Note: Below are extracts from an article published by Radio Teilifis Eireann (RTE) (02nd February 2024) and EY-Parthenon, a brand of Ernst & Young Global Limited (EY.com), as referenced below.

Europe moves closer to adopting new AI rules and regulations whilst Biopharmaceutical companies see potential for GenAI to reform early-stage drug discovery.

Europe within reach of landmark AI rules after nod from EU countries.

RTE (2024) reports on the EU's latest endorsement of a political deal reached in December which aims to regulate the AI industry and its impact on a wide range of industries, in an attempt to strike a balance between innovation and safety:

> Europe moved a step closer to adopting rules governing the use of artificial intelligence and AI models such as Microsoft-backed Chat GPT after EU countries endorsed a political deal reached in December. The rules, proposed by the European Commission three years ago, aim to set a global standard for a technology used in a vast swathe of industries from the banking and retail to car and airline sectors.
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> They also set parameters for the use of AI for military, crime and security purposes. EU industry chief Thierry Breton said the Artificial Intelligence (AI) Act is historical and a world first. "Today member states endorsed the political agreement reached in December, recognising the perfect balance found by the negotiators between innovation and safety," he said in a statement.

> Under the AI Act, unacceptable risks like emotion recognition technology in the workplace will not be allowed. High risk areas such as health, recruitment and law enforcement will be subject to mandatory compliance requirements. Medium risk systems will be subject to transparency requirements and low risk AI systems are permitted without restrictions.
>
> RTE (2024)

According to RTE (2024) the AI Act has been welcomed at home in Ireland and has successfully reached agreement with certain EU members to progress with the legislation, following lobbying from key AI players in those countries:

> Minister for Enterprise, Trade and Employment, Simon Coveney, said the AI Act is "a hugely important piece of legislation".
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> "It will help foster trust amongst its users through its compliance obligations, transparency and accountability requirements while also ensuring the responsible development of AI which will encourage enterprises to invest and innovate in this new technology."
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> Minister of State for Trade Promotion, Digital and Company Regulation, Dara Calleary, said: "The AI Act is the first of its kind and will ensure that AI systems will be used in a trustworthy and ethical manner to protect the rights of the individual while ensuring that the opportunities that this technology brings in areas such as health, the environment, education, will be maximised through responsible, trustworthy innovation.
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> Today's agreement was a foregone conclusion after France, the last holdout, dropped its opposition to the AI Act after securing strict conditions that balance transparency versus business secrets and reduce the administrative burden on high-risk AI systems. The aim is to allow competitive AI models to develop in the bloc, an EU diplomatic official who declined to be named because they were not authorised to publicly comment on the issue, had earlier on Friday told Reuters.
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> French AI start-up Mistral, founded by former Meta and Google AI researchers, and Germany's Aleph Alpha have been lobbying their respective governments on the issue, sources said. Germany earlier this week also backed the rules.
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> RTE (2024)

The lobbyists referred to by RTE (2024) above, which include the major tech players globally, will require that the new regulations are implemented properly and swiftly, so as not to act as a burden on AI companies and actively encourage growth in this dynamic sector:

> Tech lobbying group CCIA which counts Alphabet's Google, Amazon, Apple and Meta Platforms as members, warned of roadblocks ahead. "Many of the new AI rules remain unclear and could slow down the development and roll-out of innovative AI applications in Europe," CCIA Europe's Senior Policy Manager Boniface de Champris said.
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> "The Act's proper implementation will therefore be crucial to ensuring that AI rules do not overburden companies in their quest to innovate and compete in a thriving, highly dynamic market."
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> RTE (2024)

RTE (2024) was able to provide a timeline for implementation of the legislation, anticipating a vote by a key committee of EU lawmakers on February 13 and the European Parliament vote either in March or April. Thereafter, it is expected that the new AI Act will be fully in force by 2026, with certain elements applying earlier.

How pharma can benefit from using GenAI in drug discovery.

