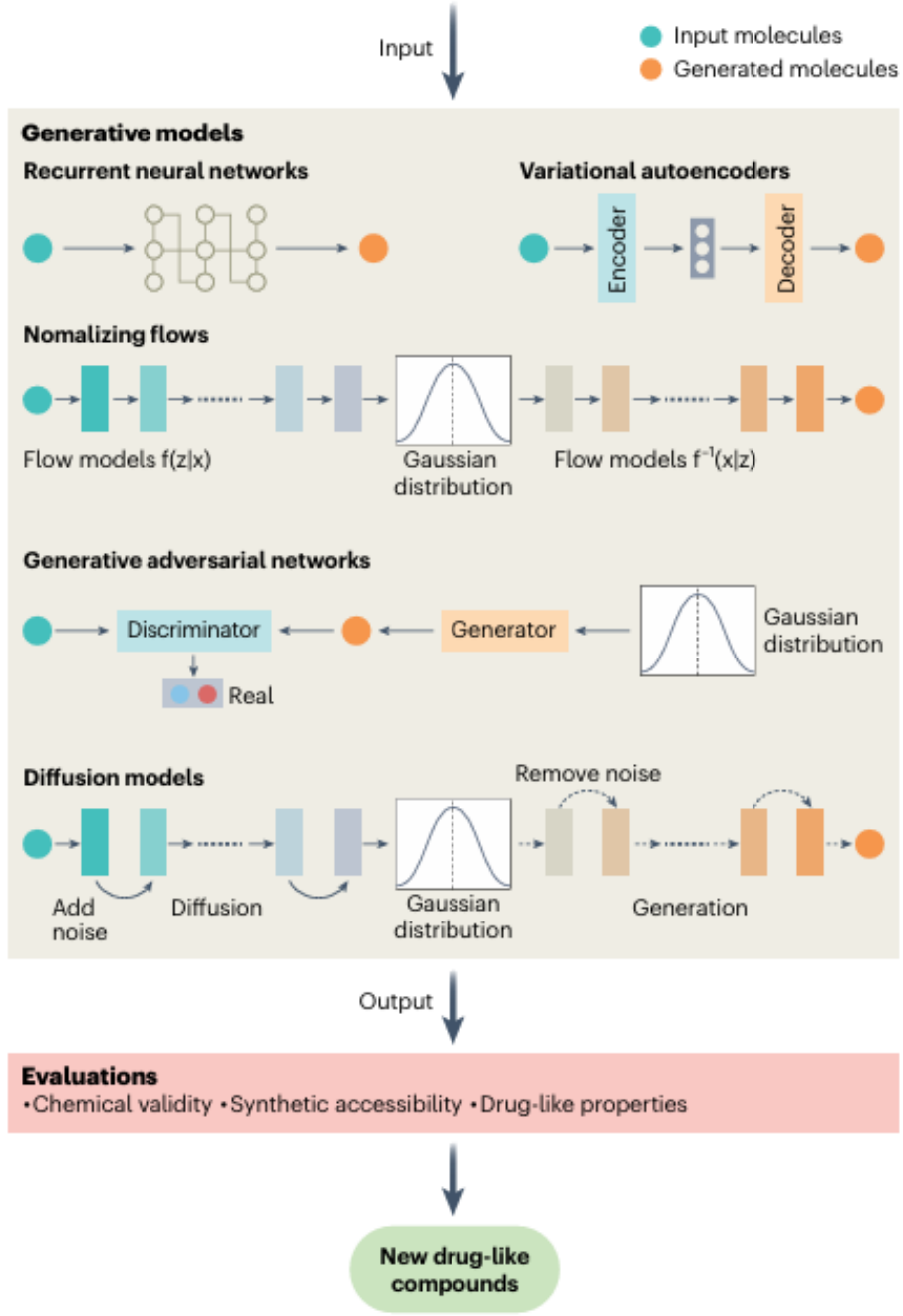
- ✓ The conventional drug discovery pipeline is labor-intensive, time-consuming, and costly, involving target identification, hit discovery, lead optimization, and extensive preclinical and clinical evaluation. To overcome these limitations, **AI has emerged as a transformative tool in drug discovery, gaining widespread adoption in the pharmaceutical industry during the 2010s** due to advances in computing power, data availability, and deep learning.
- ✓ AI-based approaches, including molecular property prediction, protein structure modelling, natural language processing, and ADME/Tox prediction, have enhanced efficiency, reduced costs, and improved decision-making across multiple stages of drug development. **Several AI-guided molecules have progressed into clinical trials, with encouraging early-phase success rates, highlighting the potential of AI to accelerate innovation**.
- ✓ However, despite more than a decade of intensive research, **no AI-only originated drug has yet achieved full regulatory approval, reflecting persistent challenges** consistent with Eroom's law. Key limitations include poor data quality and accessibility, lack of model interpretability, gaps between computational predictions and chemical feasibility, and the inherent complexity of biological systems that limit translational success. Furthermore, AI-driven hypothesis generation does not replace the need for scientific reasoning and experimental validation. Overall, **while AI has significantly accelerated early drug discovery stages, it remains a supportive tool rather than a standalone solution**, underscoring the continued need for human expertise and experimental research.

K. S. Harini, D. Ezhilarasan *Drug Dev. Res.* **2026**, *87*, e70257 - doi: 10.1002/ddr.70257

AI-driven molecular generation

Molecular representations are derived from diverse compound, target and drug-target interaction databases and are used to train **AI models** such as generative adversarial networks, recurrent neural networks variational autoencoders, normalizing flows, and diffusion models. These models generate **novel molecules**, which are subsequently assessed for chemical validity, synthetic accessibility and drug-like properties, which ultimately enables the **identification of novel drug-like compounds**.





