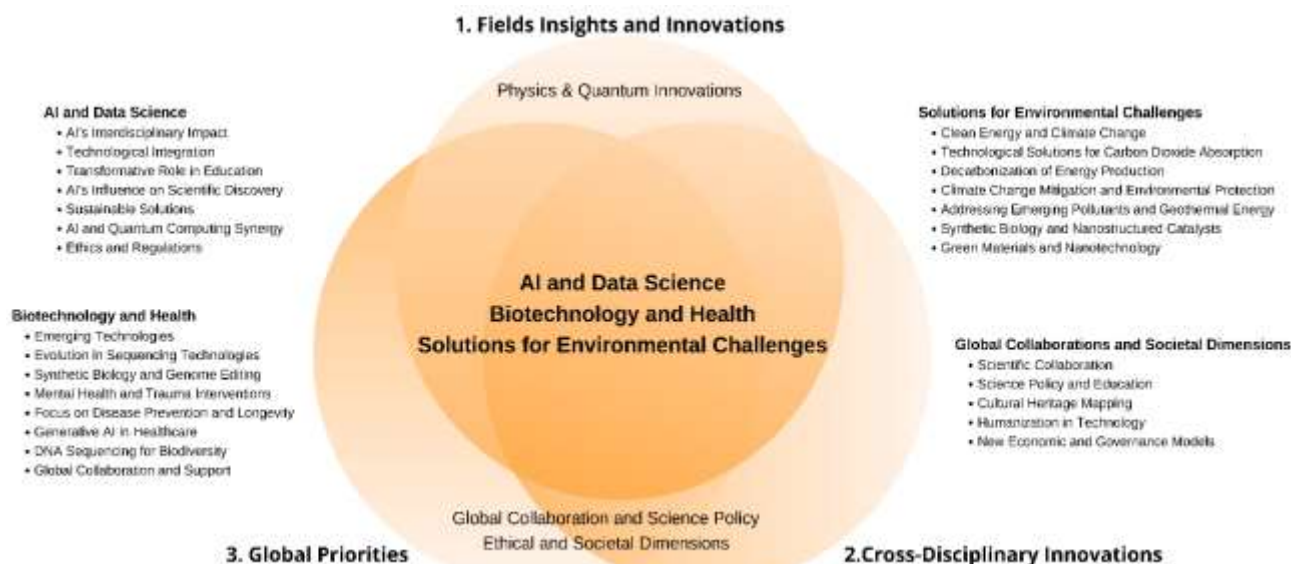# A GYA Outlook on 2024 Scientific and Social Trends

Summary

This concise report outlines the GYA's foresight for 2024 regarding scientific and social innovations, as derived from an internal consultation conducted through an online survey. The survey garnered 20 responses, featuring a balanced representation of gender (9 women, 11 men) and geographical diversity (8 from the Global South, 12 from the Global North). Participants engaged in reflective exercises encompassing their specific fields, exploring cross-disciplinary potentials, and contemplating global priorities for the forthcoming year. Responses were systematically categorised into overarching themes, with three prominent transversal themes identified across the survey sections: AI and Data Science, Biotechnology and Health, and Solutions for Environmental Challenges. The report delineates specific innovations within each theme. The outcomes of this internal consultation serve as a pertinent snapshot, reflecting the thoughts, aspirations, concerns, and expectations of the GYA community. These insights will contribute valuable perspectives to inform the UN Secretary-General's Scientific Advisory Board in navigating the intricate intersection of science and society throughout 2024.

1. Fields Insights and Innovations

Physics & Quantum Innovations

AI and Data Science
- AI's Interdisciplinary Impact
- Technological Integration
- Transformative Role in Education
- AI's Influence on Scientific Discovery
- Sustainable Solutions
- AI and Quantum Computing Synergy
- Ethics and Regulations

Biotechnology and Health
- Emerging Technologies
- Evolution in Sequencing Technologies
- Synthetic Biology and Genome Editing
- Mental Health and Trauma Interventions
- Focus on Disease Prevention and Longevity
- Generative AI in Healthcare
- DNA Sequencing for Biodiversity
- Global Collaboration and Support

Solutions for Environmental Challenges
- Clean Energy and Climate Change
- Technological Solutions for Carbon Dioxide Absorption
- Decarbonization of Energy Production
- Climate Change Mitigation and Environmental Protection
- Addressing Emerging Pollutants and Geothermal Energy
- Synthetic Biology and Nanostructured Catalysts
- Green Materials and Nanotechnology

