BINANCE RESEARCH

From Challenges to Opportunities: How DeSci Reimagines Science

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01 / Key Takeaways

- The scientific research process faces significant challenges, particularly in translating basic research into practical applications through translational research. The "Valley of Death" leads to 80–90% of research projects failing before reaching human trials, with only 0.1% of drug candidates becoming approved treatments.

- Misaligned incentives across academia, funding bodies, and industry lead to challenges such as a **lack of funding**, **reduced collaboration between scientists and clinicians**, and **poor replicability and reproducibility of scientific findings**, causing most research to falter in the "Valley of Death."

- Decentralized Science (DeSci) is a movement that leverages the Web3 stack to create a new scientific research model that can tackle the challenges above.

- By using Decentralized Autonomous Organisations (DAOs), blockchains and smart contracts, DeSci can solve the key coordination problem. This enables different groups of stakeholders to align their interests on capital formation, providing incentives to see research through to the clinical stages.

- We have identified 4 key areas of innovation across the DeSci landscape: **Infrastructure, Research, Data Services and Memes.**

    - **Infrastructure** includes subsectors like funding platforms and DAO tooling which form the building blocks for DeSci DAOs.

    - **Research** includes grassroot DeSci communities that host events globally and DAOs that formalise aligned interests from multiple stakeholders.

    - **Data Services** includes publishing and peer review platforms that enable open access to scientific publications, and data management tools that provide strong data integrity and the access controls for collaboration.

    - **Memes** directly contribute funding to scientific experiments, or serve as investment vehicles into other DeSci projects.

- While the existing stack can already support basic and translational research, it caters less towards clinical research which is where products have direct benefits for patients.

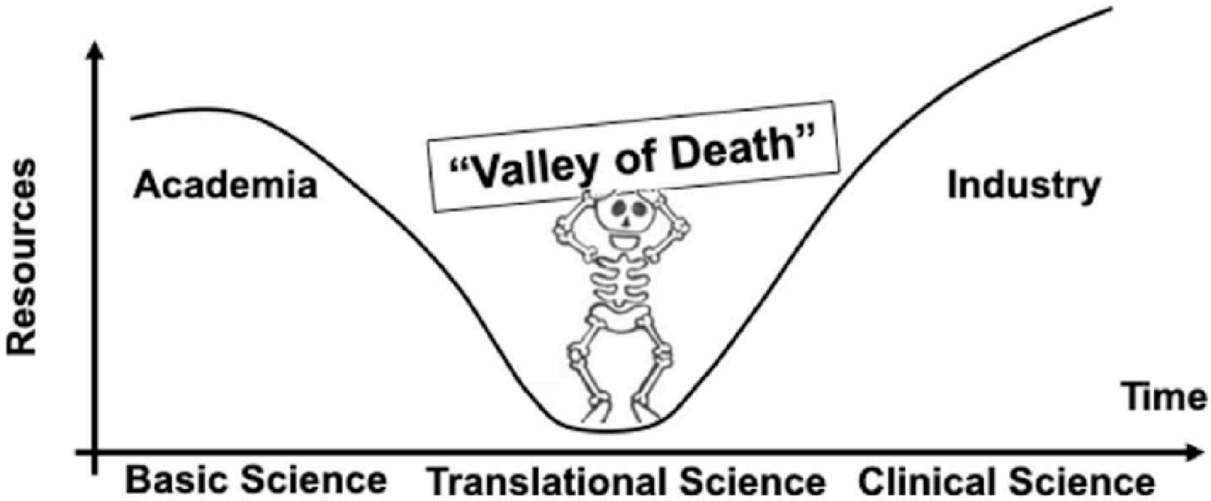
- To sum it up, decentralised science is already mature enough to impact the way scientific research is being conducted today. While there are some gaps and challenges in the current landscape, tackling the "Valley of Death" in research is already a huge step forward.

02 / Introduction

Background on Traditional Scientific Research

The scientific industry's process of producing new knowledge and inventions can be broken down into distinct stages, primarily categorised as the basic research and clinical research stages. These two main stages are connected by translational research, which serves the critical function of converting the findings of basic research into practical applications that can be tested through clinical research. This process ultimately aims to commercialise discoveries into products that benefit society.

