Neuroscience Institute

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Advancing African Neuroscience

Contents

Foreword

The purpose of the *Showcasing African Neuroscience* meeting was to facilitate a dynamic and interactive stakeholder engagement process that would: highlight the best examples of research in basic and clinical African neuroscience, explore the potential for enhancing the connection between these fields in the African research context, and draw attention to the significant potential for new discoveries from those closest to the health challenges on the continent.

Our aim was also to showcase the potential for health impact by expanded investment in neuroscience in Africa, and more broadly, to provide an opportunity to engage with a variety of stakeholders on strategies for accessing existing funding pipelines, while also facilitating informal discussions around some of the additional opportunities emphasised in this report.

As a global organisation, the Wellcome Trust supports research on a wide range of topics and looks for potential areas of growth and opportunity within research communities worldwide. The potential in the African neuroscience research landscape was identified as one such area. Through informal conversations and a survey of African neuroscientists, and with generous input and assistance from other groups already well-embedded in this landscape (e.g. SONA and IBRO), the concept for a strategic, forward-thinking meeting was born.

The guiding principle was that the African neuroscience community would lead the engagement process, with support provided by Wellcome. Following the meeting, a series of workshops has drilled further into the issues raised, starting discussions on how best to address them, and ultimately working towards increased investment from all stakeholders, institutions, researchers, and funders. This report builds on these discussions. In it, we highlight early advances in neuroscience research in Africa, and outline a framework for further developing the capacity of African neuroscience to explore the unique challenges facing brain health and development on the continent.

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Executive Summary

The African neuroscience community is a vibrant hub of research excellence, innovation, and opportunity that is exploring dramatically different populations from those on other continents.

Populations from this region exhibit the greatest genetic diversity, live in ecosystems with highly diverse flora and fauna, and face unique stresses to brain health, including child brain health and cognitive development resulting from issues ranging from traumatic brain injury to diseases endemic to the region.

Despite the manifold opportunities for research that could impact the field globally, African neuroscience has yet to reach its full potential – it remains under-resourced and under-valued. As a result of the Covid-19 pandemic, however, dramatic changes in the operating environment have now brought the field to an inflection point: a moment of opportunity to take a fresh look at a new future for neuroscience in Africa.

Between November 2021 and January 2022, the African neuroscience community came together for a series of facilitated meetings and workshops aimed at identifying issues impeding advances in the field, exploring possible solutions, and identifying unique and important avenues for research. More broadly, this initiative's vision is to elevate to global prominence the role that African neuroscience can play in improving lives and advancing understanding of the human brain. This report captures the outcomes of these discussions [For an overview of the stakeholder engagement process, see Appendix 1].

According to the steering group, the goal of the initiative and overall process is *to strengthen the neuroscience research community in Africa, moving towards the vision of realising a globally recognised, unique, and sustainable neuroscientific research landscape.*

Three critical targets for action were defined. These targets aim to direct efforts to both evolve the African neuroscience ecosystem and increase the visibility and impact of African neuroscience.

1

Target One focuses on increasing the visibility and subsequent impact of African neuroscience at local, regional, and global levels to drive change. These priorities were identified:

A. Promote areas of distinction – six domains of distinction have been identified where African neuroscience excels and provides a unique, important and/or world-leading contribution, or opportunity for development. The marketing of these areas of unique value offers a coherent approach for the neuroscience community to build a compelling case for increased attention, investment, and support

B. Champion innovation within African neuroscience

2

Target Two aims to nurture and support neuroscientists at every stage of their career. Three priorities were identified:

A. Draw on networks to build a stepped training programme

B. Promote learning across a range of disciplines

C. Develop neuroscientists as active citizens

3

Target Three directs efforts to improve infrastructure development and maintenance for all those working in African neuroscience. This priority was identified:

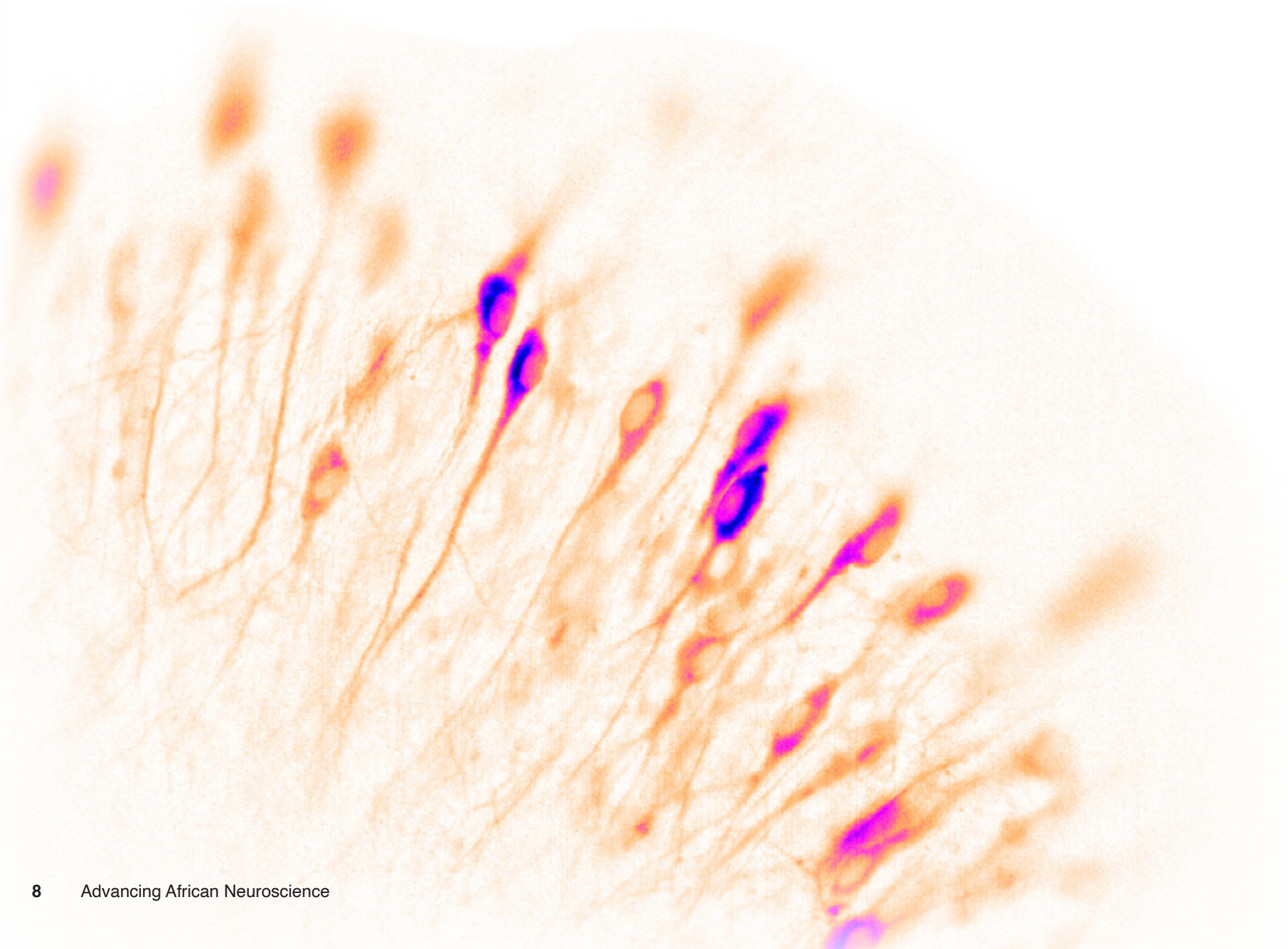
A. Establish hubs for African neuroscience infrastructural facilities and expertise

This report offers the African neuroscience community ideas on where to focus efforts, and suggests first steps in taking action. It provides an ambitious yet practical vision for what a successful and thriving African neuroscience industry looks like in terms of achieving break-through science, supporting neuroscientists at every stage of their career, and providing the infrastructure required to support the ongoing development of neuroscience in Africa.

Background

The need to advance the African Neuroscience ecosystem and increase its visibility and impact on the world stage

While African neuroscience is an important emerging field, when addressing regional and global brain health issues, it has yet to reach its full potential; As an under-resourced sector, it has struggled to consistently access significant platforms and opportunities to contribute to global health broadly.



However, dramatic changes in the operating environment sparked by the Covid-19 pandemic have brought the field to an inflection point: a chance to take a fresh look at a new future for neuroscience in Africa.

There is an expanding human capital and infrastructure for neuroscience in Africa, creating opportunities to make seminal scientific discoveries, and develop tailored interventions to promote brain health and wellbeing in Africa with global impact. However, several critical issues for the African neuroscience ecosystem must be addressed if it is to flourish and have equitable visibility on the global stage:

- The African continent hosts a rich pool of passionate and dedicated neuroscientists. However, various issues create barriers to career progression, limiting both individual growth and the breadth of available expertise across the neuroscience community. These include the need for improved mentorship opportunities for early-career researchers and incentive systems that better recognise research excellence. The need to improve collaboration between basic and clinical neuroscientists is critical, as well as with other disciplines, such as engineering, data and computer scientists, law, etc.[1]

- International funding, a significant driver of neuroscience research in Africa, skews research towards international priorities. A 2020 review of two decades of neuroscience publication trends in Africa[2] found publications reporting on African neuroscience to be heavily biased towards authors in the Global North. Greater intracontinental resourcing and collaboration is required to empower scientific independence and strategic leadership in research priorities.

- Highly variable neuroscience facilities and infrastructure across the African continent mean that many neuroscientists have limited or inconsistent access to critical resources and expertise needed to deliver high-quality science.

For more detail on challenges and barriers, see Appendices 2 and 3.

"Dramatic changes in the operating environment sparked by the Covid-19 pandemic have brought the field to an inflection point: a chance to take a fresh look at a new future for neuroscience in Africa."

[1] Maina MB, Ahmad U, Ibrahim HA, et al. Two decades of neuroscience publication trends in Africa. *Nature Communications* 12, 3429 (2021). https://doi.org/10.1038/s41467-021-23784-8

[2] The lack of collaboration between basic and clinical neuroscience was also earlier identified in: Maina MB, Mohammed YG, Bukar AM, et al. African neuroscience on the global stage: Nigeria as a model. *European Journal of Neuroscience*. 49(12): 1544-1551 (2019). https://doi.org/10.1111/ejn.14372

Target One

Showcasing African neuroscience

Rachael Dangarembizi – Neuroscientist

A unique value proposition for neuroscience

Sub-Saharan Africa is one of the last remaining regions of accelerating population growth, with consequently younger populations. Compared to traditional research contexts, an extraordinary set of environmental and genetic factors affect brain health in the region: 1) higher than average incidence of infections, 2) higher exposure to toxins and poor nutrition, 3) far higher exposure to trauma and violence and, 4) dramatically higher genetic diversity. This unique context creates opportunities to make break-through scientific discoveries and develop, or tailor, more suitable interventions to promote brain health and wellbeing.