K. Zhang, X. Yang et al. *Nat. Med.* **2024**, *31*, 45-59 - doi: 10.1038/s41591-024-03434-46

AI applications in the "drug development" pipeline

Pipeline of drug development	Target identification	Drug discovery	Preclinical studies (animal)	Clinical trials (human)	Approval/launch	Post-market surveillance
Main tasks	New target 	Discovery of active compounds (hits/leads) Lead optimization for drug candidates CMC	Biomarker discovery DMPK evaluation Safety evaluation Pharmacodynamics evaluation Medication scheme		New drug 	Evaluating or monitoring - Therapeutic efficacy - Side effect - Drug stability - Medication plan Failure analysis Counterfeit analysis
AI-powered applications	• Multi-omics data analysis • Biological network construction and analysis • Literature and real-word data mining • Knowledge graph construction • Target validation	• Virtual screening • Prediction of ligand–receptor interaction • Molecular generation • ADMET prediction • Lead optimization • Synthesis route planning • Automated synthesis	• Diagnostic, predictive and prognostic biomarkers • Pharmacometrics property prediction • Clinical trial success prediction • Prediction of drug side effects • Digital Twins in clinical trial design • Drug repurposing • Regulatory approval support		• Personalized efficacy assessment • Personalizing patient care • Early detection of safety issues • Automated adverse event reporting • Continuous safety monitoring • Drug benefit–risk assessment • Enhancing pharmacovigilance compliance	

K. Zhang, X. Yang et al. *Nat. Med.* **2024**, *31*, 45-59 - doi: 10.1038/s41591-024-03434-4

Widescale adoption and application of AI in "healthcare"

Timeline	Connected/ augmented care	Precision diagnostics	Precision therapeutics	Precision Medicine	Summary
Short term: 0–5 years	Internet of things in healthcare Virtual assistants Augmented telehealth Personalised mental health support	Precision imaging (eg diabetic retinopathy and radiotherapy planning)	CRISPR (increasing use)	Digital and AI enabled research hospitals[30]	AI automates time consuming, high-volume repetitive tasks, especially within precision imaging
Medium-term: 5–10 years	Ambient intelligence in healthcare	Large-scale adoption and scale-up of precision imaging	Synthetic biology Immunomics	Customisation of healthcare Robotic assisted therapies	AI uses multi-modal datasets to drive precision therapeutics
Long term: >10 years	Autonomous virtual health assistants, delivering predictive and anticipatory care Networked and connected care organisations (single digital infrastructure)	Holographic and hybrid imaging Holomics (integrated genomic/radiomic/ proteomic/clinical/ immunohistochemical data)	Genomics medicine AI driven drug discovery	New curative treatments AI empowered healthcare professionals (eg digital twins)	AI enables healthcare systems to achieve a state of precision medicine through AI-augmented healthcare and connected care

J. Bajva, U. Munir et al. *Future Healthc. J.* **2021**, *8*, e188-e194 - doi: 10.7861/fhj.2021-0095

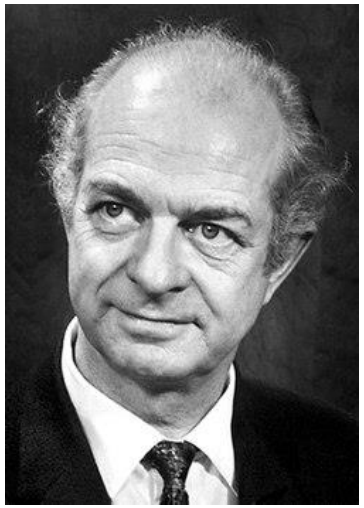
IA e salute (dossier AIFA, marzo 2026 - pag. 16)

Il contributo dell'IA ridefinisce l'universo salute in **cinque pilastri fondamentali**:

1. **Accelerazione della scoperta scientifica:** grazie agli algoritmi, oggi è possibile identificare molecole, target terapeutici e combinazioni farmacologiche in tempi e con costi drasticamente inferiori.
2. **Personalizzazione delle cure:** ogni paziente è unico e l'IA consente di profilare geneticamente e clinicamente ogni individuo per offrire la terapia più efficace e sicura.
3. **Ottimizzazione della sperimentazione clinica:** dal reclutamento alla definizione dei protocolli, fino alla gestione del rischio e del monitoraggio, i trial clinici diventano più veloci, mirati e accessibili.
4. **Supporto ai professionisti sanitari:** strumenti intelligenti aiutano medici, ricercatori e operatori sanitari a prendere decisioni migliori, riducendo errori e migliorando l'organizzazione del lavoro.
5. **Coinvolgimento dei cittadini:** chatbot, assistenti virtuali e sistemi informativi intelligenti rendono i pazienti più informati, attivi e protagonisti della propria salute.

https://www.aifa.gov.it/documents/20142/3346516/Dossier_stampa_IA_e_Salute.pdf

Linus Pauling (1901-1994), uno straordinario chimico e pacifista



Nobel per la Chimica (1954)
Nobel per la Pace (1962)

Si dedicò soprattutto allo studio della chimica quantistica e della fisica ed è considerato il **«padre del legame chimico».** Nell'ultima parte degli anni '20, Pauling iniziò a pubblicare una serie di lavori sulla natura dei legami chimici, che lo hanno condotto alla pubblicazione del suo famoso libro intitolato *The Nature of the Chemical Bond*, pubblicato nel 1939. Il Premio Nobel per la Chimica del 1954 fu un riconoscimento **"..... alle sue ricerche riguardanti la natura dei legami chimici e la comprensione della struttura di sostanze complesse".** Nel 1953, Pauling e Corey proposero un'interpretazione della struttura ripiegata del DNA (α-eliche e β-foglietti) come modelli geometrici della struttura secondaria della proteina.

Oltre ad essere stato fra le menti chimiche più brillanti del XX secolo, Pauling fu un attivista politico e un pacifista molto impegnato. Nel 1946, dopo la seconda guerra mondiale, spinto anche dall'impegno politico della moglie, aderì all'**Emergency Committee of Atomic Scientists**, diretto da Albert Einstein. La sua missione era quella d'informare la popolazione riguardo ai rilevanti pericoli associati allo sviluppo delle armi nucleari.