In their recent EY.com paper, Carroll and Anderson Jr. (2024) highlight the excitement in the biopharma sector about the potential benefits of adopting and applying AI techniques to the drug-discovery business. Cost savings and speed are identified as the main benefits and seen as key components for competitiveness into the future:

- Embrace GenAI as game-changing technology and increase levels of expertise and experience in the organization.
- Leverage an integrated suite of all emerging technologies, including GenAI, to improve operations.
- Invest in digital infrastructure to increase agility and performance.

The emergence of generative AI (GenAI) has the potential to reform early-stage drug discovery and development. Large language models are being harnessed to create novel molecules tailored for specific properties, positioning them as potential drug candidates while also revolutionizing various aspects of the drug development process.

This innovative methodology promises to potentially mitigate formidable costs and time constraints traditionally associated with drug discovery. It could also unveil previously overlooked therapeutic possibilities. To achieve these benefits, though, pharmaceutical company leaders need to make sure they have a sound strategy to implement and support the technology, as well as to manage the massive organizational change it will involve.

"In terms of the preclinical, GenAI has a lot of applicability to save resources. You can use GenAI to make predictions, from selecting targets for drug development, to putting together combinations of genes for prognosis. Once GenAI is optimized, it's going to reduce timelines by 50%."- Former Clinical Development Director, Medical & Scientific Affairs at Biotech.

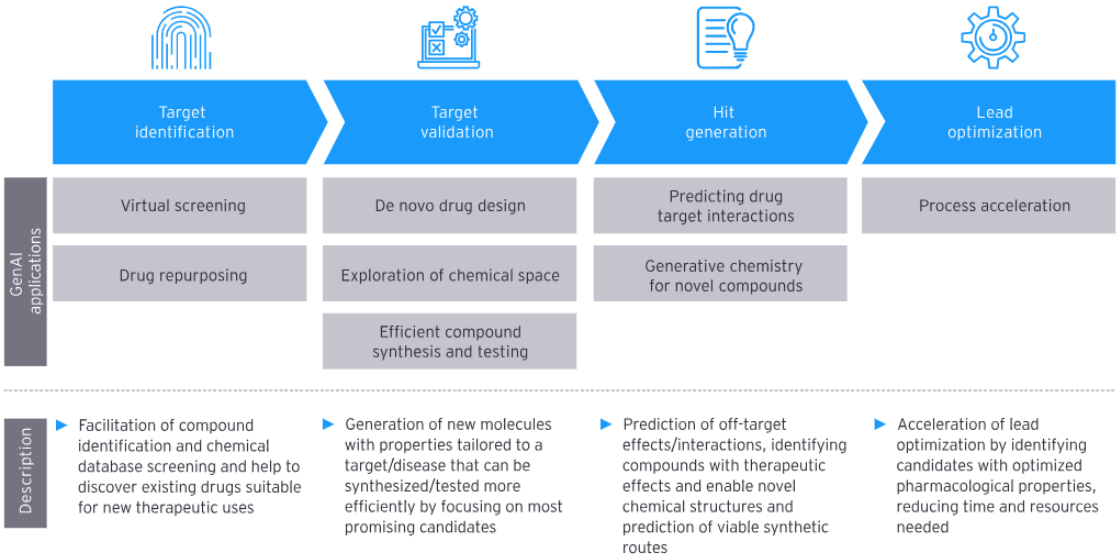
Carroll and Anderson Jr. (2024)

According to Carroll and Anderson Jr. (2024), there are many drug discovery issues which can be addressed by GenAI. With the proliferation of AI start-ups, pharmaceutical companies are increasingly engaging with AI vendors to identify areas where digital transformation can be applied, particularly in the process to clinical trials:

The profound impact of artificial intelligence (AI) on the pharmaceutical industry is evident in the rapid adoption of digital transformation. Over the past several years, a surge of interest in AI technology has emerged. This has been supported by the proliferation of GenAI-focused start-ups, substantial investment and increased collaborations between pharmaceutical companies and AI vendors. A particular emphasis has been the integration of GenAI solutions. The use of GenAI holds great potential for a drug discovery process known to take up to a decade or longer, with an average cost of $1b to $2b per therapy that makes it to the market. GenAI has the potential to expedite and reduce the cost of every step of the drug discovery and early-stage development process, where only 10% of candidate molecules advance to clinical trials. (Figures 1A, 1B).