Not only does Sub-Saharan Africa provide a high prevalence of neurological conditions to challenge the scientific community, it also offers a research environment with great translational potential. Large patient numbers and low doctor-to-patient ratios expose the typical clinician to a larger patient population, increasing opportunities for developing expertise in the field. This exposure also provokes research questions that are more directly relevant to the local environment. Clinical trials become feasible over shorter time spans, with benefits not only for Africa, but also the Global North. For example, recruiting patients for clinical trials in traumatic brain injury takes less time in Africa compared to Europe. Finally, there is much room for clinically oriented neuroscience research to improve healthcare in Africa, especially in young people. Specific outcomes include enhancing the developmental potential and mental health, and the reduction of mortality and neurological disability.

Showcasing areas of excellence

The November meeting showcased areas of excellence in African neuroscience to illustrate the breadth of research activity across the continent and raise its profile amongst meeting participants. A combination of keynote presentations, early career talks, and panel discussions covered topics of research excellence by African neuroscientists, including: the neurobiology of paediatric brain injury, genetics in psychiatry and neurology, the developing brain, sleep and circadian neuroscience, the neuro-protective properties of medicinal plants, animal models in Africa, and innovative approaches in African neuroscience. The below examples offer a sample of the outstanding initiatives and research taking place:

- The collaborative use of trans-omics to study risk factors for stroke in African populations, via the SIREN project (part of the H3Africa Consortium), a transnational, multicentre study focused on people in Ghana and Nigeria.

The creation and operation of the Neuroscience Institute at the University of Cape Town was highlighted as a centre of excellence in integrating academic research, clinical practice, teaching, training, and advocacy http://www.neuroscience.uct.ac.za. Efforts were specifically invested in developing necessary infrastructure and bringing together connected disciplines to provide the supportive framework that enables world-class research. It is committed to collaboration and aims to become a neuroscience institute for Africa at large.

- The Egyptian Network for Neurodegenerative Diseases (ENND) (2013-2020) project created a network of neurology departments across Egypt to collaborate in studying critical research questions in neurogenerative diseases and is developing a range of supportive resources for widespread use.

- Following recognition that current tools for measuring the developing brain are poorly validated in the African context, thereby hampering the implementation of large collaborative studies, pioneering work from South Africa and Kenya is developing measures that are both culturally sensitive and of global relevance.

Research, led from Nigeria and Ghana, to increase understanding of the medicinal properties of plants on the African continent (here and here), is an area of enormous potential for the treatment and prevention of disease.

- An innovative project in Ghana where an institution built their own lab equipment, and subsequently promoted the use of open hardware in neuroscience research.

"I am looking forward to bringing African neuroscience onto the world stage."

– Showcasing African Neuroscience meeting participant

"There is much room for clinically oriented neuroscience research to improve healthcare in Africa, especially in young people."

A. Six domains of distinction

While examples of research excellence can be found across the continent, six thematic areas have been identified where African neuroscience excels and provides a unique, important and/or world-leading contribution or opportunity for development. These areas of unique value provide a clear focus for the neuroscience community to build a persuasive case for increased attention, investment and support.

The six domains of distinction:

1. Diverse DNA of African populations
2. Diverse African flora, fauna and ecosystems for comparative research
3. Child brain health and development
4. Impact of climate change on neurological health
5. Access to clinical populations with important conditions less prevalent in the Global North
6. Resourcefulness: Pockets of resilience reusing and adapting existing technology and resources to answer new questions

5 Tactics for Action

Promote the six domains of distinction:

1. Determine primary goal
2. Map and engage stakeholders
3. Find opportunities to showcase
4. Partner
5. Share

DOMAIN ONE: Diverse DNA of African populations

Humans evolved in Africa and then dispersed across the world, resulting in the DNA of those of African ancestry exhibiting the greatest diversity. Given that all humans trace their genetic lineage back to Africa, there is significant global interest in using genomic studies of African populations to study human evolution as well as early migration patterns.

Genomic diversity has significant implications in the clinical neurosciences. Specific mutations may be the cause of rare neuropsychiatric conditions, and broader genetic and environmental variations are beginning to shed light on risk and resilience for disease at the regional level. Currently, African populations are under-represented in genomics research. It is increasingly recognised that whole genome association studies need to have greater diversity if findings from such work are to be generalizable to global populations.

DOMAIN TWO:
Diverse African flora, fauna and ecosystems for comparative research

The diversity of animal models in the African ecosystem (e.g. Meriones shawi, jerboa, rabbit, baboon, monkey, buffalo, elephant, guinea pig and chameleon) is a unique strength, as it can offer a novel perspective into the understanding of brain health and disease, the transmission of nervous system diseases from animals to humans, and screening for novel drugs. Research into the nervous systems of these fauna has already delivered breakthroughs in neuroscience (https://fbresearch.org/medical-advances/nobel-prizes/).

Africa's fauna could provide access to model systems that might reveal clues to solving problems in basic and clinical neuroscience today. The naked mole rat, for example, can endure extreme hypoxic conditions, has an unusual nociceptive system, and seems not to show cognitive decline associated with aging. The spiny mouse, *Acomys*, is being used to study spinal cord regeneration, due to its ability to heal wounds with little scarring. Examples such as these demonstrate the potential of novel model systems to drive scientific breakthroughs; research in this relatively untapped area is expected to bring these, as well as new, genetically modified model organisms to the global stage, generating opportunities to study relevant brain disorders.

DOMAIN THREE:
Child brain health and development

The early months and years in a child's life set the foundation for lifelong physical and mental health. During this stage, when nearly all physical, cognitive and social skills are being developed, the 500 million children and adolescents in sub-Saharan Africa face a unique set of challenges. Adverse events and exposures during this sensitive period can impact brain health and development throughout the course of life. While large studies have been done in the Global North, less is known about the risk architecture of intellectual and developmental disabilities in African ecosystems. Prospective studies, conducted in the last decade, have shown that nutrition (including iron-deficiency anaemia), infections (e.g. HIV, malaria), environmental stimulation and interaction, and psychosocial factors may all impact brain development. In addition, social/gender inequalities further amplify developmental differences. Building on this work, more cohorts are currently being recruited to provide opportunities for scientific discovery and for tailoring interventions to promote the best potential for child brain health and wellbeing on the continent.

One key question is how non-invasive techniques can (neuroimaging, microbiome, functional measures such as EEG, culturally appropriate developmental tools) be used in resource-limited settings to address questions around the trajectory of brain growth and development in this high-risk context. While these tools are available in limited contexts across the continent, the challenge is to take this new technology to scale in this rich, but barely explored region.

DOMAIN FOUR:
Impact of climate change, environmental risks and conflicts on neurological and mental health

While well-resourced, industrialised economies are strong enough to withstand the immediate effects of climate change, poorer regions may face not only gradual climatic change, but also extreme weather events with weaker resources and often inadequate energy infrastructure. Children are particularly sensitive, suffering from direct effects of climate change such as temperature instability and a host of indirect effects such as poor air quality (burning of wood for heat and cooking), malnutrition (food insecurity from crop failures), disease (cholera outbreak following flooding), and parasites. Emerging research suggests that climatic factors including heat stress during pregnancy negatively impacts both maternal and new born outcomes. Collaborative and interdisciplinary work is needed to understand the potential impact of climate change on early brain development in Africa. Moreover, war and conflicts are known to influence child and adult neurological and mental health. Many parts of Africa are affected by militarised conflicts, however, the impact of conflict on neurological and mental health in different ancestral populations and geographical locations is not well understood. Data science in this particular area of research is a particularly promising field, as modern technology, driven through the mobile network – ubiquitous in Africa – has the potential to record answers to questions relevant to population brain health, develop predictive models to identify potential risks to a population, and inform policy and practice related to climate change and conflicts.

DOMAIN FIVE:
Access to clinical populations with important conditions less prevalent in the global North

African neuroscience is at an advantage in the study of brain injuries and infections. The region has the highest incidence of traumatic brain injury and spinal cord injury, driven largely by road traffic accidents and assaults. Brain infections are more common, caused by bacterial meningitis, tuberculous meningitis, neurocysticercosis, HIV, and cerebral malaria; and hydrocephalus and epilepsy are also more common given the prevalence of brain infections, injury, and spina bifida as underlying conditions. While the socio-economic reality of Africa and its broad-based population pyramid accounts for the high prevalence of these conditions, these circumstances also offer opportunities for research. For example, these conditions often share secondary mechanisms of progression, inviting research into the definition of neurobiomarkers. Further, African neuroscience can test the efficacy of therapeutics in local settings, often leading to potential for improved access to safe and appropriate treatment.

DOMAIN SIX:
Innovative reuse and adaptation of existing technology and resources to answer new questions

Despite restricted access to state-of-the-art technologies, many African neuroscientists are employing innovative approaches to pursue their research goals. Some have adapted existing technologies and the unique systems around them to build their own equipment, others are developing specialised research methodologies to generate robust, culturally-relevant scientific data on diseases affecting their communities. Many have ventured into medicinal flora research and collaborate with the public and traditional healers to understand the scientific validity of traditional medicine and how it can result in the development of effective and affordable therapy for world diseases. For example, African research on medicinal flora provides a novel avenue for discovering treatments for currently untreatable diseases such as Alzheimer's disease and depression.

For expanded versions of these six domains of distinction, see Appendix 4.

B. Champion innovation within African neuroscience

A second area of importance meriting future consideration is the need to foster innovation in African neuroscience. Preliminary discussions highlighted areas of current innovation that may be built upon, as well as those with future potential (see points below). Many more areas across the span of neuroscience are likely to be ripe for exploration within this context and could contribute to stimulating an innovative research environment.

- Promote resourcefulness in re-using / re-inventing use of equipment and tools to suit purpose
- Enable multidisciplinary collaboration to help to maintain infrastructure (e.g., local people, such as engineers, to fix things, break them down, and create new solutions)
- Consider commercial impact of research and how to capitalise on it – success depends on effective collaboration
- Champion community engagement models for including the voices of those with lived experience of neurological and mental health conditions from the African region
- Create an export model for other developing regions (i.e., to gain knowledge for African experience) and to advance global research
- Build a community to facilitate discussions and offer avenues for future-thinking
- Encourage innovative interdisciplinary collaboration
- Support the principle of open science and sharing intelligence

"African neuroscience has incredible prospects. It's time to really showcase this potential."

Promoting the six domains of distinction

The marketing of the six domains of distinction offers a coherent and compelling approach to showcase African neuroscience, increase active advocacy for it, and convince wider stakeholders to extend their support. Each of the domains is summarised below, setting out key points of interest and future considerations. These summaries provide a foundation to enable the community to articulate in one voice the unique and important value of African neuroscience, and to construct persuasive arguments for support.

There will be many ways of advancing African neuroscience and these will necessarily comprise a combination of proactive and reactive opportunities. Strategies to capitalise on these opportunities will be highly context-specific and dependent on diverse factors, such as expertise, connections, available time and resources, and cultural considerations. Despite this diversity of prospects, a number of common tactics for taking action are suggested.

