Neuroscience Research and Education in Nepal: Exploring Major Fields and Progress

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Abstract

Neuroscience in Nepal is a developing discipline facing many challenges but showing gradual progress . Traditionally, clinical neuroscience areas such as neurology, neurosurgery, and psychiatry have been the main focus primarily to pressing public health needs. Institutions like the Nepalese Society of Neurosurgeons and the Neuroscience Society of Nepal have played central roles in promoting education, research, and clinical care.

Although molecular and cellular neuroscience remains limited because of lack of sophisticated equipment and funding, some progress has been made through collaborative and computational studies. Cognitive neuroscience research addresses unique environmental impacts and educational factors in Nepal, supported by emerging laboratories and international partnerships. Neurophysiological research, initially focused on clinical diagnosis, is expanding into studies of brain function and neurological disorders using modern electrophysiological techniques. Computational neuroscience is an emerging field with increasing interest driven largely by advances in artificial intelligence and data analysis skills among younger researchers. Despite the shortage of trained experts, limited infrastructure, and low public awareness, neuroscience in Nepal benefits from the return of internationally trained professionals and growing institutional support. Unique cultural, geographic, and epidemiological factors provide specific research opportunities relevant to the Nepalese context.

This review aims to provide a comprehensive overview of the development of neuroscience in Nepal, highlighting both key achievements and persistent challenges. It emphasizes the necessity of sustained investment in education, infrastructure, and collaborative research networks to build a robust neuroscience community capable of addressing local health challenges and contributing valuable insights to the global understanding of neuroscience.

Keywords: Neuroscience Nepal, Research Progress, Neuroscience Education, Neuroscience Development.

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Introduction

Neuroscience as a formal discipline in Nepal is relatively young and underdeveloped compared to global centers. The country's research ecosystem has long been dominated by clinical neurology, neurosurgery, psychiatry, and public health, with basic or systems neuroscience largely absent or peripheral (Chaurasia et al., 2023; Sapkota et al., 2022). Neurosurgery in Nepal began in 1962 when Dr. Dinesh Nath Gongal performed the first brain surgery at Bir Hospital, Kathmandu (Gongal, 1980). The field of neurosurgery advanced significantly under Dr. Upendra Devkota, who established Nepal's first dedicated neurosurgical unit and ICU at Bir Hospital after returning from the UK in 1989 (Bagan, 1997). A notable institutional anchor is the Nepal Journal of Neuroscience, established in 2004 by a group of neurologists, neurosurgeons, radiologists, and physicians. It was initiated by the Neurosurgical Forum, a team formed at the Institute of Medicine, Tribhuvan University, to provide a local platform for neuroscience and neurosurgical topics relevant to Nepal (Sharma, 2018). The Nepalese Society of Neurosurgeons (NESON), founded in 2008, has expanded from 17 to 120 members and became affiliated with the World Federation of Neurosurgical Societies in 2010 (Sapkota et al., 2022). Although Nepal faces shortages in workforce and infrastructure, neurosurgeons across the country have continued to provide effective care using limited resources, producing noteworthy case reports and clinical studies that have strengthened the field. These collective efforts are gradually advancing neuroscience and neurosurgery in Nepal.

Although neuroscience research in Nepal remains less developed compared to fields like pharmaceutical science and biotechnology, notable progress has been achieved in recent years. Neuroscience Society of Nepal (NSN) was founded in 2016 under the leadership of Dr. Sunil Dhungel, marking a significant milestone in the formal development of neuroscience in Nepal. Since its inception, NSN has brought together neuroscientists, preclinical graduates, and physicians from across the country who share a common interest in the study of the brain and nervous system. Members of the society actively engage in teaching, learning, and research across diverse disciplines such as neuroanatomy, neurophysiology, neuropharmacology, neurochemistry, neuroimmunology, and neurogenetics. The society organized its First Annual Conference of the Neuroscience Society of Nepal (NSN) in 2016, which represented the first major scientific gathering of Nepali neuroscientists following the establishment of NSN earlier that year. Here is a concise and polished version:

The conference showcased recent advances in neuroscience and their clinical relevance through keynote lectures and oral and poster presentations by senior experts and emerging researchers from Nepal and several countries, including Iran, South Korea, India, Japan, Australia, and the United States. This event marked an important step toward fostering collaboration and promoting neuroscience research within and beyond Nepal. The Neuroscience School, conducted multiple times across Nepal by the Neuroscience Society of Nepal (NSN) with sustained support from the International Brain Research Organization (IBRO), has played a crucial role in strengthening neuroscience education and research capacity nationwide (Bali, 2016; S. Dhungel et al., 2023).

However, fundamental neuroscience research still lags because of insufficient funding, inadequate laboratory facilities, and limited institutional and governmental support. In the last decade, incremental efforts have appeared: laboratories, training programs, institutional reflection, and a small corpus of published neuroscience work grounded in local challenges (Bali, 2016; S. Dhungel et al., 2023; Thapa et al., 2014). Neupane et al. (2023) describe efforts to build neuroscience research capacity in Nepal through mentorship and international collaboration. Despite limited resources, local trainees established a neuroscience lab and contributed to neuro ophthalmology research. The authors stress that scientific curiosity exists universally but is hindered by negligible funding and infrastructure, calling for locally driven and inclusive research development (Neupane et al., 2023). Nepalese universities have integrated basic neurophysiology and anatomy topics into MBBS, neurology, neuropsychiatry, and neurosurgery programs. However, the absence of research-oriented training still limits growth in this field.

Recent advances in artificial intelligence and computational engineering, and related fields, have created potential for significant transformation in computational neuroscience in Nepal in the near future. This review explores the various branches of neuroscience, outlining their historical development, present status, and the future challenges and opportunities they encompass.