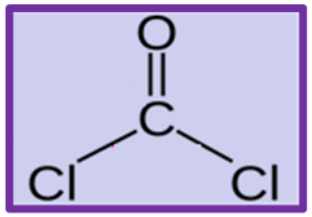
A causa delle sue convinzioni politiche, **durante il periodo del maccartismo**, il Dipartimento di Stato Statunitense gli negò il passaporto (1952) quando fu invitato a una conferenza scientifica a Londra. Il passaporto gli fu restituito nel 1954, poco prima della cerimonia nel corso della quale gli fu assegnato il Nobel per la Chimica. Otto anni dopo, premiando il suo intenso attivismo politico, il comitato del Premio Nobel gli assegnò il Nobel per la Pace, con la motivazione che **"..... sin dal 1946, Pauling si è prodigato incessantemente non solo contro i test delle armi nucleari, non solo contro l'estensione di tali armamenti, non solo contro il loro uso, ma contro tutte le guerre come mezzo di soluzione di conflitti internazionali".**

.eco
l'educazione sostenibile

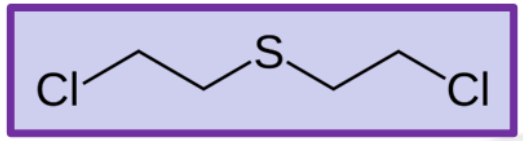
Giorgio Nebbia, il 10 dicembre 2012, scriveva su .eco l'articolo «Etica e scienza: il due volte Nobel Linus Pauling», dedicato a Linus Pauling, l'unico vincitore di due premi Nobel così differenti. L'esempio di un chimico, che ha coniugato l'eccellenza nella ricerca scientifica con l'impegno civile e con la testimonianza personale in favore della pace, del disarmo e del progresso.

Backup slides

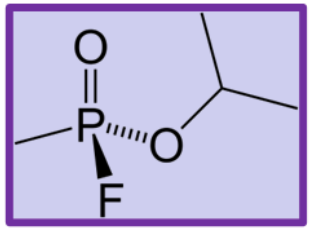
Armi chimiche: il lato oscuro della scienza



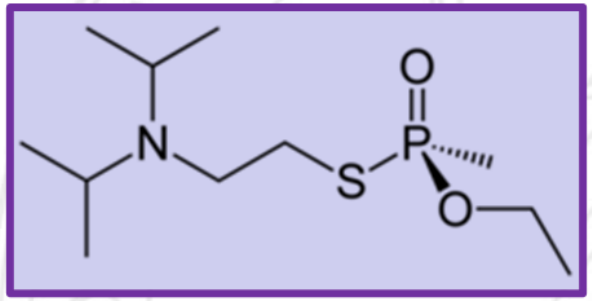
FOSGENE (agente soffocante)
diffusamente impiegato sui campi di battaglia (guerra 1914-1918)



IPRITE (agente vescicante)
utilizzato per la prima volta a Ypres, in Belgio, nel 1917



SARIN (agente nervino)
attentato nella metropolitana di Tokyo (20 marzo 1995)



VX (agente nervino)
Omicidio di Kim Jong-Nam a Kuala Lumpur (13 febbraio 2017)

M. Guidotti, M. C. Ranghieri *Sapere* **2022** (giugno) - doi: 10.12919/sapere.2022.03.01

Drugs as chemical weapons: the case of Fentanyl

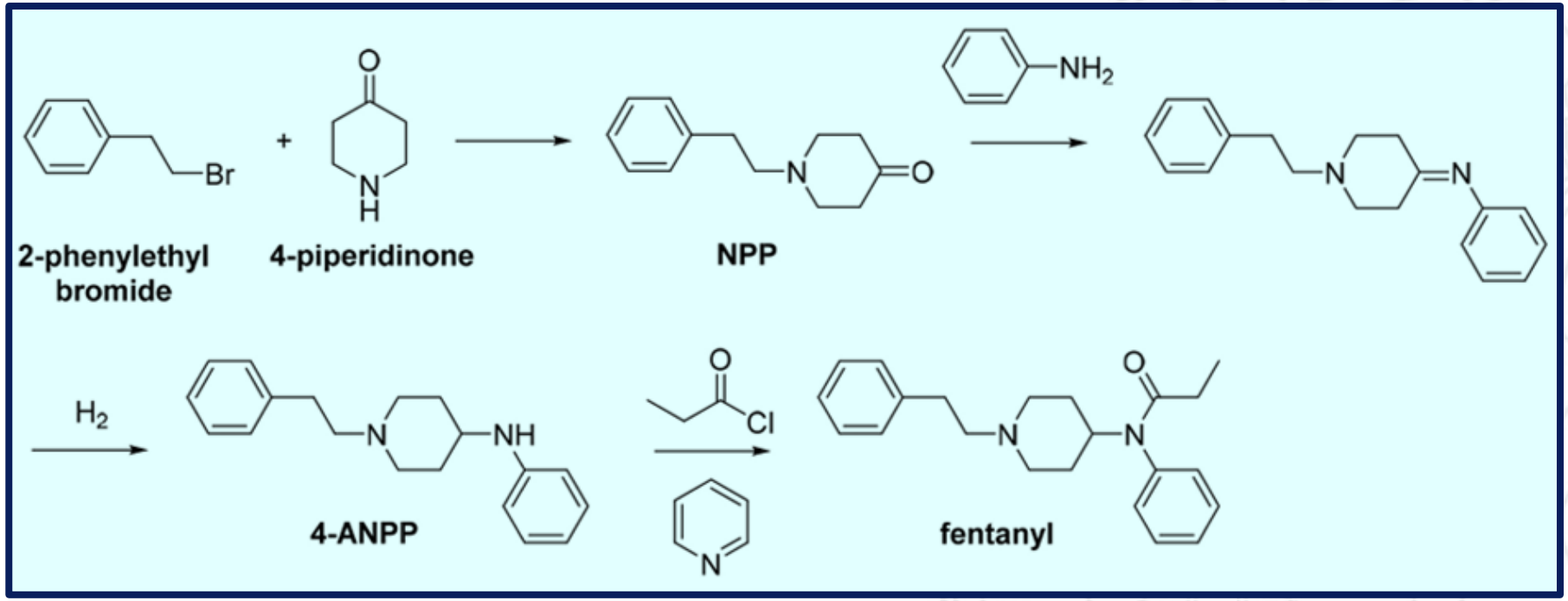
The interest in **fentanyl and its analogues as chemical weapons** can be illustrated by two examples. First, in the early 1990s, **they were studied in the context of the U.S. program to develop incapacitating weapons, specifically the chemical grenade for riot control.** Secondly, their extraordinary effectiveness was demonstrated in October 2002 during an anti-terrorist intervention by Russian special forces against terrorists in Moscow's Dubrovka Theatre. After an attack with an aerosol of synthetic opioids (apparently a mixture of **carfentanil** and **remifentanil**), all the people in the theatre fell asleep, but more than 10% died from the poisoning effects.