Global Collaborations and Societal Dimensions
- Scientific Collaboration
- Science Policy and Education
- Cultural Heritage Mapping
- Humanization in Technology
- New Economic and Governance Models

**AI and Data Science
Biotechnology and Health
Solutions for Environmental Challenges**

Global Collaboration and Science Policy
Ethical and Societal Dimensions

3. Global Priorities

2. Cross-Disciplinary Innovations

Introduction

In the global arena of science and social innovations, the Global Young Academy (GYA) stands out as a model of collaborative excellence, bringing together early and mid-career scientists and scholars from diverse disciplines across continents. As a distinctive gender-balanced organisation, the GYA captures a multitude of perspectives, fostering a unique environment for the exchange of ideas and insights.

As part of the Network of Scientific Institutions within the UN Secretary-General's Scientific Advisory Board, the GYA holds a significant role in contributing to discussions on emerging scientific and social trends. Recognising our distinctive character, the Board sought our organisation's perspective on the outlook for 2024, underscoring our commitment to being a resonant voice within the global scientific community. In response to this high-level request, the GYA leadership convened a thoughtful internal consultation.

This concise report delineates how the GYA envisions 2024 in terms of scientific and social innovations, providing a glimpse into the anticipated challenges and innovations on the near horizon. The internal consultation, conducted from 21 December 2023 to 10 January 2024, engaged our global membership through an online form. This inclusive approach ensured a comprehensive representation of insights, reflecting the voices of our diverse and multidisciplinary community. Participants were prompted to reflect on emerging innovations within their respective fields, explore cross-disciplinary possibilities, and consider global priorities that warrant attention in the upcoming year.

The 20 respondents represented a diverse cohort hailing from 15 different countries. Geographically, 8 respondents were from the Global South, while 12 were from the Global North. Gender distribution among participants revealed 9 women and 11 men, reflecting a balanced engagement of perspectives in the survey.

It is crucial to acknowledge that while this consultation and report may not represent a fully refined product, they serve as a valuable snapshot of the aspirations, concerns, and expectations of the GYA community as we navigate the complex interplay of science and society in the year ahead.

Organised into three sections, this report provides a comprehensive view of the GYA's collective outlook for 2024. The first section delves into the perspectives of our members within their respective fields, examining emerging innovations and potential transformative impacts. Subsequently, the second section broadens the perspective, capturing insights from diverse disciplines beyond our experts' areas of specialisation. Finally, the third section unveils global priorities as perceived by our community, offering thoughtful recommendations on where support, funding, governance, and advocacy should be directed to address pressing global challenges. Together, these sections illuminate the opinions and anticipations within the GYA for the year 2024.

1. Field Insights and Innovations: Perspectives of GYA Members within their Respective Fields of Expertise.

Exploring the question, "Within your field of expertise, are there any emerging innovations that you foresee having a transformative impact in 2024?" the respondents' thoughts on these potential innovations weave together a diverse range of perspectives, grouped into distinct themes. This classification (Table 1) illuminates the multidisciplinary and interconnected nature of the respondents' visions, providing a nuanced perspective on the transformative innovations anticipated across various fields in the starting year.

AI and Data Science: Respondents highlighted the game-changing role of artificial intelligence and data science. From unravelling climate change to enhancing clinical diagnostics and redefining education, the fusion of AI and data-driven technologies stands poised to redefine how we approach challenges across different disciplines.

Biotechnology: The survey unveiled a focus on biotechnological and medical breakthroughs. Whether it's the frontiers of memory technologies, the precision of diagnostic tools, or the groundbreaking potential of gene editing and bioeconomy, there's an evident surge in endeavours that promise to reshape healthcare, agriculture, and sustainable practices.

Innovative Solutions for a Sustainable Future: Environmental and energy solutions took centre stage, reflecting a collective thought towards addressing emerging pollutants, tapping into geothermal energy, and harnessing nanotechnology for sustainable applications.

Ethical Considerations in the Digital Era: Ethical considerations took a place within the realm of information technologies. Respondents emphasised the need for ethical AI governance, recognising the enduring impacts of research beyond the immediate horizon.

Physics and Quantum Insights: A theme revolved around the long-term outcomes of scientific research, particularly in physics and quantum innovations, as well as breakthrough announcements of astronomical projects.