1. Determine the primary goal for showcasing research

- Specify what change is envisaged and plan what would be needed to achieve this

2. Map and engage key stakeholders (i.e. who are the most interested and/or influential stakeholders relevant to a particular aim?)

- Narrow down which stakeholders to involve, identify their needs and interests, plan how to engage them, and be clear about what is being requested of them specifically

"The marketing of the six domains of distinction offers a coherent and compelling approach to showcase African neuroscience, increase active advocacy for it, and convince wider stakeholders to extend their support."

"African neuroscience visibility is lagging, compared to the Global North."

Stakeholders are likely to include many of the following: African scientists and academic communities, laboratory personnel, educators, clinicians, African families and communities, policy makers and other relevant local or regional organisations and government bodies, global organisations (e.g. UNICEF, the WHO, European Animal Research Association), funders (local and international), non-academic communities, including local start-ups, engineers, traditional healers, ecologists, veterinarian specialists, and hunters, tech companies within and outside Africa, interest groups, the media and the public.

3. Identify and target proactive and reactive opportunities to showcase African neuroscience research to gain support.

- For example, to find or create opportunities to:
  - Apply for collaborative grants, or influence funders to prioritise a key research area or innovation
  - Inspire international experts to collaborate
  - Influence decision-makers in meetings or at events
  - Submit evidence or information to policy makers
  - Respond to media requests or generate media-worthy stories
  - Create enticing roles to attract the best candidates
  - Release social media posts to coincide with other relevant stories or announcements

- To upskill the community, and where necessary, be able to identify and capitalise on opportunities to showcase the domains of African neuroscience (e.g. provide training, guidance, tools and/or support) Partner with other individuals and organisations

- To increase reach and chances of success, as well as amplify impact, partner with those with the same aims to influence change

4. Share examples of outcomes and impact from showcasing African neuroscience (e.g. via conferences, professional societies, and hubs)

- Communicate to the wider community about how the outcomes met the original aims, what factors drove success, and to discuss learning points for the future

- Share any tips, tools, or resources that may support others to drive change

"There will be many ways of advancing African neuroscience and these will necessarily comprise a combination of proactive and reactive opportunities."

"It is critical that we can integrate our research areas into the global research environment."

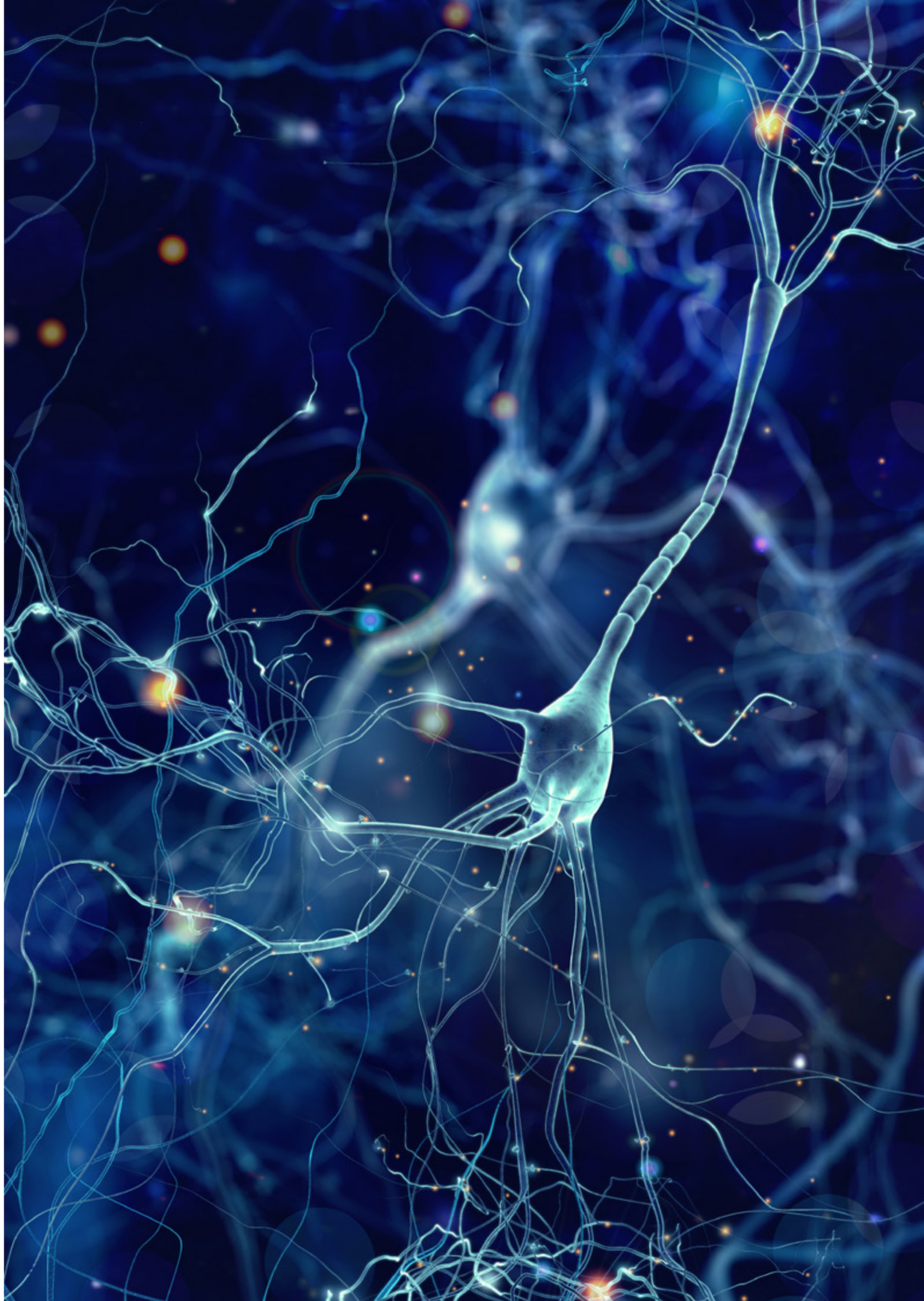
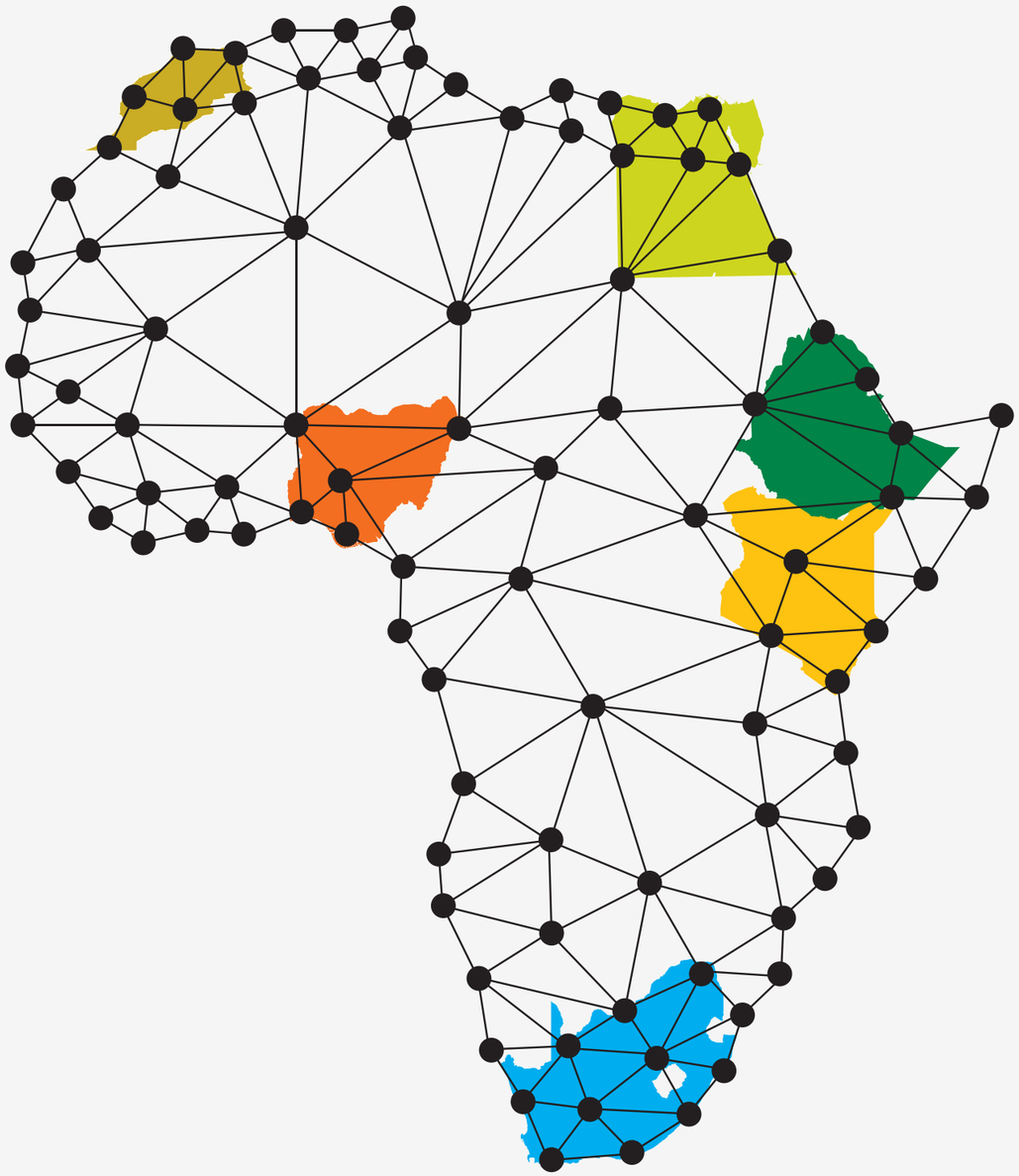


Figure 1: The research across Africa at the Showcasing African Neuroscience Meeting



- *African neuroscience: Current status and prospects*
  Kirsty Donald & Mahmoud Bukar Maina
- *Studying the neurobiology of paediatric brain injury*
  Anthony Figaji, University of Cape Town
- *Transgenerational trauma in a South African birth cohort study*
  Nastassja Koen, University of Cape Town
- *Survivors of neonatal insults: Perspectives on developmental outcomes and associated factors*
  Dorcas Magai, Aga Khan University
- *Role of cannabinoidergic system in opioid receptor signalling in pain and reward*
  Oualid Abboussi, University of Mohammed V, Rabat
- *Why do men rape? A translational approach*
  Lihle Qulu, Stellenbosch University
- *Open Reviewers Africa: A workshop to empower the next generation of African peer reviewers*
  Aurelia Munene, Eider Africa
- *Tackling stroke and its risk factors in Africa through trans-omics: Insights, challenges and opportunities*
  Mayowa Owolabi, University of Ibadan
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  Mohamed Salama, American University in Cairo
- *Research capacity for genetics of epilepsy and neuropsychiatric comorbidity in Africa*
  Symon Kariuki, KEMRI
- *Risk and resilience for the developing brain: Opportunities for collaboration*
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- *Sleep under the desert biotope: A polysomnographic and behavioural study in the dromedary camel*
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  James Olopade, University of Ibadan
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- *Ethics of using diverse models systems in neuroscience research*
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- *Neurocysticercosis-related seizures: Looking for answers*
  Doctor Priscilla Kolibea Mante- Kwame Nkrumah University of Science and Technology

Target Two

Nurturing and supporting neuroscientists

Yanelisa Pulani – Neuroscience student

At the heart of brilliant neuroscience is the people who deliver it, but without a strong workforce the field cannot thrive.