Compound	Relative Efficacy	Therapeutic Index	LD_{50} (Rat, i.v.), mg/kg
Morphine (standard)	1	70	<200
Methadone	4	12	Not known
Alfentanil	75	1100	47.5
Remifentanil	220	33,000	Not known
Fentanyl	300	300	3.5
Sufentanil	4500	25,000	17.9
Carfentanil	Up to 10,000	10,600	3.4

V. Pitschmann, Z. Hon *Toxics* **2024**, *11*, 52 - doi: 10.3390/toxics11010052

Fentanyl and its analogs: pain-killers or man-killers?

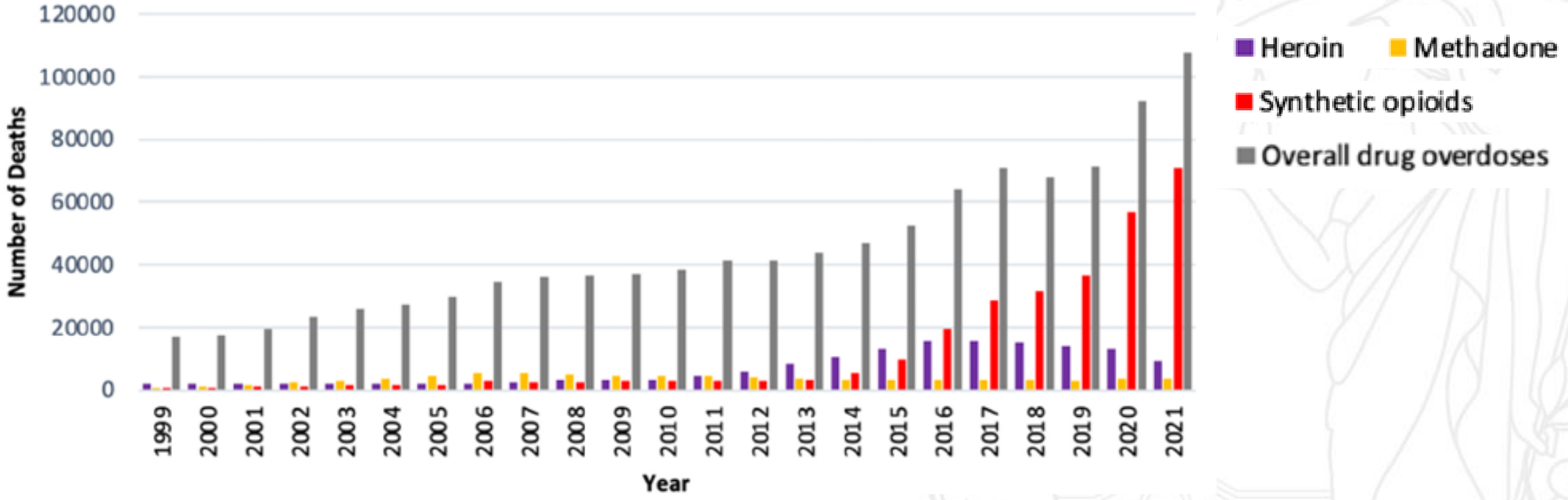
Fentanyl is a **synthetic μ-opioid receptor agonist approved to treat severe to moderate pain with faster onset of action and more than 100 times potent than morphine**. Over last two decades, abuse of fentanyl and its derivatives has an increased trend, globally. Currently, the US faces the most serious situation related to fentanyl overdose, commonly referred to as the opioid epidemic. **Nowadays, fentanyl is considered as the number one cause of death for adults aged 18-45 in the US**. Synthesis and derivatization of fentanyl is inexpensive to manufacture and easily achievable.



J. Patocka, K. Kuca et al. *Heliyon* **2024**, e28795 - doi: 10.1016/j.heliyon.2024.e28795

Deaths for drug overdose in the USA (1999-2021)

Due to synthetic accessibility and pharmacological profile of fentanyl derivatives, these compounds represent an excellent example of designer drugs. **A designer drug can be defined as a structural analog or derivative designed to mimic pharmacological effects of original controlled substance, with aim to avoid its classification as an illicit drug**. Fentanyl derivatives, as designer drugs, are commonly also termed as **I**llicitly **M**anufactured **F**entanyl**s** (**IMFs**), that in recent years found their use as street illicit drugs.



J. Patocka, K. Kuca et al. *Heliyon* **2024**, e28795 - doi: 10.1016/j.heliyon.2024.e28795

La prima edizione dei "Pharma Awards"

Nell'ottobre 2025 ha avuto luogo a Milano la Cerimonia di Premiazione dei **Forbes Italia ESG - Sustainability Pharma Awards**, premi finalizzati al riconoscimento dell'eccellenza nella **sostenibilità ambientale, sociale e di governance (ESG) nel settore farmaceutico**.

I Pharma Awards sono promossi da Forbes Italia, Pro Format Comunicazione e MP Film, con l'obiettivo di valorizzare le imprese che, nel campo del farmaco e dei dispositivi medici, sviluppano progetti innovativi, misurabili e allineati ai criteri ESG.

L'iniziativa scaturisce dalla collaborazione tra tre realtà di riferimento nei rispettivi ambiti:

- **Forbes Italia** come autorevole piattaforma di informazione e networking;
- **Pro Format Comunicazione** come partner strategico specializzato nella comunicazione in ambito sanitario e farmaceutico e nella valorizzazione dei progetti ESG;
- **MP Film** come realtà di produzione e innovazione creativa al servizio della cultura d'impresa.