Figure 1: "The Valley of Death" is the phase between basic science and clinical science where most research fail

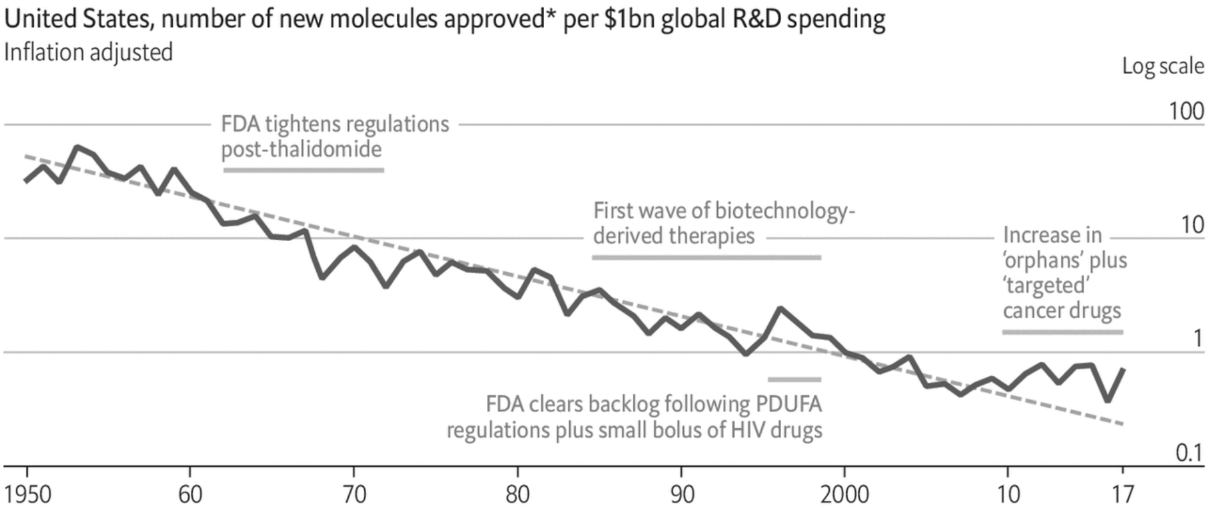


Source: BioMed Central, Binance Research

However, a significant challenge in this process is the "Valley of Death," where many scientific endeavours fail due to a lack of effective translational research. According to the National Institutes of Health (NIH), 80 to 90% of research projects fail before they ever reach human trials. Furthermore, for every drug that gains FDA approval, over 1,000 candidates are developed but ultimately fail. Even at the later stages, the challenges persist — almost 50% of all experimental drugs fail during Phase III clinical trials[1].

To put this into perspective, the probability of a new drug candidate progressing from preclinical research to FDA approval is just 0.1%[2]. This striking statistic underscores the significant challenge of translating the knowledge and innovations developed at universities and research institutions into practical products or treatments for human applications.

Figure 2: No. of new molecules approved per US$1B global R&D spending has been declining



Source: Scannell et al. (2012), with additional post-2012 data by Scannell et al.

Compounding these challenges is the growing inefficiency of research and development (R&D) processes in drug development. In the US, the cost of developing and approving a new drug roughly doubles every nine years – a phenomenon known as Eroom's law, the reverse of Moore's law for microprocessors. Some reasons could be stricter regulatory standards, a high bar for new medical discoveries to serve a different need from existing drugs, and high costs of Contract Research Organizations that design and run clinical trials. If this status quo continues, the biopharmaceutical industry could face costs of up to US$16B for developing a single drug by 2043. This financial burden often leads the industry to focus on developing drugs with higher profitability, which can often overshadow the urgency of addressing other critical health needs[(2)].