The African continent hosts a rich community of passionate and dedicated neuroscientists, but many face difficulties in progressing their careers due to limited resources, relevant support, and access to development opportunities.

A variety of issues create barriers to career progression, limiting both individual growth and the breadth of available expertise across the neuroscience community. Priority attention to tackling the challenges listed below is required to cultivate an effective and supportive neuroscience sector.

- Highly variable quality and quantity of mentorships in neuroscience
- Uneven mentee understanding of the mentorship relationship and how to benefit from it
- Variable access to career opportunities and support in making the transition from researcher-in-training to academic independence
- Need for confidence-building amongst early career researchers
- Excessive administrative and teaching burden on early career researchers, limiting time for research
- Pressure to publish for local career advancement may be at odds with requirements of the wider neuroscience field
- Limited current collaboration, between basic and clinical sciences

More details concerning each of the challenges/barriers are shown in Appendix 2.

Ideas and potential actions to address the key challenges and barriers were discussed and three priority areas emerged.

"When we see colleagues elsewhere in Africa publishing in high-impact international journals, it builds our confidence and ambition in the rest of us to do more and better."

– Showcasing African Neuroscience meeting participant

A. Draw on networks to build a stepped training programme ('Community model')

To develop future neuroscience leaders with depth in neuroscience insight, a broad skillset, and experience requires exposure to a range of techniques, settings, and expertise. An effective way to achieve this is to involve different people and opportunities from across the African neuroscience community. There is an appetite to better use networks to curate training programmes that cultivate a richer experience for trainees and help connect the community as a whole. Sharing training responsibility across the neuroscience community could ultimately strengthen the workforce, increase leadership opportunities, and better share resources. Here are some ways to encourage a more pro-active training path:

- Co-supervision and/or co-mentorship across programmes and subject areas should be encouraged to help trainees think in different ways
- The flexible movement of students and early career researchers should be facilitated to increase exposure to different lab groups, techniques, and countries, to build skills and networks, increase confidence, and provide a wider African perspective
- A pool of strong colleagues from different fields (from both basic and clinical sciences) could be grown, who are motivated to develop good mentor programmes, as well as support each other
- Training in mentoring skills should be a prerequisite for becoming a student supervisor to enhance the student's full experience and development
- Supervisors and students should be involved in actively identifying mentors appropriate to individual needs
- Fora for peer groups at different career stages (from mentees to mentors) should be established to aid learning and support
- Professional societies have a critical role to play in acting as a conduit to local or international partners
- There is a need to identify what is unique about the African neuroscience context – is a new African approach or principles for mentors required to fill in any gaps?

Research and cultural heterogeneity across the African continent may provide practical challenges in fostering a community approach to training programmes. Such challenges are likely to require bespoke solutions tailored to the local contexts and cultural sensitivities. What is needed, however, is a willingness and commitment to promote the community model to encourage an environment of cross-learning, collaboration, and networking in African neuroscience.

"We need to think of a strategy for mentorship as a community but consider the heterogeneity of cultures across Africa."

– Showcasing African Neuroscience meeting participant

B. Promote learning across a range of disciplines

Exposure to different disciplines and skills is needed to build experience and depth as a scientist, colleague, and mentor. Opportunities to network beyond an individual's research specialism and institution are necessary to develop broader scientific understanding and stimulate new ideas and innovative approaches. These are some ways to encourage active cross-discipline collaboration:

- Raising awareness of the importance of interdisciplinary collaboration and impactful examples highlighted
- Fora and initiatives identified or established where neuroscientists can cross-pollinate ideas (e.g. via cross-programme learning, group mentorship, secondments, exchange programmes, or training placements in other institutions)
- Professional societies could take a lead in promoting and enabling cross-networking, and consider offering honorary memberships to individuals from outside disciplines to draw in different expertise and promote other fields
- Carefully curated conferences that actively bring joint insight from basic and clinical sciences
- Opportunities to bring basic and clinical scientists together to consider priority research questions and different approaches to them
- Training could be offered that would enable better interdisciplinary working, such as networking skills, collaborative grant writing, and facilitating partnerships
- Both basic and clinical scientists should be encouraged and enabled to teach on neuroscience programmes to increase student exposure of both fields
- Neuroscientists who spend time in institutions outside their home country should be incentivised to return and enrich the local academic environment with their newly gained knowledge, skills, and contacts
- Funders could be influenced to incentivise multidisciplinary collaborations
- Industry could play a role in demonstrating the impact of interdisciplinary working and may be able to provide training resources or placement opportunities

"Collaborations need to be consciously planned and deliberately designed. We can't rely on chance."

– Showcasing African Neuroscience meeting participant

Professional societies need to be encouraged to broaden their reach to better support their members. Pressures to publish may reduce appetites for interdisciplinary collaborations so demonstrating the impact of such work is important to incentivise cross-working. Bringing in alternative expertise (e.g., local engineers) is likely to expand the capabilities of research teams and increase impact.

C. Develop neuroscientists as active science citizens

It is essential for all scientists in Africa to actively participate in the broader scientific community. There are many opportunities to share expertise and engage with others beyond specific fields of study and this should be encouraged. It is imperative to consider early career researchers as future leaders and develop their skills and experience to participate as thought leaders and to better engage with wider society. These are some of the ways to nurture active science citizens:

- Training and practical opportunities should be provided in skills such as: science communication, communication and media skills, stakeholder and public engagement, policy making and influencing, collaboration building
- Training in time management and people management (including awareness of and how to support the different needs of individuals) is essential for anyone planning to lead a team
- Any training should be relevant to the African context, as some aspects, such as the language spoken in a specific region, may differ from other regions (e.g., public engagement in science)
- Mentors and mentees should work together to identify opportunities to learn and grow as active science citizens
- Mentors should try to find relevant occasions to offer development opportunities to their mentees, while lending their personal credibility (e.g., meetings that involve policy discussions, media responses)
- Mentors can help mentees translate their work within a broader context and demonstrate its importance in terms of societal need
- University networks could offer to host relevant initiatives to upskill early career researchers from different institutions

"The best way to overcome challenges is to strengthen collaborations."

– Showcasing African Neuroscience meeting participant

Lack of resource to provide training and tools is a significant challenge in some places. Sharing training resources across institutions, networks or societies may help. International funding agencies may also have useful resources. Many people may feel they don't have enough time to undertake activities outside their research or may see little value in doing so. Demonstrating (to both scientists and their institutions) the importance of participating as active science citizens is essential to capture buy-in.

A wide range of stakeholders will necessarily need to be involved to improve professional development for neuroscientists. These might include neuroscientists, professional societies, funding agencies, universities and university networks, HR specialists, training providers and industry.

"There are many opportunities to share expertise and engage with others beyond specific fields of study and this should be encouraged."

First steps

To effectively nurture and support neuroscientists across Africa, five main steps are recommended:

1. Identify what the neuroscience community needs across the African continent

   - Identify the priority personnel needs that might be addressed by the neuroscience network
   - Map development opportunities and training programmes available and identify any gaps
   - Share intelligence and reach out with opportunities across neuroscience networks (this could be linked into the 'hub' initiative(s))
   - Develop training programmes that take into account the whole person, tailoring opportunities to fit their needs

2. Establish the key elements of a good mentorship relationship

   - Map what guidance and tools currently exist for both mentors and mentees
   - Identify best practice guidance and tools, and any gaps that could be filled
   - Raise awareness of best practice guidance locally to help ensure understanding of what good mentorship looks like (this could be linked into the 'hub' initiative(s))
   - Promote the formation of peer support groups (formal or informal) – e.g., a monthly café

3. Identify potential candidates to increase the pool of available mentors

   - Assess priority support and training needs for new mentors
   - Offer opportunities to participate in a mentorship training programme or other skills training
   - Actively encourage candidates to step up
   - Establish a database of neuroscientists who are willing to mentor (this could be linked into the 'hub' initiative(s))
   - Consider feasibility of new mentors co-mentoring with an experienced mentor, across different institutions

4. Actively build links across basic and clinical neuroscience

   - Map what people are working on across the continent, starting at the local/institutional level
   - Create a database of African neuroscientists, their research specialisms and interest in collaboration
   - Identify local and wider opportunities for interdisciplinary networking (this could be linked into the 'hub' initiative(s))
   - Undertake activities to identify common research questions across basic and clinical sciences and opportunities for cross-working to tackle them
   - Encourage participants from both fields into early career research peer support groups
   - Highlight examples of interdisciplinary impact
   - Increase professional societies' awareness of the advantages of collaboration
   - Identify opportunities to prepare for joint funding bids

5. Push professional societies and funders to increase support for neuroscientists

   - Push societies to offer and promote training in mentoring and leadership skills
   - Request that societies disseminate guidance on best practice in mentoring
   - Encourage societies to design and run a range of networking initiatives to suit different contexts and needs
   - Encourage different societies to work with each other to better connect their members
   - Press funders for more grants for training and career development initiatives to offer their own support activities and provide resources that are tailored to the African neuroscience context
   - Influence funders to ensure mentoring is a requisite component of funded projects
   - Press for grants and funding mechanisms that specifically support researchers-in-training to transition to academic independence
   - Press conference organisers to include greater opportunities to network and discuss cross-working within meeting agendas

Target Three

Developing and maintaining infrastructure

3

Delivering world-leading scientific research is highly dependent on appropriate, effective and well-supported infrastructure.

However, many neuroscientists throughout the African continent are working in sub-standard facilities lacking critical resources and expertise.

To tackle these inadequacies and develop good quality and well-maintained infrastructure, a range of challenges and barriers must be overcome. These include:

- Most African institutions lack basic infrastructure
- Limited funding and political and institutional prioritisation
- Limited sharing of available resources
- Limited individual motivation and incentives
- Limited ability to work as a research team and to-scale
- Currently no robust central body exists to promote and coordinate opportunities

More details concerning each of the challenges/barriers are shown in Appendix 3.

Ideas and potential actions to address the key challenges and barriers were discussed and two priorities emerged, with a particular emphasis on the first.

"Having continuously trained people to run the facilities is essential. It will take years for everyone to piece together the infrastructure they need."