Alcune delle principali aziende farmaceutiche attive in Italia - Alfasigma, Amgen, Astellas, Hoya, Leo, Lilly, MSD, Novartis, Novo Nordisk, Roche, Servier, Pfizer ed EG Stada Group - hanno presentato **progetti e iniziative che considerano la sostenibilità non solo come obbligo normativo, ma come leva strategica per reputazione, competitività e valore a lungo termine**.

Main points of the “End Tuberculosis” WHO program

World Health Organization Global Strategy "End Tuberculosis"

In 2014, the World Health Organization introduced the "End TB" strategy, which envisages reducing tuberculosis incidence by 80% and mortality by 90% by 2030. Key provisions:

- Use of short-term and effective treatment regimens.
- Expanding access to innovative diagnostic methods.
- Strengthening the system of financing anti-TB programs.
- Implementation of people-centered approaches to treatment.

New approaches to the treatment of drug-resistant tuberculosis

- In 2022, the World Health Organization recommended the use of short-course regimens for multidrug-resistant tuberculosis, including BPaL (Bedaquiline, Pretomanid, and Linezolid). By 2023, 109 countries had switched to oral regimens instead of injectable drugs.

Impact of the COVID-19 pandemic on tuberculosis

According to the World Health Organization, the COVID-19 pandemic has slowed global progress in the fight against tuberculosis. Key impacts include:

- A decline in the number of reported cases from 7.1 million in 2019 to 5.8 million in 2020, indicating underreporting.
- An increase in deaths to 1.5 million in 2020 due to limited access to treatment.
- Funding cuts: In 2021, spending on tuberculosis programs decreased from US$6 billion in 2019 to US$5.4 billion.

In countries with a high burden of tuberculosis, the fight against TC is a priority of state policy, as this pathology remains one of the main causes of mortality. As a part of the Global Strategy of the WHO, access to free treatment has been expanded through international donor programs (the Global Fund to Fight AIDS, Tuberculosis and Malaria). For example, in India, in 2022, the Ni-Kshay Mitra initiative, which means “Friend in the Fight against Tuberculosis” or “Partner to eliminate Tuberculosis”, was introduced, involving public organizations and private companies in supporting TC patients by providing them with medicines and food rations.

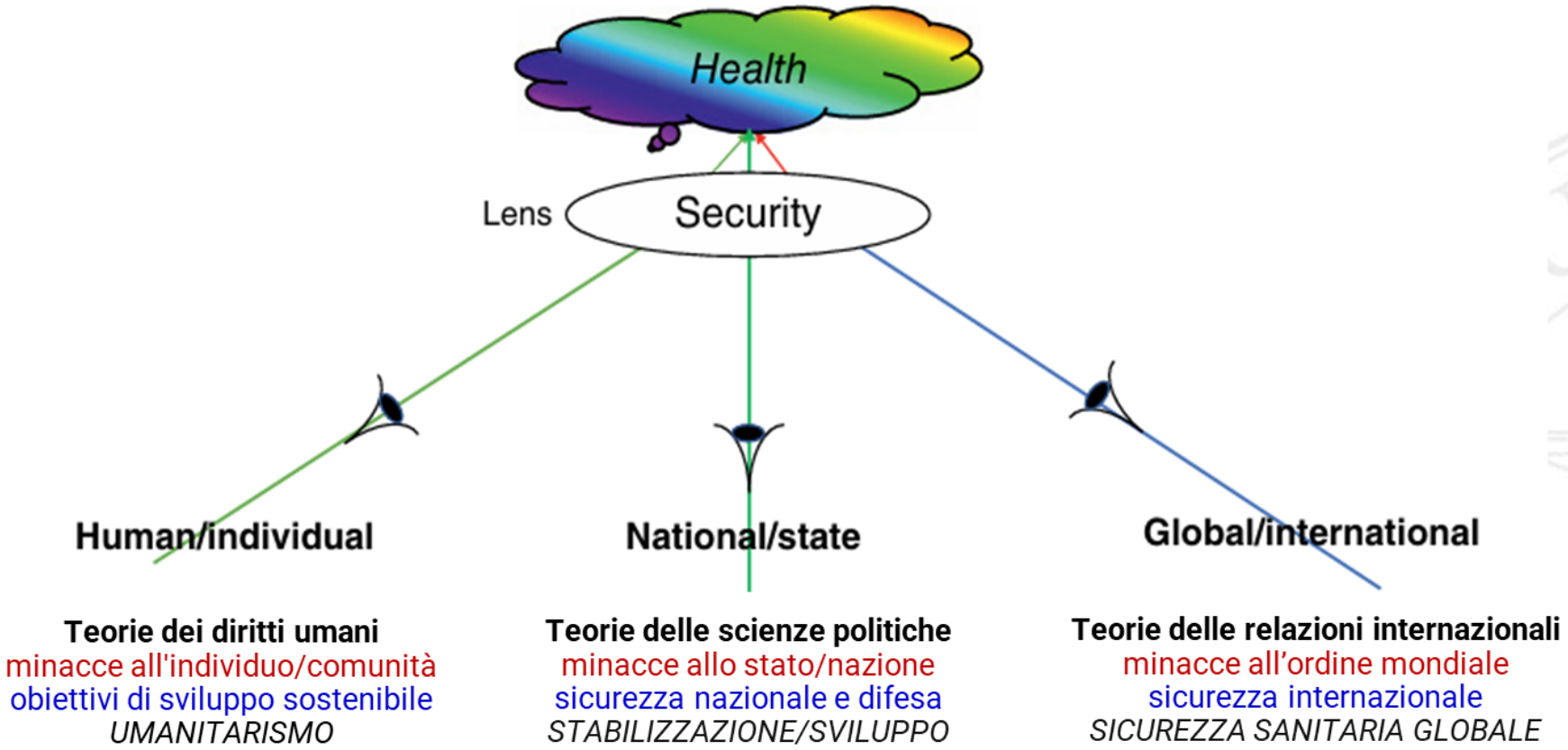
S. Osyntseva *SSP Mod. Pharm. Med.* **2025**, *5*, 1-14 - doi: 10.53933/sspmpm.v5i2.188