Sustainable Nanotechnology and Material Science: A cohesive theme of sustainable nanotechnology and material science emerged, highlighting the growth of green materials and their applications in agro-nanotechnology, antimicrobial resistance, and targeted cancer treatment. This trend signals a conscious shift towards eco-friendly material innovations.

Table 1. Perspectives of GYA members within their fields of expertise.	
Identified Categories	**Survey Responses**
AI and Data Science	o Spatial database related to climate change and environmental impacts. o Real-world data in clinical R&D. o Applications of AI to mimic human attributes and behaviour. o Computational Protein Design (using AI). o Generative AI may have an impact on transforming education and assessment. In particular, new important aspects of education that should be taught to every learner in every school that drive and contribute towards sustainable development goals - such as climate change education, scientific literacy, global citizenship, emotional intelligence, and AI literacy. If new forms of teaching and assessment (e.g. more fun, interactive, relevant and engaging) can be implemented in every school, the global youth mental health problems will decline. o Ethics and regulations of AI.
Biotechnology and Medical Innovations	o Emerging memory technologies for neuromorphic computing and low-intensity-light photovoltaics. o Advanced Diagnostic Tools: Technologies that combine fluorescence-based chemosensors and biosensors with AI and machine learning algorithms for more precise and early diagnosis of diseases. o Sequencing technologies continue to evolve with new sequencers becoming more efficient and accessible beyond research. o Bioeconomy, bio-based products, health/well-being. o Innovative synthetic biology, particularly CRISPR-based genome editing techniques, is enhancing crops without falling under the conventional GMO category. This distinction allows for quicker cultivation and market entry compared to traditional biotech counterparts. These modified crops offer benefits such as biofortification for consumers and pest resistance for farmers. In a different domain, human gene therapy, first approved in December 2023, holds

		promise for treating various ailments in 2024. Additionally, synthetic biology continues to impact the food industry by producing plant-based and cultured protein sources. Looking at the environmental perspective, I anticipate progress in developing enhanced gene-drive organisms. These advancements aim to address invasive species and reduce the incidence of vector-borne diseases in the future.
	o	Ongoing work regarding mental health/trauma interventions provided by trained lay people in low-resource settings.
Environmental and Energy Solutions	o	Tackling emerging pollutants from freshwater to the sea, the effect of climate on biodiversity.
	o	Innovations in geothermal energy may lead to a radical change in our preferences for the source of renewable energy.
	o	Synthetic biology will start to dramatically decrease energy, fertilizer, pesticide, and waste associated with the production of valuable chemicals.
	o	Nanostructured Catalysts: The ability to fine-tune both the structure and chemistry of catalysts opens many doors to reducing our dependence on natural resources and energy while minimizing industrial CO_2 emissions. These include mesoporous zeolites that convert plastics into useful products and fuels, nanostructured electrodes that convert CO_2 into chemicals and fuels, and nanophotocatalysts that convert CO_2 and water into chemicals and solar fuels using only visible light as an energy source.
	o	Within the fields of materials science and nanotechnology, significant growth will be seen using green materials and green chemistry to develop multifunctional and multidimensional nanomaterials for agro-nanotechnology applications (which may include nanofertilizers that have a higher nutrient use efficiency, less manufacturing and application costs, and can be designed towards targeted nutrient release), antimicrobial agents to support antimicrobial resistance, and anticancer agents as a more targeted approach to cancer treatment.
Physics and Quantum Innovations	o	Long-term outcomes of scientific research, including quantum computers, quantum communication, and data derived from astronomical projects.

2. Cross-Disciplinary Innovations: Insights from Diverse Disciplines Beyond GYA Members' Areas of Expertise.

As we expand our vision beyond individual expertise, the panorama of transformative innovations broadens, revealing interconnected threads through diverse disciplines. When asked "Beyond your field of expertise, are there any emerging innovations that you foresee having a transformative impact in 2024?" respondents foresee a range of advancements set to redefine the scientific landscape in 2024. Here, we categorise and explore these responses (Table 2) to provide a holistic view of the cross-disciplinary innovations that can potentially shape our collective immediate future.

Quantum Computing and AI Integration: Signifies a pivotal convergence with transformative implications across material design, healthcare, blockchain technologies, air purification, and the Internet of Things.

Biodiversity and AI Synergy: Advances in DNA sequencing technologies intersect with AI, elucidating genetic cataloguing for biodiversity studies and climate change protection.