– Showcasing African Neuroscience meeting participant

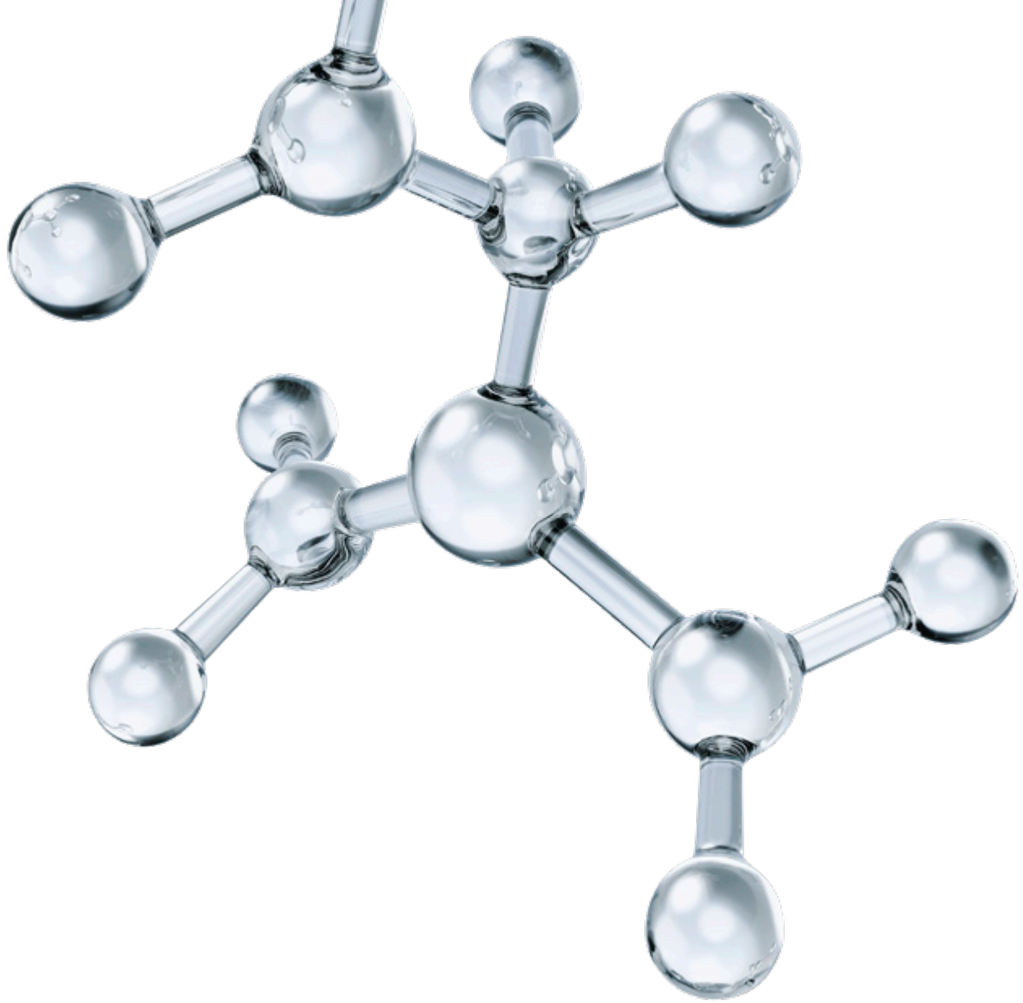
A. Establish a hub for African neuroscience

The concept is to build a hub of African neuroscience researchers with networking capabilities, including a database of information about their research interests, equipment, and resources they can share, and opportunities such as grants, collaborations, training, and mentoring. The hub should be flexible in its structure to suit different contexts, with sub-networks where relevant. The broad aims of the hub are to:

- Promote greater interaction, networking, and collaboration within and between scientific fields, institutions, countries, and the African continent; build relationships and trust
- Build capacity within African neuroscience by sharing information, expertise, and resources
- Amplify the voices of neuroscientists across the continent by advocating together on shared issues
- Encourage innovative neuroscience

While a pan-African hub would offer opportunities to draw together African neuroscience, the hub concept could be delivered as local or regional hubs, may stem from centres of strength, or could even build on existing initiatives. Efforts to subsequently link the hubs would amplify the benefits of individual initiatives, and provide greater opportunities for connecting people, resources, and ideas. Getting started should be seen as more important than waiting for the perfect solution.

A number of elements to be included in the development of the hub(s) are suggested (see Appendix 4).



"Establishing and maintaining clear and effective governance will be essential to get the project off the ground and ensure it achieves its vision and goals."

Several issues will need to be tackled to progress this initiative. Establishing and maintaining clear and effective governance will be essential to get the project off the ground and ensure it achieves its vision and goals. Any potential ambivalence towards the initiative may need to be overcome if it is to be effective in bringing together the neuroscience community and potentially securing funds for its running and expansion. Forging closer links between basic and clinical neuroscientists, as well as other disciplines (e.g., engineering, data science), will also be needed to secure maximum buy-in and ensure that networks, collaborations and opportunities are forged across the breadth of neuroscience. It is essential that any such hub is not created at the expense of overburdening existing centres.

While stakeholder mapping will reveal who best to involve in this initiative, initial ideas (beyond neuroscientists) included the following stakeholders: project management officers to champion the concept in their individual spaces (e.g. accountability, project management, strong data expertise); respected scientists to act as leaders and mentors (thereby also gaining their trust and buy-in); support from philanthropic funders to leverage university support (e.g. co-payment of a maintenance requirement to the donation or funding); and donors, with conditions for research infrastructure.

First steps

To drive the development of the hub(s), eight initial steps are recommended:

1. Understand the context
    - Map the current African neuroscience landscape – what's happening, what's available, who's involved etc. (e.g., stakeholders, facilities, resources, opportunities)
2. Define a common vision and goals
    - Clarify what the hub will aim to achieve
3. Establish what values and skills the hub needs to encompass to achieve its goals
    - Agree to the remit of the hub and what it will comprise
4. Identify and engage the initiative leads
    - Secure leadership for this initiative and institute a support framework to provide effective management and governance
5. Design a strategy for long-term operation
    - Plan for long-term momentum and implementation, including relevant metrics to demonstrate accountability as well as impact and growth
6. Identify key stakeholders and plan how to engage them
    - Identify exactly who needs to be involved and informed, who is accountable and responsible, and establish stakeholder roles. Inspire and secure respected advocates to help create buy-in and bring others on board the initiative
7. Secure practical help to get the hub underway
    - Identify initial funding and resources required, and potential available sources to establish the hub. Develop a plan for long-term income streams
8. Agree on initial information dissemination
    - Agree on first messages about the hub and target audiences and set an initial communications plan to inform stakeholders about the initiative and request involvement. Develop a long-term communication plan for varying audiences and purposes

"It's important that funders believe excellent science can be done in Africa beyond areas that are already well funded."

– Showcasing African Neuroscience meeting participant

A vision for advancing African Neuroscience

This report sets out the case for taking action to invest in advancing the neuroscience ecosystem in Africa and to raise the visibility and impact of its research on the global stage.

The three critical targets for action represent a clear direction for the neuroscience community to channel its efforts if it is to grow and enhance its impact.

Within these, the following **key priorities** for advancing African neuroscience were identified:

1. Champion innovation within African neuroscience
2. Draw on networks to build a stepped training programme (‘community model’)
3. Promote learning across a range of disciplines
4. Develop neuroscientists as active science citizens

Three phases chart the journey for African neuroscience

The report, has thus far, described the challenges and opportunities facing African neuroscience; it also identified four key priorities that form the strategic plan for delivering on the process goals to strengthen the African neuroscience community. Figure 2 outlines a suggested process to move through three phases on the journey, with progress being measured at each phase against the six key priorities.

Phase 1 – Mapping exercise

- Understanding the location of current strengths in terms of infrastructure, training opportunities in post-graduate neuroscience, as well as in specific skills (such as MRI analysis, use of advanced laboratory equipment) and scientific leadership
- Identifying gaps and opportunities

Indicators	Key Priorities
Number of neuroscience Masters and PhDs programmes and their distribution across the continent	1, 3, 4
Map of major scientific infrastructure, identifying gaps and opportunities	2, 3, 4

Phase 2 – Advance African neuroscience

- Consolidate scientific leadership and regional networks and build capacity pipelines, and within this do the following:
  - Build human capital in specialty skills relating to basic neuroscience, as well as key areas of clinical neuroscience, including neurobiological mechanisms, psychometrics and measurement, and intervention science
  - Encourage the careers of female African scientists through a supportive environment of female mentorship.
  - Build continuous career trajectories, from emerging interest to independent researcher, through a network of connecting degree and postdoctoral consolidation programmes
  - Enhance human resource policies to protect against workplace harassment and promote equitable hiring, retention, and promotion of young, especially female, African scientists
- Create a data platform to connect people and evidence as well as modelling a system of data accessibility
- Through sister mentorship-schemes between universities, disseminate best practice African systems for grant and facilities management

Indicators	Key Priorities
Increase numbers of funded research projects with African PIs	1, 2, 3, 4
African-led funded research projects (e.g., two or more African investigators across two or more countries)	
Portal for African researchers to access resources, including infrastructure, data, expertise, and training opportunities	

Phase 3 – Policy changes for brain health

- Engage the public through community advisory boards, science cafés and media campaigns
- Tailor concise messages and deliver them effectively to policy makers
- Collaborate with other scientists, educators, and the business community to bring new advances to scale

Indicators	Key Priorities
Policy changes related to neurological health	4
Changes in regional funding mechanisms (equivalent to SA's MRC and NRF)	

Figure 2: A route-map for advancing African Neuroscience

4 Key Priorities

1. Champion innovation within African neuroscience
2. Draw on networks to build a stepped training programme ('community model')
3. Promote learning across a range of disciplines
4. Develop neuroscientists as active science citizens

Phase 1: Mapping exercise

- Map of major scientific infrastructure, identifying gaps and opportunities
- KP 1, 3, 4
- Number of Masters and PhDs and their distribution across the continent
- KP 2, 3, 4

Phase 2: Advance African Neuroscience

- Increase numbers of funded research projects with African PIs
- African-led funded research projects (e.g., two or more African investigators across two or countries)
- Portal for African researchers to access resources, both infrastructure, expertise and training opportunities
- Increase in African-led and authored publications
- KP 1, 2, 3, 4

Phase 3: Policy changes for brain health

- Policy changes related to neurological health
- Changes in regional funding mechanisms (equivalent to SA's MRC and NRF)
- KP 4

Ultimate Vision

Our vision is an Africa where people achieve their full potential through brain health

Relevant indicators for SDG: 1, 2, 3, 4, 5, 6, 9, 10, 11, 17

Conclusion

The purpose of this report has been to record the stakeholder input discussed at the Showcasing African Neuroscience meeting. We have highlighted the best examples of research in basic and clinical African neuroscience, explored the potential for enhancing the interface between them in the African research context, and provided a platform to highlight the significant potential for new discovery from the populations and health challenges within the continent. Our aim was also to showcase the potential for health impact by expanded investment in neuroscience in Africa, and, more broadly to provide an opportunity to engage with a variety of stakeholders on strategies for accessing existing funding pipelines while facilitating informal discussions around some of the additional opportunities highlighted in this report.