Progress in TB vaccine development

- An expansive portfolio of TB vaccine candidates, spanning various stages of development, underlines the global commitment to innovating and strengthening the arsenal against TB. Through collaborative research and rigorous clinical trials, these initiatives represent hopeful strides toward a future where TB is no longer a public health menace.
- However, despite advances in TB vaccine development, challenges such as the need for a deeper understanding of TB immunity, achieving long-lasting vaccine efficacy and overcoming clinical trial and distribution complexities continue to hinder progress. Ensuring access to new vaccines in high-burden areas remains a critical obstacle. Central to this collaborative spirit is the envisaged development and licensing of a new TB vaccine by 2027.
- This aspiration necessitates a meld of scientific acumen, financial investment and policy advocacy, coordinated in a manner that fuels innovation while ensuring accessibility. The roadmap heralds an era where academia, the pharmaceutical industry, and public health institutions should converge toward a common goal, fostering a crucible for innovation and expediting the journey from research laboratories to communities in need.
- In addition, the roadmap accentuates the imperative of governmental engagement and commitment. Governments are envisaged as pivotal actors in mobilizing resources, enacting conducive policies and fostering an enabling environment for the implementation of TB interventions. The engagement extends beyond health ministries to include a whole-of-government approach, implicating sectors such as finance, education and social protection in the collective endeavor to curb TB.

B. Haruna Gulumbe et al. *FUTURE SCIENCE OA* **2024**, *10*, 2418787 - doi: 10.1080/20565623.2024.2418787

Perspectives on health and security



Senior health practitioners need to understand how their role in global health is informed by **non-biomedical topics such as international relations, security studies, international development, International Humanitarian Law, and healthcare ethics in crises.** These topics are not normally covered in books and courses on global health yet are an essential part of the knowledge base needed by health practitioners who work in complex security environments.

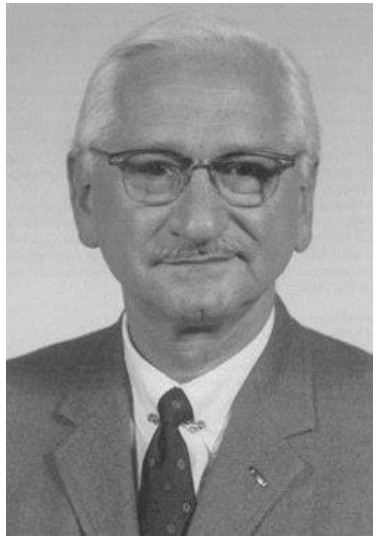
"Handbook of Global Health, Security and War" - M. Bricknell, R. Sullivan Editors, John Wiley & Sons Ltd (2025)

Principi essenziali nel contesto di eventi catastrofici

Una serie di valori è sintetizzati in forma di principi dal **Codice di condotta per il movimento internazionale della Croce Rossa e della Mezzaluna Rossa e delle ONG nella risposta ai disastri**. Il Codice è stato redatto all'indomani della crisi umanitaria di Goma del 1994, in cui 150.000 persone morirono in seguito a carenze gravi nella risposta umanitaria. L'iniziativa fu promossa da alcune delle principali organizzazioni internazionali: Caritas Internationalis, Catholic Relief Services, Federazione Internazionale della Croce Rossa e Mezzaluna Rossa, International Save the Children Alliance, Lutheran World Federation, Oxfam, The World Council of Churches, e il Comitato Internazionale della Croce Rossa. **Attualmente, il Codice è stato adottato da oltre 450 organizzazioni internazionali**.

1. Imperativo umanitario priorità assoluta. Il diritto di ricevere ed offrire assistenza umanitaria è un principio umanitario fondamentale di cui devono godere tutti i cittadini di tutti i paesi.
2. L'aiuto è portato senza alcuna considerazione di razza, di credenza o di nazionalità dei beneficiari e senza discriminazione di alcun genere. Le priorità in materia di assistenza sono determinate in funzione dei soli bisogni.
3. L'aiuto non sarà utilizzato al servizio di convinzioni politiche o religiose, di qualunque tipo.
4. Ci sforzeremo di non essere strumento della politica estera dei governi.
5. Rispetteremo le culture e i costumi.
6. Cercheremo di fondare i nostri interventi sulle capacità locali.
7. Ci impegneremo a trovare i mezzi per associare i beneficiari dei programmi alla gestione dei soccorsi.
8. I soccorsi devono allo stesso tempo mirare a limitare le vulnerabilità future e soddisfare i bisogni essenziali.
9. Ci consideriamo responsabili, tanto verso i beneficiari potenziali delle nostre attività che verso i nostri donatori.
10. Nelle nostre attività di informazione, di promozione e di pubblicità, presenteremo le vittime di catastrofi come esseri umani degni di rispetto e non come oggetti di commiserazione.

Sabin e il vaccino contro la poliomielite mai brevettato



Albert Bruce Sabin
(1906-1993)