Ethics-Driven Humanisation in Technology: Underscores the imperative to infuse technological advancements with ethical considerations, emphasising the rehumanisation narrative in innovation.

Healthcare Frontiers: Gene therapy emerges as a focal point for addressing intractable diseases, complemented by the deployment of CRISPR-CAS9-based genome editing. Disease Prevention, Longevity, and

Food as Medicine signify a comprehensive healthcare paradigm embracing medical and nutritional advancements.

Nanotechnology in Medicine: Nanorobots pioneer cancer treatment, exemplifying the intersection of nanotechnology with medical interventions.

Cultural Heritage Mapping: Illuminates the fusion of technology and heritage preservation, delineating a commitment to safeguarding collective history.

Interdisciplinary Sustainability Endeavours: Clean Energy, Sustainable Production, AI, and Climate Change integration exemplify a concerted effort to address global challenges through interdisciplinary solutions.

Table 2. Insights from diverse disciplines beyond GYA Members' fields of expertise.	
Identified Categories	**Survey Responses**
Artificial Intelligence & Machine Learning	o Artificial Intelligence. o AI for accelerating scientific discovery. o AI-driven material design and healthcare, blockchain technologies, cost-effective air-purification systems (sustainable mitigation of airborne diseases); self-powered Internet of Things. o Applications of machine learning to extract findings across existing public and (private) research data. o The application of Artificial intelligence in different fields will have transformative impacts. o New AI and machine learning applications will continue to grow in 2024, bringing more complexity to the international regulatory landscape. o Generative AI will have a more significant impact on drug discovery, whilst machine learning and chemometrics may have more routine use in environmental, forensic, food, and health research. The potential of ChatGPT will also extend to the healthcare and clinical settings. o The integration of quantum computing and AI is anticipated to significantly advance various areas such as drug discovery, medical research, genome sequencing, precision medicine, cybersecurity, and financial modelling. The enhanced computing and processing power of quantum computers will enable AI models to handle massive datasets and produce novel outputs, leading to significant growth in scientific research and applications.
Health and Disease	o Disease Prevention/ Longevity/ Food as Medicine. o Gene therapies finally deliver cures for intractable diseases. o CRISPR-CAS9-based genome editing for the health and food industry. o The use of nanorobots to treat cancer. o Vaccine development for tropical diseases like malaria, Lassa fever, etc. o There is notable excitement around Generative AI and its potential to transform healthcare delivery. AI technologies are anticipated to bring groundbreaking changes in the healthcare sector, impacting areas like diagnostics, treatment planning, and patient care management.
Biotechnology	o Better DNA sequencing technologies can allow better genetic cataloguing of biodiversity. Increased genetic knowledge of species on earth can allow inquiring into their adaptation to environmental conditions, which is a step forward to using this knowledge for climate change protection of species. At the same time, AI can enable a better use of these discoveries, train models

	from well-characterized species, and speed up discovery in other less-characterised ones. o Genetically Modified Organisms.
Clean Energy and Climate Change	o Clean energy, sustainable production, climate change. o Development of technology for atmospheric carbon dioxide absorption, advancements in nuclear fusion, and progress in the field of AI (within a five-year time frame) o Decarbonization of energy production by replacing fossil fuel-based energy sources with alternative sources such as biowaste that may generate less carbon dioxide will have to be prioritised in light of climate change.
Cultural Heritage Mapping	o Building a map-based database of cultural heritage.
Humanization in Technology	o Insights into how to "rehumanise" (instead of dehumanising) others will be key for peace-building efforts. In general, there is an enormous need for an equity and justice lens on policy developments and technological innovations (e.g. AI).

3. Global Priorities for 2024.

In response to the question "Considering global challenges, which scientific and social innovations do you believe the UN System should prioritise in terms of support, funding, governance, or advocacy in 2024?", participants outlined their perspectives on pressing global issues. The diverse range of responses (Table 3) reflects a keen awareness of the interconnected nature of challenges that demand innovative solutions.