Teresa Steyan, Sagel Kundieko and Roxanne Hattingh – Neuroscience students

Acknowledgements

We wish to thank all the speakers and contributors to the meeting, workshops, and report for their time and considered input.

Particular thanks goes to the steering group for their dedication and vision that was so critical to the development of this meeting, with special mention of co-chairs **Kirsty Donald** and **Mahmoud Bukar Maina**, who contributed an incredible amount of time and effort into making the meeting and workshops happen.

This initiative would not have been possible without the efforts of the support team: Wellcome, in particular **Matthew Brown**, for convening and developing the meeting along with **Raliza Stoyanova** and **Andrew Welchman**; **Delight Masocha** from the Neuroscience Institute at the University of Cape Town for coordination support; **Natasha Walker** for co-designing and facilitating the process; and **Alexis Willett** for co-designing the process and contributing to the report.

Appreciation also goes to the **Wellcome Trust** for providing funding for this initiative.

Appendix 1: The stakeholder engagement process

The goal of the overall process was agreed by the steering group as follows: *to strengthen the neuroscience research community in Africa, moving towards the vision of realising a globally recognised, unique and sustainable neuroscientific research landscape.*

In November 2021, African neuroscientists, along with funders and policymakers with an interest in African neuroscience, were invited to attend a two-day meeting to highlight excellence in African neuroscience and discuss critical issues for the African neuroscience ecosystem.

Wellcome previously carried out a scoping survey with members of the African neuroscience community to understand some of the current broad challenges and opportunities for the field. From this survey, it was recognised that a better understanding of the diversity of neuroscience happening across different African countries could help foster new potential collaborations and inform efforts to address issues hampering progress. An emphasis was placed on recruiting a wide range of participants to ensure good representation from the neuroscience field across Africa. As broad a representation as possible was sought for the meeting, covering basic and clinical neuroscience, as well as different geographies and career stages. Upon registration, participants were required to complete a brief, anonymous survey (survey questions shown in Appendix 1A). Eighty-six responses were received. The feedback helped to inform the content of the meeting and the starting points for discussion.

The event aimed to stimulate conversations to meet the following objectives:

- Showcase existing excellence in African neuroscience to the diverse meeting participants
- Understand challenges and barriers for African neuroscientific research: what is stopping individuals and systems engaged in neuroscience from flourishing in Africa?
- Identify strengths and potential (unique) opportunities: e.g., how African neuroscience actors could collaborate and how African ecosystems can be a breeding ground for innovative and globally relevant science
- Agree on next steps and a way forward for the sector

At its peak, 50 participants were present at the online event and over 30 speakers and co-chairs took a lead in highlighting issues and facilitating discussions (see Appendix 1B for speaker list). While many of the participants had decades of research experience, roughly one third were early career scientists. The meeting comprised a combination of presentations showcasing areas of excellence in neuroscience, alongside facilitated discussions on the challenges faced by this research field across Africa. Views and ideas on the barriers and potential solutions for driving neuroscience research forward were deliberated, aided by an external, professional facilitator.

To encourage networking, the meeting booklet (made available to all attendees) provided the biographies and email addresses of the main contributors to the meeting, as well as other attendees who indicated that their contact details could be shared should participants want to continue conversations afterwards.

Following the main meeting, three facilitated follow-up workshops were held to probe the critical issues for priority action. The steering group, plus motivated attendees of the main meeting, were invited to participate in the workshops, based on their expertise and interest in the themes and commitment to the process. The workshops were delivered in an iterative manner, with each building upon the discussions of the previous workshop. Ideas from both the pre-meeting registration questionnaire and main meeting were fed into the workshops as starting points for discussions. **Three pressing action areas were chosen for further exploration:**

1. Developing and maintaining infrastructure
2. Nurturing and supporting neuroscientists
3. Showcasing African neuroscience

A number of fundamental principles were agreed upon to frame the discussions and future thinking and promote a cohesive approach. These were:

1. Made and maintained in Africa for Africa;
2. Build on, and use, African neuroscience unique selling points;
3. Think out of the discipline and sectoral box; and 4. Leave no-one behind – whole of Africa approach.

Participants, who hailed from a range of institutions and backgrounds with different research needs, were asked to identify the most important root causes for challenges in African neuroscience and suggest ideas to address them.

Outcomes

Through dynamic and interactive engagement, fundamental challenges facing the neuroscience community were spotlighted and actions necessary to overcome hurdles, as well as capitalise upon existing and new opportunities, were proposed. (*N.B. Those identified in this report are not considered blanket issues or solutions for every country, institution, and field of neuroscience research, and each should be reflected in context.*) Six domains of distinction in African neuroscience that offer unique global potential were identified, and ways in which to use these to influence change were suggested.

The process offered a convincing case for excellence in African neuroscience, highlighting key areas where African neuroscientists are pushing the needle, and what the continent has to offer funders and researchers. There was broad interest in further collaborating around key issues, seeking sustainable solutions, and strategically engaging stakeholders to move African neuroscience to the next level.

Anonymous quotes used throughout the report came from meeting participants.

Appendix 1A: Pre-meeting registration questions

Demographic and professional data were captured, alongside the following questions (open text was enabled for all answers):

1. What do you hope to get out of the meeting?
2. What are three important neuroscience-related questions that you think need answering if funding were no problem?
3. What are the main challenges you personally face as a researcher in the neuroscience field?
4. Besides funding, what are the three main challenges hindering the growth of neuroscience research in Africa?
5. What can be done in next 3-5 years?

Appendix 1B: Meeting speakers and co-chairs

Event co-chairs:

Kirsty Donald, University of Cape Town

Mahmoud Maina, University of Sussex & Yobe State University

Organising committee:

Amadi Ihunwo, University of the Witwatersrand

Willie Daniels, University of the Witwatersrand

Charles Newton, KEMRI & University of Oxford

Nilesh Patel, University of Nairobi

Wael Mohamed, Menoufia Medical School & International Islamic University

Carine Nguemeni, University Hospital Wurzburg

Support team:

Matthew Brown (convener, Wellcome)

Delight Masocha (co-ordinator, Neuroscience Institute, University of Cape Town)

Natasha Walker (independent facilitator)

Alexis Willett (independent science writer)

Speakers and session co-chairs:

Oualid Abboussi, University of Mohammed V

Amos Abolaji, University of Ibadan

Amina Abubukar, KEMRI

Adhil Bhagwandin, University of Cape Town

William Daniels, University of the Witwatersrand

Kirsty Donald, University of Cape Town

Khalid El Allali, Hassan II Agronomy and Veterinary Institute of Rabat

Yasser El Wazir, Suez Canal University Mohamed Elsaey, Technische Universitat Braunscheig

Anthony Figaji, University of Cape Town

Dorit Hockman, University of Cape Town

Amadi Ihunwo, University of the Witwatersrand

Symon Kariuki, KEMRI

Nastassja Koen, University of Cape Town

Priscilla Kolibea Mante, Kwame Nkrumah, University of Science and Technology

Victor Kumbol, Charite Berlin
Dorcas Magai, Aga Khan University

Mahmoud Maina, University of Sussex & Yobe State University

Ernesta Meintjies, University of Cape Town

Wael Mohammed, Menoufia Medical School & International Islamic University

Aurelia Munene, Eider Africa

Royford Mwobobia, University of Copenhagen

Elisabeth Ngo Bum, University of Maroua

Charles Newton, KEMRI & University of Oxford

Carine Nguemeni, University Hospital Wurzburg

James Olopade, University of Ibadan

Mayowa Owolabi, University of Ibadan

Nilesh Patel, University of Nairobi

Lihle Qulu, Stellenbosch University
Jo Raimondo, University of Cape Town

Mohamed Salama, American University in Cairo

Dan Stein, University of Cape Town

Thomas Tagoe, University of Ghana

Dexter Tagwireyi, University of Zimbabwe

Appendix 2: Challenges and barriers to nurturing and supporting neuroscientists

1. Highly variable quality and quantity of mentorships in neuroscience Mentorships are a key ingredient for the growth of neuroscience researchers. Mentors support and guide researchers-in-training to enable them to reach their full potential and eventual research independence. However, not all neuroscientists across the African continent have access to experienced and supportive mentors, with some having no access at all. In some places, there are too few mentors and resources to support them, and others lack experience or training in effectively guiding junior colleagues. The lack of diversity amongst mentors is also a barrier to some mentees receiving support from people who appreciate their challenges. This results in many researchers-in-training missing out on important opportunities to network, learn new skills, and grow.	**A.** In many places, there are too few mentors and resources to support them in mentoring and support, and in finding opportunities for their mentees **B.** Many more individuals could become mentors but perhaps lack training or confidence to do so. Mentorship should be encouraged, and potential mentors incentivised **C.** Not all neuroscientists are clear on what the mentor role is and what a good mentorship relationship should look like. Greater understanding is required about what makes a good mentor **D.** While mentors should be able to identify where any particular needs can be met (e.g., through networks and development opportunities) this often isn't happening and limits mentees' growth **E.** Limited diversity in neuroscience that may make some mentees feel uncomfortable or have trouble finding their 'fit' **F.** Tribe and religion can influence who's willing to mentor whom in some places **G.** Some professional societies are not encouraging career opportunities, mentoring, or using networks to best support early career researchers and mentors
2. Uneven mentee understanding of the mentorship relationship and how to benefit from it For a fruitful relationship, it is critical that mentees understand the role of mentorship and their part in it. Many mentees lack guidance on what a good mentorship relationship looks like and hopes to achieve, and may not appreciate how to use their mentor relationship wisely. Some lack peer support to learn what they need from mentorship and how to achieve their aims.	**A.** Many mentees don't know what they want or need from a mentor **B.** Mentees may lack understanding of what they can bring to the mentorship relationship and what the relationship is for **C.** Some mentees are unmotivated or unprepared, which limits the effectiveness of mentorship **D.** A good mentee needs to know how to make use of mentors and the people around them wisely, and help guide the mentor on what they need to create an atmosphere of 'collaborative learning' **E.** Some research and/or regional cultures make it more difficult for mentees to secure and utilise appropriate, supportive mentors (e.g., cultures that are particularly hierarchical or misogynistic)

3. Highly variable access to career opportunities and support in making the transition from researcher-in-training to academic independence

A critical function of mentorship is to help bridge the gap from researcher-in-training to academic independence. Without broad support and exposure to a range of colleagues, fields of study, new techniques, training, and leadership opportunities, it can be very challenging for some to achieve that career step. Some lack access to the relevant labs and grants and may have only limited opportunities to present at national or international conferences and professional meetings. Many are burdened with excessive administrative responsibilities, hindering their research output, and some are faced with additional challenges (e.g., women feeling pressures of family expectations or caring responsibilities) that make the transition to independence an even greater hurdle. Currently, many individuals also lack access to skills training, such as writing skills, how to network, science communication, engaging with the media and the public, and policy engagement. These skills are increasingly needed as people move up the career ladder in neuroscience and competition for roles is fierce as posts and funding are limited.