This inefficiency has significant economic and societal consequences. The high cost of R&D, combined with frequent failures, contributes to escalating healthcare costs, which are ultimately borne by patients, governments, and insurance providers. Additionally, the delays and failures in translating research into viable treatments mean that patients are often left without access to potentially life-saving therapies, exacerbating public health challenges. For example, rare diseases and conditions that affect smaller populations are often overlooked because they are deemed less profitable, despite the pressing need for treatments[(3)].

Why Most Research Does Not Make It Out of the "Valley of Death"

The fundamental issue lies in misaligned incentives, giving rise to three primary challenges: lack of funding, reduced collaboration between researchers and clinicians, and poor replicability and reproducibility of scientific findings. These challenges ultimately result in research falling at the "Valley of Death".

We explore each of these primary challenges in more detail below:

Lack of funding

The lack of funding, especially when moving from the stages of basic research to clinical research, can be attributed to misaligned incentives between funders and researchers, and also a lack of transparency in the grant review process.

From a funder's perspective, they will prioritise actionable research that translates into products that can generate recurring revenue. The knock-on effect is that researchers tend to work towards the expectations of funders given the competitiveness of funding, which means choosing more conservative research and effectively stifling innovation.

Moreover, an opaque review process means that a single proposal to different panels might yield diverse outcomes. In cases where the grant review panel is unpaid, it may lead to other complications such as bias from competing researchers, poor attention to detail, and significant delays in getting grants approved. This means that researchers tend to spend more time working on publications to build a standing within the scientific community, rather than running experiments.

Reduced collaboration between researchers and clinicians

Given that most research falters at the "Valley of Death", alignment between basic researchers and clinicians during translational research is of paramount importance. Effective collaboration fosters the design of innovative clinical trials that integrate biomarkers or personalized approaches derived from basic research. For instance, oncology has seen significant progress through collaborative efforts where genetic and molecular findings from the lab directly inform targeted therapies and trial designs for specific cancer subtypes. Such synergies reduce the risk of late-stage trial failures and improve the likelihood of delivering effective treatments to patients.

However, basic scientists (preoccupied with discoveries) and clinicians (focused on patient care and clinical studies) currently have little motivation to collaborate. Promotions in basic scientific research are often tied to the number of funded grants and publications in top journals, rather than contributions to advancing clinical science and medicine. Conversely, many clinicians whose success is measured by how many patients they treat often have little time or motivation to do research and seek funding opportunities to do it. Therefore, these two groups end up working in silos, which means that the likelihood of aligning laboratory findings with clinical relevance diminishes.

Poor Replicability and Reproducibility of Scientific Findings

Reproducibility refers to the ability to obtain consistent results using the same data, methods, and computational steps as the original study. Replicability, on the other hand, involves conducting a new study to arrive at the same scientific findings as a previous one. Without replicability and reproducibility in scientific findings, it is difficult to prove the validity and soundness of the basic research, which then makes it challenging to extend to clinical applications.

The challenges of translating animal studies to human studies have resulted in inefficiencies — it has been claimed that just 6% of animal studies are translatable to human response[3]. Other problems such as differences in methodological differences (e.g. type of coating on tubes, what temperature are cells grown, how cells are stirred in culture) can also result in complete failure to replicate the results.

While the scale of the problem can largely be attributed to the complexities of science, misaligned incentives between publishers and early stage researchers also play a role in the lack of reproducibility and replicability of scientific findings. Publishers play an important role in establishing early stage researchers, where published work grants greater credibility which increases the chances of funding. Therefore, researchers who manage to get statistically significant findings on the first try are less inclined to repeat the experiment and instead proceed straight to publication[4].

03 / Decentralized Science 101

What is DeSci?

Decentralized Science ("DeSci") is a movement that leverages the Web3 stack to create a new scientific research model.

Blockchains are uniquely positioned to tackle the challenges discussed above, by offering a trustless way to coordinate funding, while ensuring a transparent and immutable way to track and record progress which enables all stakeholder interests to be accounted for.