Table 3. Priorities for the UN in 2024 according to surveyed GYA Members.	
Identified Categories	**Survey Responses**
Climate Change and Environmental Protection	o Climate change. o Climate change impacts. o Climate Change and Environmental Protection. o Strengthening of One Health Approach and implementation of The Biodiversity Plan. o Reaching net-zero emissions and even net-carbon removal to mitigate the climate emergency.
Health and Disease	o Disease Prevention/Longevity/Food as Medicine. o Support the use of AI for diagnosis of diseases and drug repurposing. o Vaccine development funds for African scientists. o Computational Protein Design and Genome Editing. o Clean air technologies for airborne diseases
AI & Technological Innovations	o Artificial intelligence and blockchain technologies. o Digital Future and Technological Innovations. o Education and Assessment Transformation in every school. o Facilitation of AI literacy for scientists outside computational sciences to harness existing technologies, enabling new applications. This also involves creating interdisciplinary spaces of interaction, funding for challenges, hackathons and interdisciplinary research, always including fundamental research. o Understanding the impacts of advances in AI and machine learning on humans and scientific discovery.
International Scientific Collaboration and	o Establish a network of international laboratories for scientists from different countries.

Science Policy and Education	o Development of innovative leadership on a global scale and offer assistance, financial backing, governance, or advocacy for better leadership. o Policy studies support both social and natural scientists. o Education and Assessment Transformation in every school.
Economic and Governance Models	o Decarbonization of all economies. o Sustainable cities, well-being, local production & consumption. o Alternative governance models beyond capitalism, neoliberalism, socialism, and communism, incorporating social data analytics. o Humanitarian Aid and Crisis Management. o A comprehensive, holistic approach to climate change, conflict and migration.
Utilization of Waste and Green Chemistry	o More dedicated monetary support should be channeled to research focused on using green chemistry for the development of biomaterials, nanomaterials, and energy storage materials. Utilizing green waste also significantly supports the bio-circular-green economic model currently only implemented in a few countries such as Thailand and the European Union.

Discussion and Conclusions

This short report provides insight into the GYA's vision for 2024 concerning scientific and social innovations, shedding light on the anticipated challenges and breakthroughs on the imminent horizon. The responses from the survey have been categorised into themes, and noteworthy amongst them are three transversal themes (Figure 1) cutting across the three survey sections:

1. **Artificial Intelligence and Data Science.** In 2024, AI stands not just as a technological tool but as a transformative force shaping the future of research, education, and societal progress.

    o AI's Interdisciplinary Impact:
        ▪ Facilitation of AI literacy for non-computational scientists.
        ▪ Creation of interdisciplinary spaces for collaboration.
        ▪ Support for fundamental research.
    o Technological Integration:
        ▪ Integration of AI with blockchain for enhanced security.
        ▪ Digital future shaping technological landscapes.
    o Transformative Role in Education:
        ▪ Revolutionising education through AI-driven approaches.
        ▪ Innovative assessment methods driving transformative learning experiences.
    o AI's Influence on Scientific Discovery:
        ▪ Acceleration of scientific breakthroughs across diverse fields.
        ▪ Growing complexity in international regulatory landscapes.
    o Sustainable Solutions:
        ▪ Application of AI in sustainable solutions like air-purification systems.
        ▪ Addressing environmental challenges through spatial databases.
    o AI and Quantum Computing Synergy:
        ▪ Anticipation of revolutionary advancements in drug discovery, medical research, and cybersecurity.
        ▪ Enhanced computing power for handling massive datasets.
    o Ethics and Regulations:
        ▪ Ongoing considerations and regulations addressing the ethical dimensions of AI.

2. **Biotechnology and Health.** The synergy between biotechnology and health technologies unfolds, promising transformative solutions that span across agriculture, healthcare, and environmental conservation in 2024.

   o Emerging Technologies:
      - Neuromorphic computing and low-intensity-light photovoltaics.
      - Advanced diagnostic tools combining fluorescence-based sensors with AI.
   o Evolution in Sequencing Technologies:
      - Increased efficiency and accessibility beyond research.
   o Synthetic Biology and Genome Editing:
      - CRISPR-based genome editing in agriculture and human gene therapy.
      - Distinctive benefits of modified crops and potential for treating various ailments.
   o Mental Health and Trauma Interventions:
      - Laypeople providing interventions in low-resource settings.
   o Focus on Disease Prevention and Longevity:
      - Emphasis on food as medicine and gene therapies delivering cures.
      - Nanorobots for cancer treatment and vaccine development for tropical diseases.
   o Generative AI in Healthcare:
      - Transformation of healthcare delivery through AI technologies.
   o DNA Sequencing for Biodiversity:
      - Better genetic cataloguing for biodiversity conservation.
      - AI-enabled utilization of genetic discoveries.
   o Global Collaboration and Support:
      - Vaccine development funds for African scientists.
      - Support for disease diagnosis and drug repurposing.