- **A.** Too few grants available to support individuals in the transition to independence
- **B.** Limited secure and good jobs – funding for posts at universities is limited and competitive
- **C.** Too much bureaucracy and administration steals time away from research and personal development opportunities
- **D.** There is a focus on teaching in many institutions and guidance on research can be limited
- **E.** There is no defined path in neuroscience research and for some there are gaps in training in neuroscience techniques
- **F.** Many individuals lack awareness of how to achieve promotion
- **G.** Variable mentor awareness and effort in recognising individual mentee needs and finding appropriate development opportunities – this requires more effort and time which some mentors do not feel able to provide
- **H.** Competition is felt by some female neuroscientists in a male-dominated environment – they feel the need to compete, plus juggle other expectations of them (e.g. family), and they may be prevented from career opportunities

4. Lack of confidence amongst early career researchers

Some early career researchers lack confidence in their own ability to mentor others or to participate in wider career activities, such as policy engagement or media responses. They may perceive that they are not qualified to mentor someone who is working on a different research area. They may lack access to training in wider career skills or opportunities to step up and take part in more leadership activities, which hinders individual growth and, potentially, career advancement, while also reducing the pool of available mentors.

- **A.** Very hierarchical structures in some fields (e.g., medicine and clinical science) that can make it difficult for early career researchers to grow and advance
- **B.** Mentors should also learn from mentees and adjust their mentoring approach to their needs, but hierarchical structures may hinder this
- **C.** Some early career researchers experience imposter syndrome while navigating the transition from academic dependence to independence – this can lead to a lack of confidence in an individual's own ability and a lack of understanding about what's involved in the mentor role
- **D.** The breadth of neuroscience as a field and the many gaps in training mean that some potential mentors feel they lack the knowledge or expertise to mentor someone studying something different to themselves

5. Pressure to publish for local career advancement may be at odds with requirements of the wider neuroscience field

Different academic institutions have different publication requirements for career advancement, which may not be in line with the requirements of national or international funders or other institutions. They might also prioritise the number of publications rather than the quality of journals published in, which might not be enough to obtain larger grants from international funders. Furthermore, individuals may be unaware of local requirements leading to efforts to publish in inappropriate journals or ones that are unlikely to help them in seeking promotion at their institution. These inconsistencies may hamper career progression and limit the procurement of grants, collaborations, or roles at other institutions.

- **A.** Individuals need to understand why they should publish (promotion vs. publication)
- **B.** Institutional guidelines and regional practice are very different, with different incentives
- **C.** Guidelines for publication are not always available for everyone
- **D.** Individuals are not always matching publications to institutional guidelines
- **E.** People should seek their own institution's guidance on publishing and aim their publications accordingly if they're hoping to advance their career locally
- **F.** There may be a problem for outside opportunities if recommended journals in institutional guidance don't meet minimum standards – i.e., this may be an issue when a person wishes to grow their career outside their current institution

6. Stark division and limited collaboration between basic and clinical sciences Limited interdisciplinary collaboration between basic and clinical sciences is hindering progress on studying critical research questions. The are many reasons for the division between the two areas, not least the historical nature of how these sciences evolved. This has led to many barriers to cross-working, from scientific language barriers and lack of regular interactions, to competing aims and difficulties in securing funding or publication.	**A.** Lack of insight between basic and clinical sciences on how they work etc. **B.** Scientific language barriers make understanding each other's fields more challenging **C.** Sometimes the two areas remain distanced in order to defend their own interests **D.** The two areas are not often keen to collaborate as they have different research aims **E.** It can be difficult to get funding for projects that don't fall neatly into either basic or clinical science **F.** It is often much harder to publish interdisciplinary research **G.** Collaborations can also be difficult to arrange as people don't know who the experts are in each other's fields or who to connect with **H.** Professional societies for each field don't tend to facilitate cross-networking or interdisciplinary opportunities so finding contacts is challenging

Appendix 3: Challenges and barriers to developing and maintaining infrastructure

1. Significant basic infrastructure issues Many institutions are challenged by a lack of basic infrastructure. From a lack of facilities, equipment, resources, and appropriately trained support personnel, as well as stable internet and electricity supply, there are many fundamental issues that need to be addressed in order to support great neuroscience. The needs are complex and include funding, improved understanding of infrastructure requirements, and political buy-in.	**A.** Lack of understanding on what infrastructure means (i.e., not just equipment but also data and people), and that maintenance and support in training technical staff are also required, beyond acquisition of equipment **B.** Lack of affordable, basic, and also state-of-the-art equipment (e.g., for diagnosing brain disorders, neuroimaging) and laboratories (e.g., microscopes, sequencing facilities), and storage facilities may be deficient **C.** Lack of technical support **D.** Some local institutions lack the infrastructure to support large grants and projects, and infrastructure is often not designed for context-specific needs **E.** Limited access to research resources in some places (e.g., journals, research facilities, training and maintenance **F.** Lack of internet access – Cost of internet varies widely across localities and institutions prioritise who gets internet access, disadvantaging some. Lack of internet limits ability to download instructional papers, videos, or participate in live online events (therefore limited participation in broad activities (e.g., at regional and global levels), missing voices from the wider conversation) **G.** Lack of stable electricity supply – Public entities may not take responsibility for electricity provision **H.** Rich departments may hold greatest influence / gain greatest access to resources and not share, resulting in unequal access

2. Lack of funding and political and institutional goodwill Across the African continent, neuroscience is battling for attention against competing areas that are seen as a greater priority (e.g., those that address basic needs of the population). This has resulted in a lack of recognition of the relevance of the field and the need for long-term investment and championing to drive impact.	**A.** Neuroscience is in competition with other disciplines – it is deprioritised, in competition with other areas (e.g., providing society with access to basic needs), and there is a sense that developed nations instead should drive this field **B.** Lack of case or opportunities for return on investment and relevance for global development roadmaps; lack of long-term investment in neuroscience required to ensure competitive advantage **C.** Limited opportunities to grow capacity in neuroscience in Africa when more sophisticated research work (e.g., sequencing) is outsourced to more developed countries **D.** Lack of experience in making grant applications and writing proposals **E.** Professional societies lack funding
3. Limited sharing of available resources Research resources are not distributed equally across the African continent and access to key infrastructure and facilities is highly variable. This severely limits the potential for effective collaborations and advances in neuroscience on the continent.	**A.** Limited data on available resources **B.** Lack of funds to access infrastructure **C.** Oversubscription of current shared infrastructure and capacity-building **D.** Restrictive requirements in funding for collaboration **E.** Current infrastructure is often historically built to support north-south collaborations and may not be suitable for south-south collaborations
4. Lack of individual motivation and incentives A research culture that does not recognise and reward game-changing science leads to a demotivated and demoralised workforce. Good scientists are leaving for positions in other countries where their work is more valued, while others settle for unexceptional outputs to fulfil short-term gains in career progression, rather than taking on local challenges aimed at making significant long-term contributions.	**A.** Demoralised workforce where research output is not used – Individual researchers may leave neuroscience in their own country to find opportunities abroad where their skills and expertise may be better valued **B.** Lack of reward to do good science and lack of inspiration to achieve (e.g., where greater immediate financial reward comes from increased administrative work, or to publish with fewer authors on papers thereby prompting a disincentive to collaborate, or focus on publishing anything (rather than delivering game-changing work) in order to make individual career progress)

5. Limited ability to work as a research team and to scale University research cultures frequently inhibit the ability of researchers to work to their maximum potential. Roles are often spread too thin, with individuals expected to undertake large teaching, administrative, and sometimes also clinical loads, and financial incentives are often found away from research activities. Many researchers are taking on too many non-research responsibilities and some of the brightest individuals are limiting their research careers by doing so. Silo-working is also resulting in a dearth of cross-continental collaborations, lacking focus on shared research questions and common goals.	**A.** Universities are typically built around a teaching model and don't financially invest to a great extent in research positions. A greater emphasis is placed on teaching and administrative activities (e.g., certain positions that include enhanced admin responsibilities come with additional financial remuneration so can be hard to decline) **B.** Lack of time to focus on research – Many roles pulled in too many different directions (e.g., teaching, administration, clinical, research), with little resource to allocate specific roles and responsibilities, such as science communication **C.** The brightest people often have a large administrative load, limiting research time and career progression **D.** Changemakers are often overburdened as they take on too much responsibility, especially where there may be no one else to share the responsibility **E.** Lack of experienced personnel available to supervise junior researchers **F.** Absence of well-coordinated research efforts between African scientists (e.g., researchers often working in silos) **G.** Lack of shared collaborative vision / goal and collaborative tackling of research questions **H.** Low interdisciplinary partnership and teamwork **I.** Limited dissemination of information (e.g., about grants and collaborations)
6. Lack of robust central body to promote and coordinate opportunities While many different disciplines contribute to neuroscience research, there is no single, consistent, sustainable body that brings together everyone in the field for the purposes of networking, collaboration, and information sharing. This limits interactions, and the sharing of resources, opportunities and expertise.	**A.** No scientific societies to bring together neuroscientists from all fields – Inactive in connecting people and lobbying for improvements **B.** Fluctuation in donations of resources to poorer institutions for political / administrative reasons; possible hidden agendas

Imadeldin Yahya – Postdoctoral researcher

Appendix 4: Six domains of distinction (expanded)

DOMAIN ONE: Diverse DNA of African populations

Humans evolved in Africa, and then dispersed across the world. Early evidence for this 'out of Africa' hypothesis came from archaeological and paleo-anthropological data, with the oldest *homo sapiens* skeletons found on the continent. Genetic evidence has since strongly confirmed this view, with the DNA of those of African ancestry exhibiting the greatest diversity. There is significant global interest in using genomic studies to study human evolution as well as early migration patterns. Studies of African populations are of particular interest, given that all humans trace their genetic linkage back to the continent.

Advances in human genomics have significant implications in the clinical neurosciences. In rare neuropsychiatric conditions, most of which are thought to be highly heritable, genomic sequencing studies may find specific mutations that have led to the disorder. In prevalent mental disorders, multiple common variants may play a role, and polygenic risk scores may ultimately have clinical utility. Currently, African populations are under-represented in genomics research. It is increasingly recognised that whole genome association studies need to have greater diversity if findings from such work are to be generalizable to global populations.

The diversity of DNA in Africa may also play an important role in shedding light on how genetic and environmental variation contribute to individual differences, and to risk and resilience for disease. For example, particular copy number variants are known to be associated with specific neuropsychiatric disorders in those of Caucasian ancestry, but quite different regions of the genome may be associated with the same conditions in those of African and other ancestries; if so, this would be an important contribution to understanding the relevant neurobiology.

Implementation of genomic studies in Africa is fraught with challenges, including limited funding, lack of adequate laboratories and well-trained personnel, poor participation in research hindering recruitment, sensitivity of biobanking samples out of Africa, and delayed access of data by African scientists.