The DeSci landscape is still very nascent in the crypto industry. This is evidenced by its combined market cap barely exceeding US$1.75B and only 57 projects tracked under the Decentralized Science category on CoinGecko. To put that into perspective, DeFAI (Defi x AI agents) sits at a combined market cap of US$2.7B with just 41 projects, and the wider crypto AI combined market cap is valued at US$47B (as of 15 Jan 2025)

How DeSci can address the "Valley of Death"

As mentioned earlier, most research fails at the "Valley of Death" because of misaligned incentives which give rise to the challenges such as a lack of funding, reduced collaboration and poor replicability and reproducibility of scientific results. DeSci can solve this coordination problem through the use of Decentralised Autonomous Organisations (DAOs), blockchains and smart contracts.

Below, we summarize how DeSci can provide solutions to existing challenges, first presented in a table for clarity, followed by a detailed explanation. As a movement, DeSci addresses these challenges in the following ways:

Challenge	Solution
Lack of Funding	• Stakeholder alignment through DAO formation • Programmatic funding on milestones through smart contract • Transparent decision process through decentralised governance • Shared IP rights through tokenisation
Lack of Collaboration	• Stakeholder alignment through DAO formation • Transparent decision process through decentralised governance • Shared IP rights through tokenisation
Replicability and Reproducibility	• Open access and publishing through blockchains • On-chain attribution and reputation tracking through smart contracts • Tamper proof data and access controls through decentralised storage

How DeSci can address the lack of funding

DAOs can act as a capital formation vehicle for funding research, where participants can be a mix of patients, researchers, and investor communities. Since the stakeholders come together with an aligned goal of seeing the research entering the clinical stage for it to be eventually commercialised, there is a shared incentive to help research across the "Valley of Death".

Decisions taken are done through decentralised token governance, where voting can be done in a transparent and democratic manner. Smart contracts then enforce the parameters that DAOs decide on, while ensuring transparency. Examples include milestone based funding that is released programmatically, tokenisation of intellectual property (IP) that is borne out of the funded scientific research, fractionalisation and distribution of intellectual property to all DAO participants to align interests etc.

Overall, DAOs in the DeSci landscape can provide an integrated end-to-end approach from basic research to clinical research by enabling trustless coordination between various stakeholders towards a common goal.

How DeSci can address reduced collaboration between researchers and clinicians

As discussed above, the primary cause of reduced collaboration is the result of differing incentives between researchers and clinicians. This can be solved through participation in a DAO, where research hypotheses, experiment methodologies and parameters can be agreed upon creation of the DAO, thereby aligning on the research outcomes. Coupled with IP tokenisation, both researchers and clinicians can be sufficiently incentivised and rewarded to see the research through into the clinical stages.

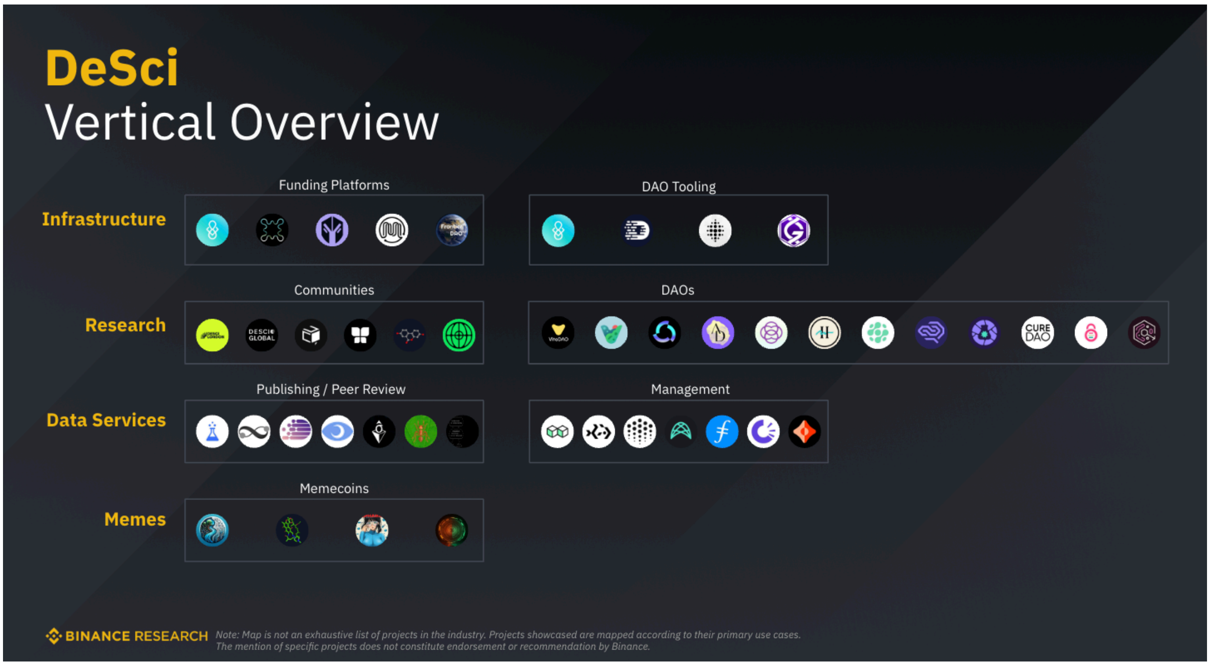
Other tools to foster greater collaboration include platforms that encourage incentivised peer review, where rewards can be programmatically distributed via smart contracts upon a successful review. This can bring clinicians closer to researchers, by giving earlier input that could steer the research towards practical implementation in the clinical stages once successful. An on-chain reputation system can also be built around members of the scientific community based on their contributions to various DeSci DAOs, peer review work, clinical implementations etc., where any work put towards the advancement of science is suitably attributed.