"Drug discovery alone takes about five years and costs ~$400m. To bring a drug to market could cost close to $2b. GenAI could potentially bring costs down by $40m to $400m by helping work with data in a way that dashboards don't always allow, in addition to scraping info from large databases and document and protocol generation."- Head of Data Science at a large pharmaceutical company.

Figure 1A: Impact of GenAI on the drug discovery process



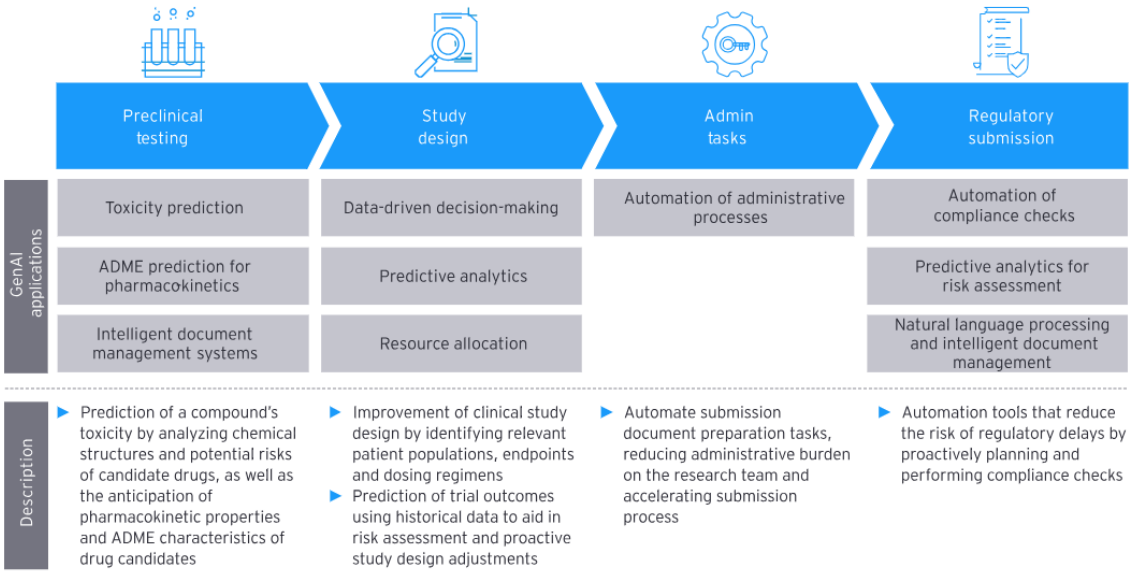
Source: Drug Discovery Online, 2024

Industry experts anticipate that GenAI will have a noticeable impact across various elements of drug discovery and development, resulting in cost and timeline reductions as adoption becomes more prevalent and models become more optimized.

Carroll and Anderson Jr. (2024)

Carroll and Anderson Jr. (2024) further emphasize the benefits of GenAI for the drug development stage, particularly in the areas of pre-clinical testing, regulatory processes, administration and the design of studies:

Figure 1B: Impact of GenAI on the drug development process



1.Preclinical testing

GenAI can help predict the toxicity of a drug compound by analysing chemical structures and potential risks associated with candidate therapies. It can also help forecast pharmacokinetic properties and ADME characteristics of drug candidates, which can inform how a given drug will act against its target, as well as, how safe it is for the patient.

