

# Development of Quantum Biology R&D in Africa

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## Abstract

Quantum Biology is a new emerging research field with enormous potential for science and technology. During the past few years, large research efforts into Quantum Biology have been launched in various parts of the world [1-10]. It is important that Africa actively contributes to the development of Quantum Biology in order to tap into the scientific and technological developments.

## Background

Quantum Biology started to develop during the past two decades as a result of convergence between quantum mechanics and biology. This emerging field stems from the interrogation of the basic principles that govern interactions at the molecular scale in living organisms. Quantum-mechanical experiments are typically performed in highly controlled environments using tools that allow the measurement and manipulation of nanoscale objects such as atoms, single molecules, or ordered solid-state systems. In contrast, biological phenomena involve large molecules (such as proteins) that are composed of typically hundreds of thousands of atoms and have, therefore, been considered too complex to be investigated by physicists using traditional quantum mechanical approaches. However, recent evidence of quantum phenomena occurring in living organisms indicates that quantum mechanics does play an important role in biological systems.

Applications of quantum biology are potentially enormous and could impact a large number of technologies, such as energy, environment, health, sensing, and information technologies [11-13]. Learning from life will not only lead to new technologies but also to new fundamental insights in physics, chemistry and biology.

For example, in the medical field, it is known that light enhances wound healing, effectively treats different types of cancer, and when applied to the brain it can have a range of physiological effects such as improved attention, memory, executive function, and rule-based learning [12]. Identifying how quantum effects might play out in the brain could offer a completely new way of imagining medical intervention beyond the purely chemical.

## Challenges

The research challenges that Quantum Biology is facing span from fundamental issues related to the interplay between the energy scales of different phenomena and the thermal noise emanating from the biological environment, to the understanding of the observed phenomena and technological bottlenecks related to measurement techniques. It is difficult to apply currently available measurement methods to *in vivo* measurements. The development of new techniques to probe and excite quantum phenomena in biomatter reflecting the *in vivo* situation would truly represent a breakthrough. Simulation and modelling tools currently cover different scales and regimes with various degrees of approximation. While entities composed of small atoms or molecules can be described accurately, we do not yet possess simulation tools that would account for quantum behaviour in systems such as proteins.

Quantum biology research needs both experimental facilities (for example sophisticated spectroscopy equipment coupled with biology laboratories) and large computational facilities to perform calculations on large, complex systems. Most of these facilities are expensive and non-existent in Africa.

### **How can Africa become actively involved in the development of Quantum Biology?**

We suggest the establishment of an African flagship programme to promote awareness, education, and research in Quantum Biology. We propose the following activities:

- Bridging the gap between academy and industry on R&D based on or inspired by Quantum Biology. Examples include phototherapy and the development of state-of-the-art chemical, magnetic and biological sensors.
- Establishing and advancing multidisciplinary research activities in Quantum Biology
- Developing and promoting joint Master's and Ph.D. programmes
- Support of student mobility between the consortium members
- Support of mobility to access expensive and sophisticated research infrastructure on other continents.
- Promotion of collaboration with established Quantum Biology research laboratories on other continents.
- Training of young researchers to build human capital and technological know-how in Africa.
- Hosting International Symposia on Quantum Biology to enable engagement between prominent quantum biologists and African students and researchers.

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