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Review

Shaping the future of bioscience in Africa: The role of young scientists

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Africa's young population represents a dynamic force capable of driving innovation and scientific progress. In biosciences, young people have demonstrated keen interest, as seen in the rise of youth-led organisations dedicated to training and mentoring the next generation of scientists. However, this enthusiasm often wanes due to systemic challenges such as limited mentorship, inadequate research infrastructure, and insufficient investment from national governments in basic and translational research. Despite these barriers, young bioscientists are taking initiatives, leveraging digital tools, forming collaborative communities, and creating grassroots programs to fill existing gaps. In this paper, we provide evidence of this growing interest by spotlighting some youth-led non-profits that are fostering scientific training, mentorship, and research development across the continent. We discuss how these groups are creating opportunities for their peers and the upcoming generation of scientists despite some having lacked such support themselves. For these efforts to be sustainable and transformative, they require structured support, particularly through funding, policy reforms, and institutional backing from governments and private stakeholders. We offer insights into how young African scientists can be empowered to lead the future of biosciences on the continent, ensuring that their passion translates into long-term scientific and economic advancement.

Key words: African bioscience, bioscience education, emerging scientists.

INTRODUCTION

Africa has been described as the youngest continent, with an under-25 populace of over 60% (United Nation [UN], 2017). Young people throughout history have been known as energetic and creative change agents whose efforts

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continue to pioneer the adoption and expansion of new technologies and innovations. On the continent, they not only make up a sizable proportion of the working class but also lie at the forefront of those leading solutions-driven initiatives, championing sustainable development goals (SDGs), and lending voices to call for accountability in governance (UN, 2017). While youths have been a subject of interest in the burden of crime, substance use, and unemployment plaguing various African societies (Ismail and Olonisakin, 2021), they also drive interest in biosciences as discussed subsequently.

Bioscience, a branch of the natural sciences, involves studying life—from tiny viruses, prions and unicellular organisms to complex multicellular plants and animals. Some sub-disciplines in bioscience include biochemistry, microbiology, zoology, botany, genetics, molecular biology, cell biology, public health, behavioural sciences, epidemiology, and environmental biology. Other equally relevant branches are genomics, bioinformatics, immunology, toxicology, parasitology, biophysics, and evolutionary biology. Bioscience provides a framework that allows scientists and society to understand and tackle various global health concerns such as climate change, food insecurity, and disease outbreaks. Among its contributions in Africa are efforts channelled into diagnosing and managing diseases, improving agricultural yield, and synthesising new therapeutics (Klynveld Peat Marwick Goerdeler [KPMG], 2015; Virgin et al., 2016).

For instance, the Africa Centres for Disease Control and Prevention (Africa CDC) has been instrumental in promoting pathogen genomics, which involves the genetic sequencing of disease-causing organisms. Also, Nature Africa (2023) highlights the bioinformatics capacity in Uganda, where scientists are leveraging next-generation sequencing technologies to improve public health responses (Olono et al., 2024). Similarly, the BioInnovate Africa programme in Eastern African countries like Ethiopia and Tanzania (Virgin et al., 2016) and research initiatives led by institutions like the International Institute of Tropical Agriculture (IITA) in Western Africa (Feleke et al., 2021) have been pivotal in supporting bioscience innovations, such as improving crop yields and developing sustainable agricultural practices that contribute to economic, social, and environmental outcomes. These initiatives have proven critical in monitoring and controlling infectious diseases, addressing food security, and promoting sustainable development across the continent.

The COVID-19 pandemic presented an avenue and rationale for maximising the interconnectedness of bioscience's numerous sub- and allied disciplines. However, it also unravelled the continent's weak structures, posing a challenge for African governments and agencies to strengthen local scientific research and development (R and D) (Nkengasong and Tessema, 2020; World Bank, 2021). While a few countries, such as South Africa, Egypt, and Morocco, have relatively developed bioscience industries, the majority continue to wobble (KPMG, 2015), depending considerably on foreign funding agencies for support. Despite making up around 15% of the world's populace and accounting for 25% of the global burden of diseases, Africa only contributed 1% to global R&D in 2016 (Schemm, 2013), with earlier commitments made by the African Union member states to invest 1% of national GDP in R&D reneged upon (African Union, 2007; Simpkin et al., 2019).