Abram Saperstejn, ebreo di nascita, emigrò negli Stati Uniti con i suoi genitori nel 1921 per evitare le persecuzioni. Dopo aver conseguito la laurea in medicina presso la New York University nel 1931, **dedicò la sua vita alla ricerca di una cura contro la poliomielite**, che all'epoca aveva raggiunto proporzioni epidemiche sia a livello nazionale che in tutto il mondo. Durante i suoi studi alla **Children's Hospital Research Foundation di Cincinnati**, nell'Ohio, dimostrò che i virus della poliomielite non solo crescono nei tessuti nervosi, ma vivono anche nell'intestino tenue. Introducendo nell'*establishment* medico questa nuova idea di enterovirus, fu in grado di dimostrare che la poliomielite è essenzialmente un'infezione del tratto alimentare e comprese che si sarebbe potuta prevenire attraverso un vaccino orale. I suoi studi vennero interrotti dalla seconda guerra mondiale. Nel 1941 entrò a far parte del Comitato epidemiologico dell'esercito degli Stati Uniti e si mosse tra Europa, Africa, Medio Oriente e Pacifico. Fu durante questa fase della sua carriera che **Sabin sviluppò vaccini per l'encefalite (la malattia del sonno), la febbre della mosca della sabbia e la febbre dengue**. Alla fine della seconda guerra mondiale tornò a Cincinnati e riprese la sua ricerca sul virus della poliomielite. I suoi studi portarono all'approvazione del vaccino che si diffuse negli USA nel 1962. Aveva il pregio di essere più semplice da somministrare rispetto al vaccino di Salk e fu quindi in grado di soppiantarlo. Il vaccino orale imitava il passaggio del virus attraverso il corpo, inducendolo a creare anticorpi che avrebbero attaccato qualsiasi virus esterno, impedendo quindi la riproduzione e la trasmissione.

Al contrario, quello di Salk proteggeva le persone dalla malattia ma non impediva la trasmissione del virus. La poliomielite è scomparsa dagli Stati Uniti nel 1979 e dall'emisfero occidentale nel 1991. Due elementi sono stati la chiave del successo di Sabin: **l'uso del vaccino orale e la somministrazione a un'intera popolazione contemporaneamente.** **Per tutta la vita Sabin si rifiutò di brevettare il suo vaccino, donando la sua ricerca all'Organizzazione Mondiale della Sanità.** In questo modo rinunciò a ogni sfruttamento commerciale da parte delle industrie farmaceutiche, in modo che il prezzo basso garantisse una più ampia diffusione del trattamento vaccinale. Non guadagnò nemmeno un dollaro dallo sviluppo del vaccino e visse unicamente del suo stipendio da professore. **"E' il mio regalo ai bambini", dichiarò nel corso di un'intervista.**

G. Remuzzi, *"Le monetine di Roosevelt - Una storia dell'umanità attraverso i vaccini"* **2022**, *Solferino Editore*
https://it.gariwo.net/giusti/coraggio-civile/sabin-e-il-vaccino-non-brevettato-contro-la-poliomielite-23268.html
https://www.my-personaltrainer.it/salute-benessere/vaccino-anti-covid-19-tipologie-come-funzionano.html

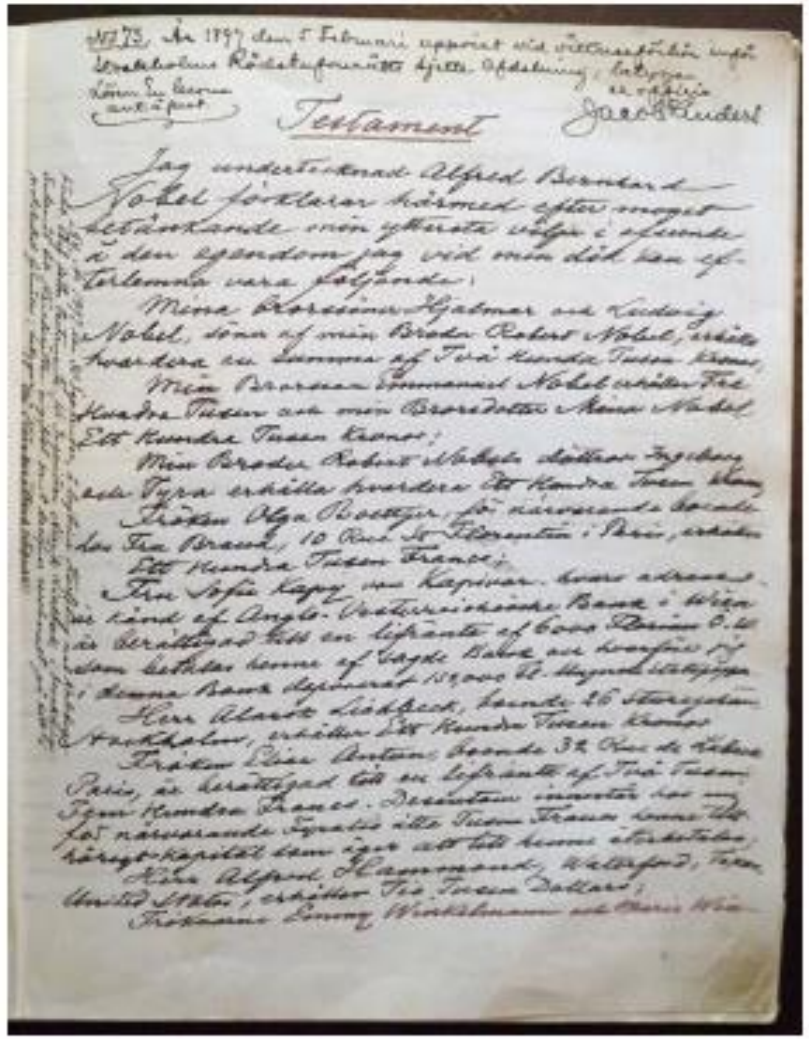
L'eredità di Sabin: il vaccino come simbolo di equità sanitaria

A Sabin è dedicato il **Sabin Vaccine Institute, fondato nel 1993**. Con un comunicato stampa, l'istituto ha così commentato la corsa al vaccino contro il COVID-19: **«Per garantire che il vaccino per il COVID-19 raggiunga coloro che ne hanno più bisogno, anche in aree remote e difficili da raggiungere, è necessario dare la priorità all'equità sanitaria»**. Il concetto che tutti, ovunque, meritino un'equa e giusta opportunità di accedere a un'assistenza sanitaria di qualità deve essere inserito nella struttura di tutti i programmi di vaccinazione. **Sabin credeva profondamente che a nessuno dovrebbe essere negato il vaccino e ha lavorato instancabilmente per distribuirlo coinvolgendo tutti gli attori globali,** affinché le campagne di immunizzazione di massa avanzassero, con l'obiettivo di garantire che nessun bambino rimanesse non vaccinato. I vaccini sono uno dei più grandi strumenti per l'equità sanitaria oggi, con il potenziale per liberare tutte le persone dal peso delle malattie prevenibili con i vaccini. Ma affinché mantengano la loro piena promessa, l'equità nella salute deve avere la priorità sin dall'inizio. Ciò richiede collaborazione e coordinamento; dai ricercatori che sviluppano il vaccino, ai produttori e fornitori che lo portano su larga scala, ai governi e ai finanziatori che determinano la politica sui vaccini, alle parti interessate della salute globale che creano linee guida per una consegna e una diffusione di successo. Sabin ha riconosciuto la natura critica di ciascuna di queste forze e come, lavorando insieme, potrebbero potenzialmente eliminare le malattie. **«Dobbiamo continuare ad attingere alla sua eredità per lavorare verso un futuro libero da malattie prevenibili con un vaccino per tutte le persone, ovunque».**