Sustainable partnerships in genomics research can be ensured through promoting collaborations, adopting shared leadership, and establishing trustworthy relationships among African researchers and collaborators, among others.

DOMAIN TWO: Diverse African flora, fauna and ecosystems for comparative research

Biological scientists study the flora and fauna of the natural world, and neuroscientists in particular focus on the normal and abnormal development and function of the nervous system. In the pursuit of discovering the mechanisms of function of the nervous system, neuroscientists have studied a diverse range of fauna such as non-human primates, rodents, squid, frog, fruit fly, sea slug and nematodes. Model systems, such as these, have been some of the significant drivers of scientific breakthroughs in neuroscience. For example, through decades of research using such models, many of the mechanisms of learning and memory have been unravelled and shown to be conserved across species.

African fauna is very diverse and unique. Although African neuroscientists rarely use genetically modified model systems in their research (unlike research conducted in the Global North), African laboratories often use animals including mosquitoes, Meriones shawi (a species of rodent), jerboa, rabbit, baboon, monkey, pigeon, chicken, donkey, buffalo, elephant, guinea pig, and chameleon. This diversity of animal models in the African ecosystem is a unique strength, as it can offer a novel perspective into animal and human neuroscience. For example, they can be used as research model organisms to understand brain health and disease, the transmission of nervous system diseases from animals to humans, and drug screening. By studying the olfactory sensing behaviour of mosquitoes in different communities, for example, researchers could easily decipher why some communities are more at risk of mosquito invasion and malaria than others.

Some of the key research directions to explore include comparative neuroscience to understand African animal models' brain anatomy, physiology, and gene expression profiles, their consequent relevance to human neuroscience, and the specific neuroscience research gaps they might help address. An important research question is: What novel animal models could be discovered in Africa that have the characteristics or structure that could be studied to solve problems in basic and clinical neuroscience? Looking specifically at the naked mole rat could be fruitful as this animal can endure extreme hypoxic conditions, has an unusual nociceptive system, and seems not to show cognitive decline associated with aging. Another interesting species is the female hyena, which, despite high testosterone exposure in utero resulting in physical male characteristics, does not display masculinization of its brain. The spiny mouse, *Acomys*, has also been shown to be a promising model to study spinal cord regeneration. Research in this area will help provide the basis for promoting these model systems on a global stage and generating opportunities for genetically modified African model organisms to study relevant brain disorders.

African natural products and folk medicine are potential sources of novel therapeutics for neurological and psychiatric disorders, and as tools for understanding the mechanism of numerous nervous system functions. The 2021 Noble Prize in Physiology or Medicine was given for the discovery of a novel family of ion channels, the transient potential receptors, research which was motivated by studying the mechanism of sensation produced by hot chilis or peppers. Study on the action of morphine led to the discovery of the endogenous opioid system, and atropine and curare derivatives are widely used in clinical medicine. While such examples from Africa are scant due primarily to the lack of extensive systemic study of the African flora, indigenous flora presents an excellent opportunity for African neuroscience research.

There are strong collaborative opportunities for neuroscientists and ecologists to research flora and fauna in their natural environments.

DOMAIN THREE: Child brain health and development

Sub-Saharan Africa is the home of 500 million children and adolescents. Child mortality in Africa has steadily dropped over the last 30 years, as children increasingly survive their early high-risk years. Although impressive, these gains have resulted in greater numbers of children living with chronic conditions, including developmental delays and mental health disorders. Brain structure and function are sensitive and responsive to environmental conditions and individual experience. The early years play a transformative role on future growth and potential, as demonstrated by their prioritisation in development agendas, such as the U.N. Sustainable Development Goals, the WHO's Nurturing Care Framework, as well as its Brain Health division.

The African region has a unique set of exposures affecting brain development. The environmental interaction with neurobiology is particularly important in this region since 1) the incidence of infections is higher; 2) the exposure to toxins and poor nutrition is more prevalent; 3) there is greater genetic diversity in African populations; and 4) exposure to trauma and violence remain high. Large studies of mechanisms underpinning brain growth and developmental disorders have been overwhelmingly based in the Global North. To date, little is known about the clinical variation or risk architecture of intellectual and developmental disabilities, autism spectrum disorders, or related developmental or mental health outcomes in African ecosystems. This unique context creates opportunities for scientific discovery and tailored interventions to promote the best potential for child brain health and wellbeing.

One key question is how non-invasive techniques (neuroimaging, microbiome, functional measures such as EEG, behaviour, and developmental tools valid for populations being studied) can be used in resource-limited settings to address questions around the trajectory of brain growth and development in this high-risk context. These tools are available in limited contexts across the continent but there is currently not enough to scale-up science in this area.

DOMAIN FOUR: Impact of climate change on neurological health

While well-resourced, industrialised economies are strong enough to withstand the immediate effects of climate change, poorer regions may face extreme weather events with weaker resources and often inadequate energy systems. Children are particularly sensitive, suffering from poor air quality (burning of wood for heat and cooking), malnutrition (food insecurity from crop failures), disease (cholera outbreak following flooding), and parasites. Collaborative and interdisciplinary work is needed to understand the potential impact of climate change on early brain development in Africa.

Data science is a particularly promising field, as modern technology, driven through the mobile network – ubiquitous in Africa – has the potential to use these observations for answering questions relevant to population brain health. Using data science, we can develop predictive models to identify potential risks to a population and contribute stronger evidence to inform policy and practice related to climate change. Africa's uniquely sensitive socio-economic environment presents a golden opportunity for data-driven research, as well as for developing harmonised approaches for sharing and analysing data across the neuroscience community.

DOMAIN FIVE: Access to clinical populations with important conditions less prevalent in the Global North

African neuroscience has the capacity to more effectively and efficiently study and address conditions that are more common in Africa than the Global North. These comprise a variety of diseases, injuries, and congenital conditions that affect the brain.

Traumatic brain injury and spinal cord injury are leading causes of death and disability across the world, but the incidence is highest in Africa, driven largely by road traffic accidents and assaults. Infections of the brain are more common, caused by infantile meningitis, bacterial meningitis, tuberculous meningitis, neurocysticercosis, HIV, and cerebral malaria. Spina bifida is a major neurological congenital condition prevalent in environments associated with poor preconceptional dietary or supplemented folic acid. Hydrocephalus and epilepsy – both major neurological conditions – are also more common given the prevalence of brain infections, injury, and spina bifida as underlying conditions. Their prevalence reflects the socio-economic reality of Africa and its broad-based population pyramid, with several implications for research:

- There is great capacity for clinically oriented, translational neuroscience research to improve healthcare in Africa, especially in young people, by reducing death rates and neurological disability
- Researchers have greater access to clinical data and rare patient samples (e.g., cerebrospinal fluid, brain tissue) critical for meaningful research
- Large patient numbers and low doctor-to-patient ratios expose the typical clinician to a greater patient population, increasing expertise and directing relevant research questions
- Clinical trials become feasible, and over shorter time spans, which benefits not only Africa, but also the Global North. For example, recruiting patients for clinical trials in traumatic brain injury would take much less time in Africa compared to Europe
- Clinically-enabled neuroscience helps us understand the brain. These conditions often share secondary mechanisms of progression (e.g., neuroinflammation, neuro-excitotoxicity, cellular failure), potential for neurobiomarkers, and therapy challenges (e.g., neuropharmacology and the blood brain barrier)

DOMAIN SIX: Resourcefulness: Pockets of resilience, reusing, and adapting existing technology and resources to answer new questions

Cutting-edge technologies have been among the major drivers of breakthroughs in neuroscience. It is no surprise, therefore, that countries that have to-date achieved high scientific success, gauged by the number of Nobel Prize-winning scientists, have access to these state-of-the-art technologies. However, there is a widespread lack of these cutting edge tools in African laboratories, partly due to funding, lack of equipment maintenance, and electricity. Furthermore, although local and international organisations have provided training opportunities abroad, the lack of available technologies at home has resulted in many scientists remaining abroad after such training.

Despite these challenges, many African neuroscientists have adapted and are using existing technologies and unique systems around them to pursue their research goals. Some are employing innovative approaches to build their equipment (e.g. using open hardware). Some are developing specialised research methodologies, like unique research questionnaires, to generate robust, culturally-relevant scientific data for their communities. Many have ventured into medicinal plant research and continue to collaborate with the public and traditional healers to understand the scientific validity of traditional medicine, and how it can boost the African economy and raise the profile of African research in this area. This resilience is important and serves as a major strength – it provides the opportunity for African neuroscientists to develop projects that fit with their unique ecosystem and diversity of the African continent, while maintaining global relevance. For example, there is currently no effective treatment for diseases like Alzheimer's and as the search to find an effective treatment continues, African research on medicinal plants provides an additonal, novel avenue.

Intra-African collaborations, as well as collaborations with the Global North, will be helpful in strengthening existing efforts in this area. This can be through collaborative funding applications to support African labs in upgrading their infrastructure or building their equipment. It can also be through network developments within African institutions to provide training to the next generation and offer access to key infrastructure for research within Africa. Moreover, collaborations will support data sharing and comparative studies on different populations, models, and the use of different technologies in consolidating data to inform global research efforts.

Appendix 5: Suggested elements for inclusion in the development of the hub

1	Explore how to set up and run a hub, and identify what the success factors might be, ensuring research cultures and context-specific factors are taken into account
2	Learn lessons from other pan-African hubs (e.g., in infectious diseases, H3A BioNet), including how to keep track of data, equipment and people. Benchmark and use what's already working sustainably in Africa in existing centres
3	Map stakeholders to identify key players
4	Develop a strategy for the hub, including its future direction and how to develop it over time
5	Secure membership from multiple disciplines across Africa, with a mutual commitment to share infrastructure
6	Start with small initiatives, and achieve quick wins to gain momentum and let it expand organically within a clear vision
7	Create and share opportunities to build networks and collaborations, as well as training
8	Identify joint scientific questions, across disciplines and basic and clinical science, to drive mutually beneficial collaborations
9	Create African collaboration-research networks that can be sustained
10	Foster advocacy to articulate and demonstrate the importance of investing now for long-term outcomes and impact
11	Engage existing initiatives (e.g., IBRO training schools)
12	Increase awareness of, encourage sharing of, and find ways to connect and expand, existing neuroscience datasets
13	Find ways to enable all neuroscientists in Africa to access state-of-the-art equipment and seek regular donation of used equipment from wealthier institutions for reuse in poorer settings, not just from Africa but around the world, too. Funders should be encouraged to enable this
14	Promote reuse of older models of equipment that may still be used to produce good science, and avoid stigmatising them as inferior
15	Promote the use of open hardware
16	Encourage collaborative grant-writing across countries
17	Share research administrative issues and experience (e.g., research grant management)
18	Build on training to maximise and leverage funds and other resources
19	Build capacity within neuroscience as a whole, rather than silo research groups (e.g., African centres with infrastructure organise workshops to train scientists who can then access that equipment in the centres)
20	Consider future international expansion of the network (e.g., African expats, international funders)