Here, we argue that Africa's growing pool of young bioscientists–individuals under 40 years of age with at least a Bachelor's degree in the life sciences–holds the key to reversing this trend, especially through youth-led communities catering to the needs of next-generation scientists. We describe how young and emerging African scientists can contribute to supporting, strengthening, and shaping the bioscience ecosystem in the continent and provide a snapshot of the various factors that could hamper or enhance this potential. We highlight useful opportunities, including increased investment, favourable policies, and targeted collaborations that may be leveraged to transform the current bioscience landscape in Africa. This article intends to offer African governments, educational and research institutions, and private agencies a guide on some of the most promising approaches to building the Africa we will all take pride in as bioscientists.

CRITICAL CONTINENTAL ISSUES ADDRESSABLE BY BIOSCIENCE

Africa is a diverse and evolving continent with different national issues across its countries. While some of these issues, like climate change, are a global problem, a few are more peculiar to African countries and can be addressed with bioscience solutions.

Food insecurity

Any society's socio-economic and environmental well-being relies on the efficiency of its agricultural sector. Despite abundant natural resources potentially available to support current population growth, there is a relative decline in agricultural production in many regions of Africa (Saghir, 2014). To illustrate this, Thailand, with less than 100 million people (World Health Organisation [WHO], 2022), contributes more to the global food market than the entire African continent and its billion people (Saghir, 2014). Also, the percentage of the African population who are malnourished and severely food-insecure has increased by approximately 20% (over 300 million people) since the COVID-19 pandemic (UN Environmental Programme, 2024). The major challenges combating African agriculture include the huge dependence on rainwater for crop cultivation, poor pest management and control, climate change, political and security issues, and the lack of resources (human, funding, machinery) for large-scale farming. Additionally, agricultural research

focused on local needs is poor (Masehela and Barros, 2023; Shimeles et al., 2018). For instance, following the Green Revolution and the resulting increase in the production of grains like rice, wheat, and corn, there was a corresponding decline in indigenous crop production, particularly those rich in micronutrients (Pingali, 2023). Systematically integrating bioscience technologies could tackle food insecurity and meet rising population needs.

Poor healthcare

Africa faces several healthcare challenges, primarily inadequate human resources, inadequate financial allocation, and poor management and leadership. Other contributing factors include drastic climate conditions like drought, health system corruption, and lack of evidence-based interventions (Oleribe et al., 2019). These issues increase the rates of preventable diseases and maternal and infant mortality and reduce overall life expectancy. The absence of advanced medical technologies coupled with situations like sociopolitical instability and conflict further worsens these problems and leaves many communities vulnerable to health crises (UN Environmental Programme, 2024). Africa is experiencing an epidemic of non-communicable diseases like cancer, heart diseases, and mental health disorders, accounting for up to 37% of deaths in 2019 (WHO Africa, 2022). Bioscience techniques can contribute to the development of rapid diagnostic tools and address the shortage of medical supplies, which will, in turn, improve patient outcomes and the survival rate.

Genetic under-representation

The genetic diversity in Africa has sparked increased interest from global players (Mulder et al., 2021). However, despite the extensive diversity and its huge contribution (about 25%) to the global disease burden, the continent contributes only about 1% of the world's research output (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2015) and has little publicly available population-level data. This data scarcity from African ancestry limits researchers' ability to identify rare African variants. For instance, a study showed that out of about 2,000 linguistic groups in Africa (Mulder et al., 2021), only 910 genomes of individuals of African ancestry were used to assemble a human pan-genome (Sherman et al., 2019). Such underrepresentation often leads to misdiagnosis of individuals of African ancestry, such as the case where patients were misdiagnosed with hypertrophic cardiomyopathy due to lack of access to non-European data, and patients from African ancestry received reports with variants misclassified as pathogenic (Manrai et al., 2016). The current trend in medical interventions to employ genomic data in providing accurate and personalised diagnosis and treatment places Africa in a dangerous spot, as African genetic diversity is largely under-represented in global datasets (Mulder et al., 2021). Increased funding, improved policies, and institutional support to advance bioscience research and development relevant to the African continent's cultural, biological, climatic, and physical contexts are urgently needed (Bjornlund et al., 2020).

CHALLENGES OF PRACTICING BIOSCIENCE AS A YOUNG SCIENTIST IN AFRICA

The role of young scientists in shaping the future of bioscience in Africa cannot be overstated. However, significant barriers to the full participation of young scientists exist, the most important of which are highlighted here.