2. Study design

GenAI can enrich data-driven decision-making, such as by helping to improve clinical study design by identifying the most relevant patient populations, endpoints and dosing regimens. It can also predict clinical trial outcomes using historical data to aid in risk assessment and proactive study design adjustments to increase the likelihood of success and reduce costly failures.

3. Automation of administrative processes

GenAI can help optimize resource allocation by predicting which studies are most likely to succeed and have the greatest impact. Additionally, AI technology can also automate administrative tasks, such as patient recruitment, data entry and regulatory document management, saving time and minimizing errors.

4. Regulatory submissions

A combination of both GenAI and more generic AI technology can aid in the integration and analysis of diverse data sources, speeding up the process and reducing errors in regulatory submissions. GenAI can be used to automate compliance checks, reducing the risk of regulatory delays by proactively performing checks against guidelines to ensuring that submissions adhere to all requirements.

Separately, generic AI's predictive analytics can be used to assess potential risks associated with regulatory submissions to help companies make informed decisions and mitigate delays. Lastly, natural language processing (NLP), a form of AI, can be used to expedite document creation and validation to enhance overall quality and accuracy in regulatory submissions.

Overall, an EY-Parthenon survey of large, medium and small biopharma sponsors indicates that GenAI is expected to have the largest impact on compound screening and prioritization, target identification and validation, as well as prediction of drug-drug interactions. Lower impact is expected to be seen in biomarker discovery and clinical trial design.

Carroll and Anderson Jr. (2024)

The impact of GenAI in reducing costs in this sector is best captured in research carried out by EY among key decision-makers and research staff at biopharmaceutical and biotech companies. Carroll and Anderson Jr. (2024) outline where these cost savings will be implemented, and the expected variations depending on the stage of development. Plus, how the research predicts upwards of 67% cost reduction, once AI adoption is at its peak:

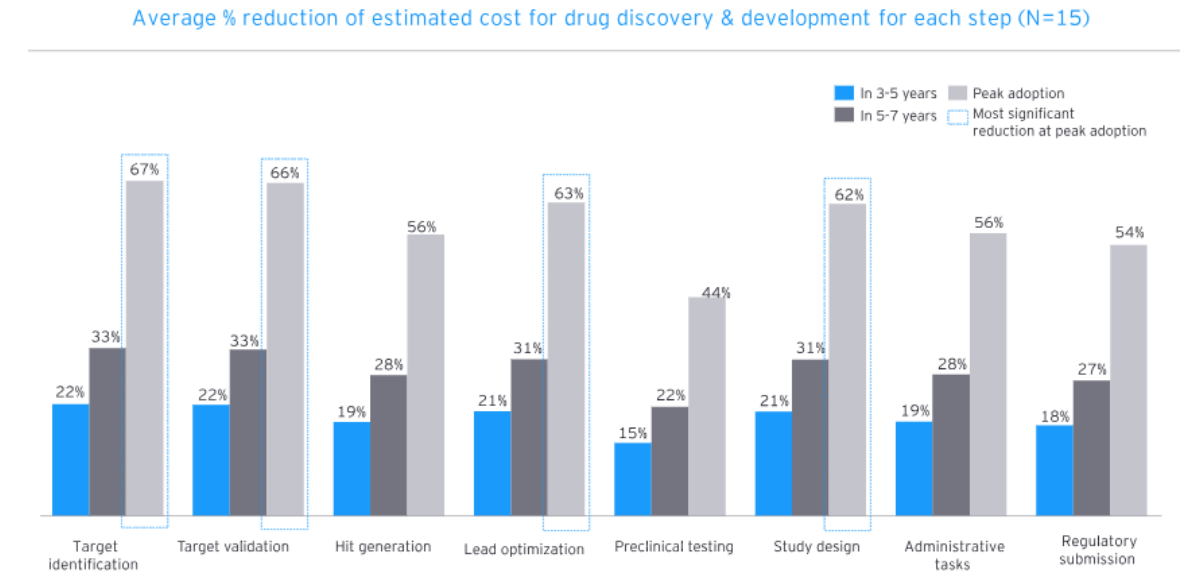
EY teams interviewed 15 senior research and development decision makers at biopharmaceutical and biotech companies to get a sense of the potential for GenAI. As the technology is adopted over time, the interviewees agreed, future cost reductions will increase significantly for all phases of the drug development value chain. (Figure 2. below) However, the extent of these cost savings

might vary significantly across different phases due to the unique advantages and challenges presented by each step.