How DeSci can address poor replicability and reproducibility of scientific findings

One way to address this issue is to record research methodologies, experiment designs and every step on the blockchain, which serves as an immutable ledger. This ensures that other researchers have full view over the experiment conducted, and can query every variable, should they wish to repeat the experiment. Furthermore, a new form of publishing that is open and accessible to all can be built using Web3 primitives, where all research (even the failed ones) can be shared. This will remove publication bias where only the successful experiments are published, given there is still value in the data from failed experiments.

Another area where DeSci can help is in the form of data integrity and compliance. While traditional archival storage also fulfills this need, they typically rely on magnetic tapes, which make data retrieval slow. Given the dynamic nature of scientific research, which involves working with the same data across multiple parties while retaining immutability and safety of the data, decentralized storage and data warehouses can be the solution. They can provide the necessary data access controls, offer greater redundancy by removing single points of failure, while offering fast retrieval of data for collaborative work. This should encourage greater rigour over the scientific research conducted, and hopefully increase the probability of replicable and reproducible results.

04 / Overview of DeSci Landscape



Do note that the mention of specific projects does not constitute an endorsement or recommendation by Binance. Instead, the projects cited are merely used for the purposes of demonstrating the examples of digital asset adoption. Additional due diligence should be taken to better understand the projects and associated risks.

We have identified 4 key areas of innovation across the DeSci landscape: **Infrastructure, Research, Data Services and Memes.**

Infrastructure includes subsectors like funding platforms and DAO tooling (e.g. IP tokenisation, DAO formation and legal agreements). These form the building blocks for DeSci DAOs which are at the frontier of scientific discovery.

Research includes grassroot communities such as DeSci Global, DeSci Collective that host events globally to connect DeSci enthusiasts, and DAOs that formalise aligned interests from multiple stakeholders. These DAOs typically focus on different scientific fields such as longevity, hair loss, women's health to name a few.

Data Services includes publishing and peer review platforms that enable open access to scientific publications which can foster greater collaboration, and data management tools to provide strong data integrity and the appropriate access controls.

Memes represent retail interest which can bring greater awareness and education to the DeSci sector which has typically been restricted to academics. Some memecoins directly contribute funding to scientific experiments, while others serve as investment vehicles into other DeSci projects.

In the following section, we dive deeper into some of the subsectors.