Limited funding and unfavourable policies

Although rich in mineral resources, which have been widely exploited and the gains reaped by a few (UN Environmental Programme, 2024), Africa has long been plagued by poverty, a barrier that has stifled the development of its bioscience sector. Statistics show that Egypt spent about 8 billion dollars on research and development in 2022, the highest amount spent by any African country, compared to the 679 billion dollars spent by the United States of America in the same year (Statista, 2024). Aside from the fact that Africa is often portrayed as a continent of low-income countries with political instabilities, African governments do not invest much in scientific research (Etoka-Beka and Samba-Louaka, 2022). Research showed that aside from Egypt, South Africa, Algeria, Kenya, Morocco, and Nigeria, most governments in African countries did not invest up to 1 billion US dollars when years 2020, 2021, and 2022 were put into consideration, with countries like Angola being as low as 0.06 billion dollars (Statista, 2023). Thus, with little or no access to funding, research is barely translational, discouraging young scientists from pursuing research on the continent. As most international funding agencies require counter-funding—recipient countries to cover certain percentages of the total cost—many African countries simply cannot afford such expenses (Bendana, 2019) and sometimes lose out on such opportunities.

Gender inequality

Despite accounting for around half of the general population, females represent only a third of the scientists in Sub-Saharan Africa (UNESCO, 2015). Gender stereotypes, alongside societal pressures of marriage and child-bearing, continue to deter young women from pursuing careers in science research (McKinnon and O'Connell, 2020; World Bank, 2020). Cultural biases that prioritise male education and limit access to quality

education for women (Founou et al., 2023) are also prevalent in several African communities to date.

Lack of mentorship

Mentorship plays an important role in influencing professional and scientific growth (Ke et al., 2022; van Balen et al., 2012) by aiding the development of relevant skills in research, scientific communication (writing and presentation), networking, and fundraising (grant writing). In different studies (Beaudry et al., 2018; Kumwenda et al., 2017), under-40 scientists have ranked a lack of mentoring and training opportunities as the third and fourth barriers to research growth and professional development after the absence of funding. Respondents also indicated most senior researchers declined mentorship roles and avoided training young researchers for unexplained reasons. The negative impact of these barriers was reportedly more prevalent among those in STEM fields, hindering the progress of young African scientists (Etoka-Beka and Samba-Louaka, 2022), and even worse, there is no proof that the situation has improved after almost a decade.

Lack of opportunities

A potential offshoot of the above barrier, also described by Etoka-Beka and Samba-Louaka (2022) and Kumwenda et al (2017), is the lack of attractive career outcomes in scientific careers. According to the World Economic Forum (2024), Africa has only 20 health researchers per million people compared to Europe's 246 researchers per million—a wide gap exists. About 23.6 million young Africans are unemployed, while those employed are not working in their studied disciplines (Mastercard Foundation, 2024). The early stage in a young scientist's journey in bioscience research requires a lot of effort and is highly time-consuming. With limited career opportunities, many young African bioscientists take up roles in other sectors to make ends meet, shelving their dreams in the process. For those science-related positions available, there is usually a high level of nepotism or such low remuneration that survival instincts force young scientists to pursue more profitable professional pathways (South African Council for Natural Scientific Professions, 2022).

The japa syndrome (Brain Drain) and diaspora racism

Issues such as limited training and funding opportunities, poor mentorship, and unappealing research environments and working conditions consequently cost African nations one of their greatest assets. They have led to the high emigration of skilled and young researchers (brain drain), with over 10% of sub-Saharan Africans with graduate degrees emigrating constantly (Lawal et al., 2022; Ndejjo et al., 2022; Simpkin et al., 2019). This emigration often happens in groups rather than individually, where individual scientists of a certain cohort in an academic year actively assist each other in securing better scientific career opportunities outside the continent. This then creates another barrier termed 'racism' by Etoka-Beka and Samba-Louaka (2022). The authors stated that most African researchers in the diaspora are often portrayed as superior researchers compared to those in Africa. If this trend of 'racism' continues, most young scientists will prefer to leave the continent to have better opportunities and avoid being sidelined, which contributes significantly to brain drain in the continent. And the cycle continues.

OPPORTUNITIES FOR THE AFRICAN BIOECONOMY TO BENEFIT FROM ITS YOUNG SCIENTISTS

As highlighted above, young African scientists face several barriers that prevent or reduce their active and efficient involvement in bioscience research in Africa. Despite these challenges, it has been established that the future of R&D in academia and industry on the continent largely rests on the shoulders of its young scientists (World Economic Forum, 2024).