Interviewees said that in the next three to five years, cost reductions from GenAI across all phases will range from 15% -22%. In five to seven years, cost savings are expected to increase to a range of 22%-33%. Once peak adoption of GenAI is reached, the expected range of cost savings was forecast to be 44%-67%. Primary opportunities for cost reduction, and the average estimate of the decision makers interviewed, include:

- Target identification (67% reduction at peak adoption): Target identification was cited as the greatest cost reduction area as GenAI-powered virtual screening is expected to be rapidly adopted.
- Target validation (66% reduction at peak adoption): Many experts believe GenAI will increase the speed of target validation through virtual drug design and chemical exploration, reducing costs significantly once fully adopted.
- Lead optimization (63% reduction at peak adoption): Lead optimization is expected to experience substantial cost reduction due to GenAI, potentially aided by GenAI's ability to optimize hit compounds rapidly, resulting in a shorter and more efficient lead optimization process. At the same time, the precision of AI in refining chemical structures and predicting pharmacological properties can contribute to this cost-saving potential.
- Study design (62% reduction at peak adoption): GenAI is poised to significantly reduce the cost of study design by leveraging data-driven decision-making. AI's capacity to analyse extensive data sets and identify optimal study parameters might streamline the process, reducing resource allocation inefficiencies. This cost reduction is particularly promising for resource-intensive clinical trials.

Figure 2: Impact of GenAI on the cost of drug discovery and early stage drug development



Source: EY-Parthenon interviews with senior executives.

Carroll and Anderson Jr. (2024)

Carroll and Anderson Jr. (2024) conclude that there is growing investment in GenAI among pharmaceutical companies. Resources are a challenge depending on size, but even small to mid-sized biopharma companies can benefit by using contract developers and manufacturers, in a desire to get new drugs to market faster:

> Given the number and diversity of therapeutic areas and indications being targeted by large pharma companies, as well as the number of resources being deployed, pharmaceutical companies are willing to make larger investments in technologies such as GenAI to get their products to market fastest. EY professionals worked with a large pharmaceutical company invested in enterprise wide GenAI capabilities that most notably reduced the total time from novel target identification to a drug in clinical trials from months or years to weeks.
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> According to a former principal scientist at a large biopharma organization, "Large biopharma companies already have experience implementing AI and ML models, throughout their organization, positioning them to continue investing in and adopting GenAI capabilities."
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> Small to midsize biopharma companies, on the other hand, typically lack internal resources and funding to implement GenAI and train their talent on its capabilities, which limit its adoption in this market segment. Nonetheless, startup companies designed with the intention of implementing GenAI in drug discovery have been successful. For example, a drug discovery company combining large-scale data with machine learning is leveraging its GenAI models to accelerate the discovery of novel small molecules.
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> The desire for pharmaceutical companies to use GenAI could also be an opportunity for contract development and manufacturing organizations (CDMOs) and contract research organizations (CROs). According to a founder and CEO of a small biopharma organization, "Smaller biopharma usually do not have internal human resources to develop or optimize their own GenAI algorithm or software, so they tend to outsource a number of drug discovery and early development tasks to contract development and manufacturing organizations, contract research organizations or software companies." As a result, CDMOs and CROs are likely to invest in GenAI capabilities over the next three to five years so that they can improve and differentiate their drug discovery offerings, such as virtual screening, to continue to drive business with biopharmaceutical companies of various sizes.
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> Carroll and Anderson Jr. (2024)

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