Notable Subsectors

Infrastructure: IP Tokenisation / Fractionalisation

IP tokenisation plays a transformative role in advancing translational science by addressing a fundamental barrier in research and innovation: the monetisation and liquidity of intellectual property (IP). Traditional systems for managing and trading IP are cumbersome, centralised, and often inaccessible to smaller stakeholders, limiting the speed at which discoveries can be commercialised and translated into real-world applications. By leveraging blockchain technology, IP tokenisation creates a decentralised and transparent framework, enabling researchers, investors, and other stakeholders to participate in and fund innovative projects more effectively.

IP tokenisation involves the conversion of intellectual property into digital assets, making them tradable and liquid. A project like Molecule exemplifies this process by introducing the concept of IP-NFTs (Intellectual Property Non-Fungible Tokens) and Intellectual Property Tokens (IPT). IP-NFTs bring the IP rights on-chain, while fractionalisation allows multiple stakeholders to collectively govern the IP rights. The desired outcome is stakeholder alignment to ensure sufficient funding to take research through to the clinical stages and eventual commercialisation.

Infrastructure: DAO Formation

DAO infrastructure represents a critical innovation in the decentralisation of science, enabling communities of patients, scientists, and biotech professionals to collectively fund, govern, and own scientific projects. Traditional scientific funding is often limited by centralised institutions, rigid gatekeeping, and opaque processes. DAO infrastructure disrupts this paradigm by providing a transparent, decentralised framework for the curation, funding, and governance of scientific initiatives.

Through DAOs, stakeholders can pool resources, make collective decisions, and directly influence the trajectory of scientific research. An example is that of BIO protocol, which enables the creation, funding, and governance of BioDAOs. Each BioDAO is specialised and focused on various scientific fields such as longevity (VitaDAO), cryopreservation (CryoDAO), hair loss (HairDAO), women's health (AthenaDAO) etc.

Infrastructure: Funding Platforms

Web 3 funding platforms are transforming the way scientific research is funded by decentralising the process and enabling broader participation. Traditional research funding often relies on grants and institutional support, which can be slow, bureaucratic, and limited in scope. Through a form of crowdfunding, it opens up opportunities for researchers to directly connect with funders, communities, and collaborators, fostering a more transparent and inclusive funding ecosystem.

These funding platforms can also differ in terms of the beneficiary of the funding. Examples include Catalyst (targeted at funding DeSci IPs), Bio.xyz launchpad (targeted at funding DeSci DAOs) and pump.science (targeted at funding compounds testing). Web3's composability allows different crowdfunding platforms to align stakeholders at various stages of research, fostering a seamless funding ecosystem. For example, a DeSci DAO funded through Bio.xyz could organise funding through Catalyst for specific IP research, or pump.science for testing and validating compounds in a transparent way.

Data Services: Publishing / Peer Review Platforms

The traditional publishing model for scientific research is often slow, expensive, and inaccessible, with high article processing charges (APCs) and limited transparency in peer review. Additionally, researchers rarely receive credit or compensation for their contributions to the peer-review process. This slows down the pace of review, and increases the likelihood of bias due to competing interests. Overall, this hinders the pace of scientific progress and limits the accessibility of knowledge to broader audiences.

Incentivised peer review and publishing platforms aim to address these issues by creating open and transparent systems where researchers are rewarded for their contributions, including publishing, reviewing, and collaborating. By integrating blockchain technology and community governance, these platforms democratize access to scientific knowledge, accelerate the dissemination of research, and foster collaboration among researchers worldwide. An example of this is ResearchHub where researchers can earn token rewards for peer reviewing articles, or collaborate with like minded individuals in their scientific field of interest. Active contributions to the scientific community can be logged on-chain, building a reputation for scientists and unlocking features such as moderation and access controls

This is also where the crossover with AI is interesting. Projects such as yesnoerror, an AI agent using OpenAI to uncover mathematical errors, are already live. It has the ability to uncover mathematical errors, identify falsified data and detect numerical inconsistencies that could compromise scientific integrity at scale with little to no downtime in between.

Data Services: Data Interoperability and Integrity

The healthcare and biomedical research industries are plagued by fragmented data systems, a lack of transparency, and an absence of patient-centric practices. Patients often donate valuable data and biological samples for research, only to lose visibility and control over how their contributions are used, while rarely benefiting from the scientific or commercial value generated. These gaps have led to mistrust, privacy breaches, and declining participation, particularly among marginalized and underrepresented communities.