Youthful brilliance and creativity

Previous reports have shown that the greatest research output and transformative innovative ideas occur more predominantly within the 20s and 30s age of most individuals and those at the early stages of their careers (Dietrich and Srinivasan, 2007). Productively engaging young scientists enables sustainable development and drives innovation and knowledge creation, which are crucial for economic growth (Adebisi et al., 2024). This underscores the huge opportunities and potential that Africa stands to benefit from its young minds, especially with its projected increasing population growth rate and vibrancy outpacing any other part of the world (Bongaarts, 2009). Harnessing the potential of early career scientists could be a catalyst for improved local and international collaborations. Ultimately, pharmaceutical and biotech industries with functioning R&D departments will benefit greatly, leading to economic growth and an overall improved standard of living among Africans. Consequently, such growth will stimulate the development of enabling government policies that will potentially enhance productivity (Emudainohwo et al., 2017; Wu et al., 2022).

Increasing research interest

In recent years, Africa has witnessed an increased number of fresh graduates interested in pursuing a research career (Uwizeye et al., 2020). This has been facilitated by the growing number of scientific hubs, research communities,

programmes, and workshops, as well as increased Africa-based research scholarships that are privately, locally or internationally funded (Uwizeye et al., 2020). These strategies, sometimes led by young scientists, are aimed at building local research capacity by involving and encouraging young minds at an early stage to participate in research activities. A few cases are highlighted below. *Pharmacometrics Africa* is a non-profit organisation actively bridging the gap of lack of pharmacometricians on the continent (Najjemba et al., 2023; Pillai et al., 2013). It organises different short- and long-term fellowships, industry exposure, workshops and seminars. More than 100 young scientists have been trained in the programme since 2019, building the capacity to apply the technique for quantitative clinical pharmacology for drug discovery and development to address some diseases burdening Africa (Najjemba et al., 2023). Another example of such communities is the *Global Health Focus*, where young minds in their early careers in Africa, including undergraduates, are transformed into global health researchers, critical thinkers and leaders (Global Health Focus, 2024). The programme has trained more than a thousand young scientists across 12 African countries since 2016. It allowed many young scientists on the continent to participate in research activities, including data curation, analysis, grants, and research writing and publications.

Biospherea, a youth-led community is committed to nurturing the potential of young and emerging bioscientists on the continent. With more than 100 members pooled from over 10 African countries, the community has contributed to fostering skills acquisition, peer-to-peer mentorship, and collaborations among its members. Through its guest sessions, it has also directly and indirectly connected members to more experienced African and non-African researchers across different organisations (Biospherea, 2024).

In addition to these established communities and initiatives, several fairly documented and undocumented communities exist, especially in higher institutions typically run by students. This highlights an undeniable growing interest in biosciences and a recognised need to routinely interact with and learn from fellow bioscientists. Notably, many African countries have entered a period of rapid growth in authored publications and scientific research since 2005, with young African scientists making up a good proportion of published authors and researchers. This trend depicts commendable progress in the state of scientific interest and knowledge on the continent (Mouton and Blanckenberg, 2018).

Digital transformation and technological advancement

Digital transformation is key in shaping the future of bioscience in Africa. The COVID-19 pandemic underscored the importance of leveraging technology for continuous scientific discovery (African Institute for Development Policy [AFIDEP], 2021). During lockdowns, virtual meeting tools became essential for knowledge sharing; universities offered short online courses, allowing professionals and individuals to continue their education in fields previously taught in physical classrooms (Manraj et al., 2022). Adopting new technologies will enable the development of future-ready and resilient bioscientists who can collaborate effectively to make significant scientific discoveries. Key technologies include online learning platforms, artificial intelligence (AI), machine learning (ML), robotics, data science, and big data analytics (Kondo et al., 2025). Big data analytics is particularly valuable for analysing large research datasets, providing insights that inform decision-making in healthcare delivery, public health institutions, and biosciences (Akinnagbe et al., 2018). The future of bioscience is promising, with young scientists adept at using data analytics applications and eager to explore similar technological tools to quickly obtain insights from vast research datasets, leading to increased efficiency. For example, vaccine manufacturing, public or community health research, and clinical trials will benefit from these technologies.

Innovation hubs

Innovation in various bioscience fields is increasing, and Africa has seen a rise in innovative solutions developed by young scientists to address its unique challenges (Bitok, 2016). Creating innovation hubs is essential to nurture and develop biotech solutions that will shape the future of bioscience in Africa (Bitok, 2016; Dandara et al., 2014). An example of an innovation hub in Africa is BioPark Mauritius, which offers a conducive environment for research and development across diverse scientific fields, from microbiology and chemistry to epidemiology and pharmacology (Bitok, 2016). Such physical infrastructures foster collaboration and capacity development, providing creative spaces for young scientists to develop sustainable solutions and innovative inventions (Dandara et al., 2014). Public-private partnerships are crucial to support the creation of these creative innovation hubs, which could give rise to numerous bioscience startups in Africa.