3. **Solutions for Environmental Challenges**. In 2024, the environmental solutions landscape is marked by a holistic approach, blending technological innovations with sustainability goals.

   o Clean Energy and Climate Change:
      - Prioritisation of clean energy and sustainable production.
      - Urgent focus on climate change mitigation.
   o Technological Solutions for Carbon Dioxide Absorption:
      - Development of technology for atmospheric carbon dioxide absorption.
      - Advancements in nuclear fusion and AI within a five-year timeframe.
   o Decarbonisation of Energy Production:
      - Replacing fossil fuel-based energy sources with alternatives.
      - Priority on biowaste for reduced carbon dioxide generation.
   o Climate Change Mitigation and Environmental Protection:
      - Strengthening the One Health Approach and implementing The Biodiversity Plan.
      - Commitment to reaching net-zero emissions and net-carbon removal.
   o Addressing Emerging Pollutants and Geothermal Energy:
      - Tackling emerging pollutants from freshwater to the sea.
      - Innovations in geothermal energy for radical changes in renewable energy preferences.
   o Synthetic Biology and Nanostructured Catalysts:
      - Synthetic biology decreases energy, fertiliser, pesticide use, and waste.

- Nanostructured catalysts for converting plastics, CO2, and water into useful products and fuels.
  - Green Materials and Nanotechnology:
    - Utilisation of green materials and chemistry in materials science and nanotechnology.
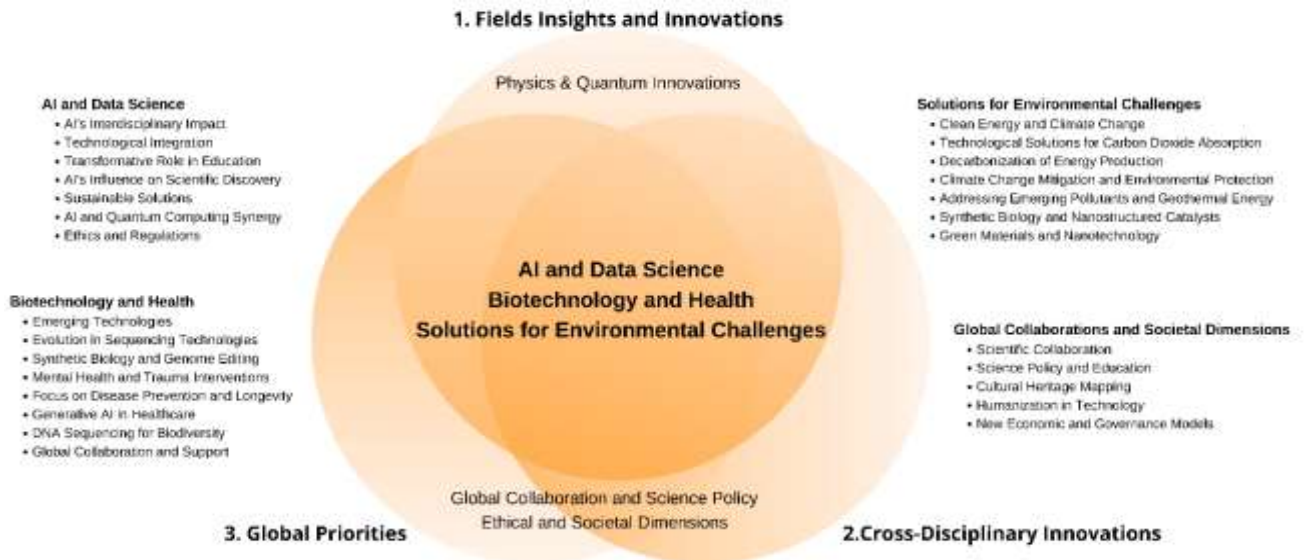   - Development of multifunctional nanomaterials for agro-nanotechnology applications

Figure 1. Overview of Themes and Trends in Scientific and Social Innovations Anticipated for 2024 as Identified by Surveyed GYA Members.

In addition to these, the report highlights multidisciplinary areas deserving priority attention from the UN, such as Global Collaboration and Science Policy (encompassing International Scientific Collaboration, Science Policy and Education, and Cultural Heritage Mapping) and Ethical and Societal Dimensions (covering Humanization in Technology and Economic and Governance Models). The GYA members also anticipate significant announcements on Physics, Quantum, and Astronomy, underscoring the diverse and expansive nature of scientific foresight for 2024.

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