Data interoperability and integrity aim to address these issues by creating systems that empower patients with transparency, control, and shared benefits, while also enabling seamless collaboration among researchers, institutions, and enterprises. Interoperable systems allow for the harmonization of disparate data sources, making them usable across networks, while preserving data privacy and integrity. This ultimately accelerates scientific discovery, streamlines clinical R&D, and builds trust in biomedical research.

An example is AminoChain, which is a decentralized platform designed to connect medical institutions and enable user-owned healthcare applications. It gives patients control over their data and samples, ensuring transparency in how they are used and allowing them to share in the value generated by research. Other decentralised data solutions include Filecoin, Arweave, Space and Time, where data is stored securely with no single point of failure, while offering flexible access controls to ensure data is treated with the sufficient care it needs.

05 / Parting Thoughts

We are in the early stages of decentralised science becoming more prominent in the way science is being conducted today. Decentralised science has the potential to align stakeholders from the early stages of research to ensure there is sufficient interest to see research through to the clinical stages.

The infrastructure to coordinate research in a decentralised way is already present. Aligned stakeholders can formalise their shared interest in scientific research in the form of DAOs, provide funding and conduct research where they can own the resulting IP, share data safely within data protection guidelines to enhance collaboration between different scientific communities.

However, the existing stack caters more towards basic and translational research and less so for clinical research. The former research stages require more of trustless coordination, while the latter require coordination with centralized groups such as regulatory agencies, pharmaceutical companies, physical laboratories etc.

Moreover, the legality of DAOs remains an area of ongoing debate and regulatory development. In the case of Ooki DAO, the U.S. District Court for the Northern District of California ruled that Ooki DAO is a "person" under the Commodity Exchange Act[(5)], setting a precedent that DAOs can be held legally accountable. This decision has significant implications for DAO members, as it suggests that token holders who participate in governance could be personally liable for the DAO's actions. Given the lack of clarity over the treatment of DAOs, it could dissuade potential funders.

To sum it up, decentralised science is already mature enough to impact the way scientific research is being conducted today. While there are some gaps and challenges in the current landscape, tackling the “Valley of Death” in research is already a huge step forward.

06 / References

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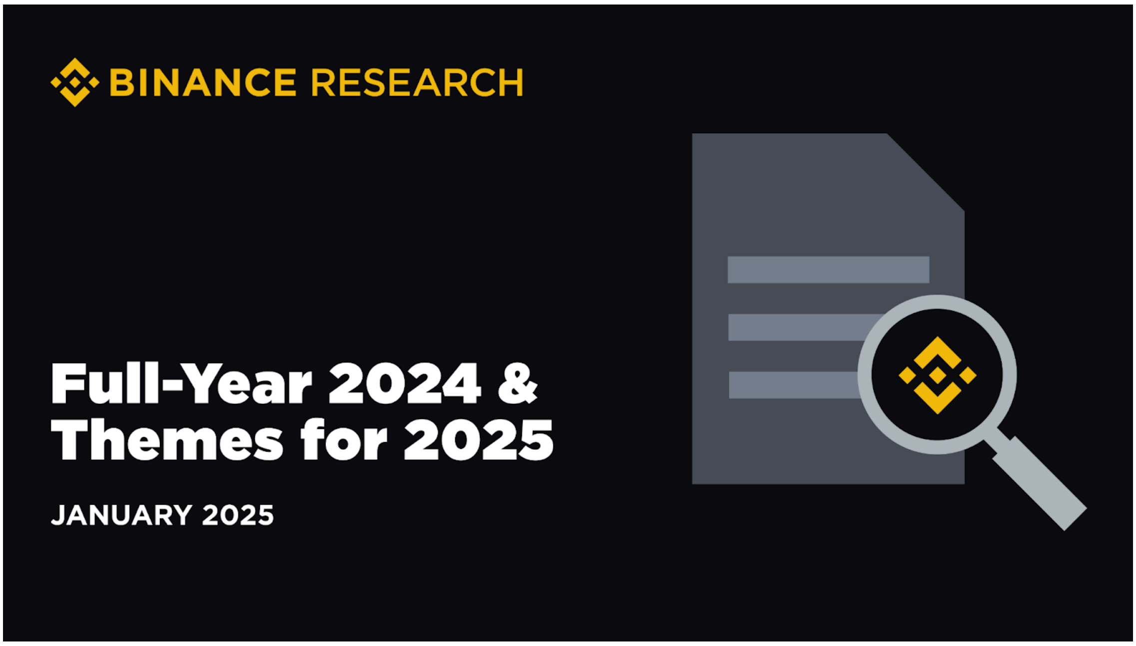
07 / New Binance Research Reports