Mentors for the younger generation

As established earlier, mentorship is crucial for the professional growth of young bioscientists. Given the prevalence of codified and limited practical knowledge dissemination in the formal education system of many African countries (Ezema and Ogujiuba, 2012), pre-university bioscience enthusiasts may have flawed or limited views about the prospects of becoming bioscientists in Africa. Breaking this cycle demands that today's young African bioscientists deliberately and voluntarily take up the role of mentors and trainers,

passing on their knowledge and experiences to the next generation to ensure they understand the importance of mentorship throughout their careers. This practice is ongoing and evident in the existence and constant growth of bioscience communities, as already highlighted.

RECOMMENDATIONS

Education and training programmes

Africa faces challenges with inadequate learning infrastructure for capacity development and training at both secondary and postgraduate levels (Adedokun et al., 2016). Addressing these issues and reducing brain drain requires significant investment in training programmes. Providing adequate training programmes and resources will bridge the knowledge and skill gap (Ondigo, 2020). Emerging fields and technologies like synthetic biology and artificial intelligence offer great prospects but require proper training (Nji et al., 2019). Public-private partnerships are essential for infrastructure development, mentorship, biotechnology education, training workshops, and grant funding for research laboratories (Nji et al., 2019). These initiatives will equip laboratories with state-of-the-art technology and research equipment, fostering capacity development and training for young scientists. Adequate funding will empower academic institutions to revise curricula and provide necessary training in various fields, including new technologies, grant and proposal writing, data analysis, and laboratory techniques (Adedokun et al., 2016).

Mentorship support

The long-term sustenance of a youth-led mentoring and training initiative would eventually require national bodies and research institutions to develop more interest in science and its promotion. A potential approach to achieving this is creating an initiative that, in addition to mentoring, also channels bioscience solutions to serve citizens and boost economic growth. This strategy would be similar to the current practices of several global young academy movements in numerous countries, including Germany, Hungary, and Indonesia, dedicated to supporting scientists at the start of their careers and tackling nation-specific issues. In Indonesia, a young researchers' group participates in open science and technology communication to address national crises and drive policy changes (Rakhmani et al., 2024). Notably, these groups are affiliated with other government science bodies, which increases the chances of recommendations being heard and implemented. Such efforts could be a reality in Africa if young bioscientists who are also facilitators of training and mentoring initiatives had a seat at the policy-making table to communicate the value of government partnerships and adequate funding for learning institutions. However, achieving this might seem like a chicken-and-egg situation: should national bodies first commit to supporting scientific mentorship or do young scientists need to secure a voice in policy-making to drive that change? While this remains to be seen, the relentless push for a better society cannot be left to any stakeholder.

Funding allocation

The transformation of Africa's bioscience sector would largely be influenced by the availability of funds, as echoed in earlier recommendations. National governments and regional agencies need to become more intentional about allocating sufficient provisions to support research and development (R&D) in the biosciences. While increasing annual budgetary allocations is a good starting point, additional funding routes such as diaspora remittances and funding partnerships could also be explored. The impact of diaspora remittances on the continent has been widely argued in literature (Akanle et al., 2022); however, efforts have not been made to adequately maximise their potential, particularly with regards scientific R&D. We propose that governments, working alongside private agencies and the scientific community, establish 'brain gain' structures for successful young Africans in the diaspora to contribute towards and invest in specific bioscience-aligned projects within the continent. Of course, beyond their direct financial benefits, these structures could also provide avenues for mentoring the next generation.

CONCLUSION

The future of bioscience in Africa is closely tied to the continent's young scientists who are eager to drive innovation. However, inadequate research funding, lack of mentorship, gender inequalities, skills gaps, and limited job opportunities for bioscience graduates are significant barriers to the development and sustainability of bioscience research. Despite these challenges, promising opportunities exist that could reshape the bioscience landscape in Africa. For example, collaborations between academia and industry will enable young bioscience students to gain practical industrial experience and apply their academic knowledge to conduct translatable research that addresses local challenges. This collaboration could also include research communities like Biospherea to offer mentorship and training opportunities, helping young bioscientists develop the expertise and transferable skills needed to succeed and become changemakers.

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