Alfred Nobel (1833-1896), un ingegnere chimico «esplosivo»

Assommando la disponibilità dei suoi allora 360 brevetti industriali, Nobel divenne un ricco imprenditore. Acquistò la grande industria svedese *Saab Bofors Dynamics* e intestò un vitalizio al collega chimico piemontese **Ascanio Sobrero**, che era stato il primo a preparare la **nitroglicerina**.

Nel corso degli anni, Nobel **perfezionò la nitroglicerina**, disperdendola nell'argilla e rendendo quindi l'esplosivo più maneggevole e stabile **(dinamite, brevetto depositato nel 1867)**; il fulminato di mercurio fu impiegato come detonatore. L'invenzione gli permise di aprire società e laboratori in circa venti paesi. Inventò anche la **gelignite**, esplosivo gelatinoso ancor più stabile e potente della dinamite, e brevettò più tardi la **balistite**, base della **cordite**. L'enorme impiego dei «suoi» esplosivi per scopi bellici gettò però Nobel nello sconforto: come sarebbe stato ricordato? All'atto dell'apertura del suo testamento, fu reso noto il lascito con il quale dava mandato di istituire i cinque premi a lui intestati. Il patrimonio stimato di Nobel nel 1895 si aggirava intorno ai 30 milioni di corone svedesi, corrispondenti a circa 180 milioni di euro odierni.



La prima pagina del testamento di A. Nobel, 27.11.1895

Roald Hoffmann - Premio Nobel per la Chimica (1981)

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June 8, 2011

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Dear Luis,

I write to EuChemMS to voice my strong support of the application of Dr. Hartmut Frank and colleagues for developing a European Working Group on Aspects of Ethics in Science.

On the importance of the subject: People are concerned about science, and specifically about our chemistry. Their concerns are ecological and moral, and they are very real. Our profession needs to convince the public that we, who create new compounds so beautifully, also care about the uses to which these molecules are put.

Ethical question also arise in our microsociety, chemistry. Ours is a fragile community of spirit as well as a profession. It is important that ethical concerns on intellectual property, publication, grants, and promotion be voiced and discussed. I believe sincerely that in this millennium chemistry will change, so as to put the ethical and ecological concerns, ones that were always there, up front.

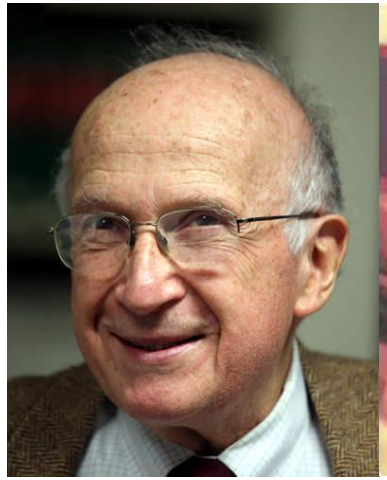
From my own experience, I know that ethical and environmental concerns are important to the young people entering our profession. I also feel that these young people feel empowered in ethical discussions, they feel free to speak, and in this way ethical discussions bring research groups together.

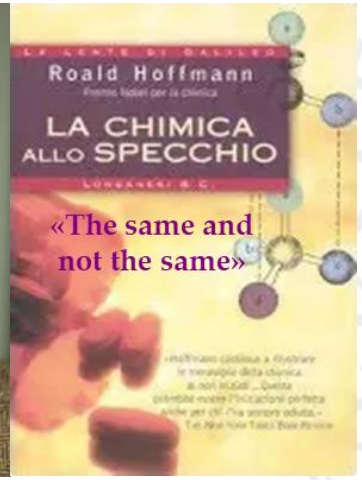
So it makes perfect sense for the European chemical community to have a working group on just this subject, ethics. Many of the colleagues in the group of people who write to you are known to me – for instance Frank, Schmidt (one of the world's best polymer chemists), Dondi and Wolfram Koch. They are first class people, some with important Chemical Society management experience. They have clearly shown their commitment by organizing a couple of workshops on ethics and the environment.

I would respectfully urge you to approve this working group, and offer it the support it deserves. The subject of ethics in our profession is very important.

Cordially yours,

Roald Hoffmann





Chimico, scrittore e divulgatore ebreo polacco (n. Złoczów 1937), naturalizzato statunitense nel 1955. Premio Nobel per la chimica nel 1981 insieme a K. Fukui, **ha svolto ricerche di chimica organica teorica, in particolare sulle regole che permettono di stabilire l'effettuazione di alcune classi di reazioni.** Ha studiato alla Columbia e alla Harvard University; dal 1965 professore alla Cornell University. Nel complesso, ha svolto intense ricerche su molecole insature, composti aromatici, radicali, teoria delle reazioni. Sotto il nome di R. B. Woodward - R. Hoffmann, sono note le regole che descrivono le interazioni tra gli orbitali π nelle reazioni pericicliche, permettendo di prevedere la stereochimica di tali reazioni concertate. Tali regole discendono dal concetto di conservazione della simmetria degli orbitali molecolari, che si è dimostrato di assoluta rilevanza in chimica organica.

The same and not the same discute il concetto di isomeria in chimica, esplorando le tematiche dell'identità non solo da un angolo visuale chimico, ma anche artistico e letterario.