Full-Year 2024 & Themes for 2025 Link
A crypto-centric review of 2024



Monthly Market Insights - January 2025 Link
A summary of the most important market developments, interesting charts and upcoming events

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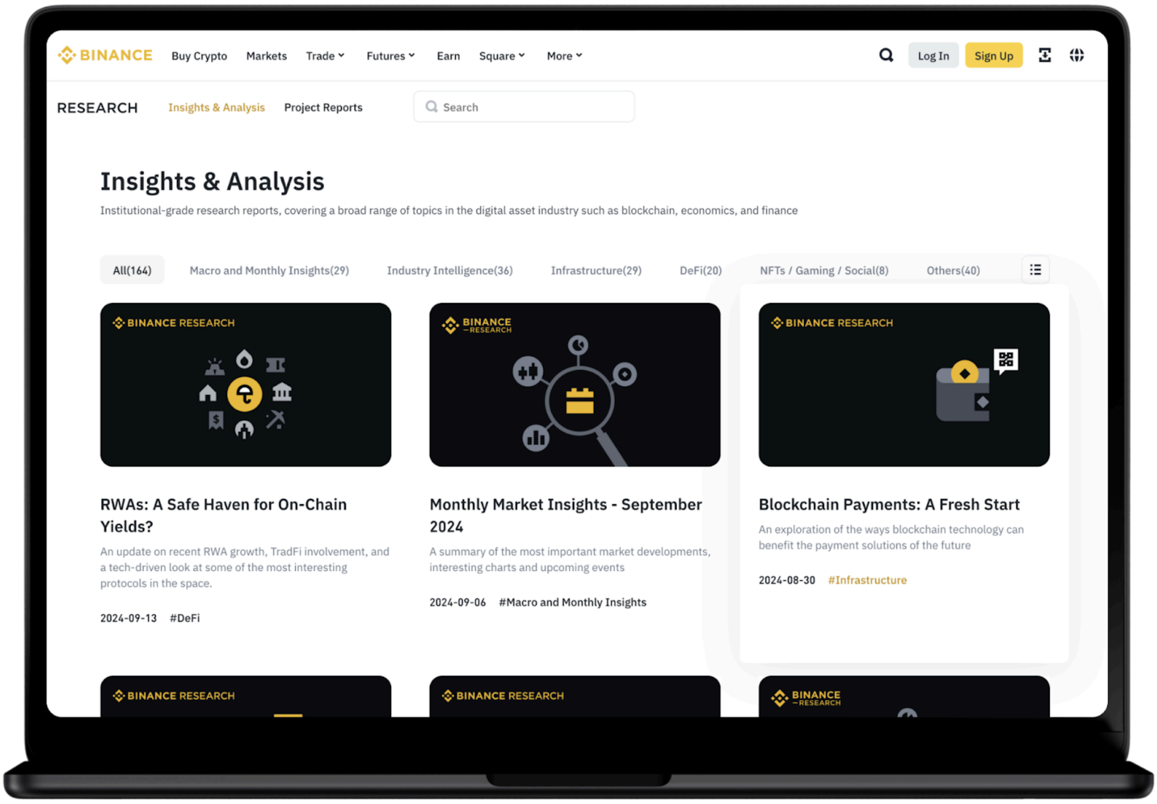

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