Clinical Neurosciences

Clinical neuroscience research in Nepal mainly concentrates on the study, diagnosis, and management of various neurological disorders that represent important public health concerns. Core research themes include

stroke, epilepsy, neurotrauma, neurodegenerative diseases, brain tumors, and peripheral nerve disorders. Stroke research holds particular importance as stroke remains a leading cause of mortality and disability in the country (Paudel et al., 2023; Pokharel & Amatya, 2019). Studies often explore its epidemiology, risk determinants, acute treatment approaches, and locally adapted rehabilitation strategies. Epilepsy-related work aims to enhance understanding of seizure types, improve diagnostic precision, expand therapeutic options, and strengthen community-based care models, reflecting Nepal's high epilepsy prevalence (Nepal et al., 2025; Rajbhandari, 2004). Neurotrauma investigations address brain and spinal cord injuries caused by traffic accidents, falls, and earthquakes, contributing to improved emergency response, surgical care, and rehabilitation practices. Research on neurodegenerative conditions such as Parkinson's and Alzheimer's focuses on defining disease patterns, cognitive and motor symptoms, assessment of knowledge, and suitable management frameworks for Nepal's population (Baral et al., 2020; Rayamajhi et al., 2024).

Studies on brain tumors assess imaging modalities, neurosurgical interventions, and supportive care for both primary and metastatic lesions, while research on peripheral nerve disorders, especially diabetic neuropathy and compressive neuropathies, remains an area of ongoing interest (Karki et al., 2018). Leading institutions like the Annapurna Neurological Institute and Allied Sciences (ANIAS), National Neuro Center, Nepal Mediciti Hospital, and Tribhuvan University Teaching Hospital are central to these efforts through clinical trials, patient-based research, and specialized training programs. These organizations serve as vital links between scientific discovery and healthcare practice tailored to Nepal's unique medical and socioeconomic landscape. The limited availability of neurosurgery training programs and their concentration in a few institutions have contributed to the persistently low number of neurosurgeons in Nepal. The current ratio stands at approximately 0.304 neurosurgeons per 100,000 population,

which is considerably below the recommended ratio of 1 per 100,000. Based on this estimation, Nepal faces a shortage of around 215 neurosurgeons to meet national requirements. Furthermore, the existing workforce is unevenly distributed, with a majority of specialists concentrated in Kathmandu, leaving peripheral and rural regions with minimal or no neurosurgical services (Kato et al., 2020; Sapkota et al., 2022). The Nepalese Society of Neurosurgeons (NESON), founded in 2008 under the leadership of Dr. Devkota, has

been actively advancing the field of neurosurgery in Nepal since its inception. The society regularly organizes various programs, workshops, and academic activities aimed at enhancing professional development and promoting excellence in neurosurgical practice. In summary, clinical neuroscience research in Nepal is steadily advancing, propelled by the need to confront common neurological disorders with contextually appropriate, evidence-based solutions that enhance patient care and health outcomes.

Molecular and Cellular Neuroscience

Molecular and Cellular Neuroscience research in Nepal is a nascent yet gradually evolving field that seeks to uncover the cellular and molecular mechanisms underlying neural function, neurodevelopment, and neurological disorders relevant to the Nepalese population. Despite increasing academic interest, the progress in this domain remains limited primarily due to the lack of advanced laboratory infrastructure, specialized equipment, and high-cost reagents necessary for conducting in-depth experimental studies. Most research efforts dealing with the nervous system at the molecular level have so far remained superficial, often constrained to biochemical or pharmacological evaluations rather than mechanistic cellular investigations. Some progress has emerged through collaborations between neuroscience and natural product chemistry disciplines. Owing to the availability of basic analytical instruments in pharmacognosy and medicinal chemistry laboratories, a few exploratory studies have examined the potential central nervous system (CNS) effects of traditionally used Ayurvedic and herbal formulations (Aryal et al., 2022; Pandey et al., 2024; Shrestha, M, et al., 2025). These investigations have largely relied on behavioral experiments, preliminary in vitro assays, or computational methods to predict neuroactive properties. More recently, molecular docking and molecular dynamics (MD) simulations have been introduced as cost-effective computational tools to explore receptor–ligand interactions, enzyme inhibition, and neuroprotective potentials of locally sourced compounds. However, such computational and surface-level approaches cannot substitute for thorough experimental validation. The absence of sophisticated cell culture facilities, molecular imaging systems, and electrophysiological tools continues to restrict the field's capacity to conduct mechanistic studies at cellular or synaptic levels. Therefore, advancing molecular and cellular neuroscience in Nepal will require targeted investment in laboratory infrastructure, training programs in modern neurotechniques, and interdisciplinary collaboration among re-

searchers in neuroscience, biotechnology, and computational modeling. Establishing such foundations would enable Nepalese scientists to transition from descriptive or simulation-based studies toward genuine mechanistic insights into neural function and pathology within the local context.

One notable hospital-based study (2009–2011) conducted at Patan Hospital, Kathmandu, represents one of the earliest molecular and serological investigations of central nervous system infections in Nepalese adults (Giri et al., 2013). By identifying pathogens such as Japanese encephalitis virus, enteroviruses, *Neisseria meningitidis*, and *Streptococcus pneumoniae* through molecular diagnostics and serology, it marked a significant advance in clinical neuroinfectious disease research and established a foundation for molecular and cellular neuroscience in Nepal. Globally, molecular and cellular neuroscience is advancing with high-resolution techniques, including single-cell transcriptomics and Clustered regularly interspaced short palindromic repeats (CRISPR) -mediated gene editing, allowing detailed mapping of neuronal circuitries and identification of molecular targets for therapeutic intervention. The Nepalese research community is progressively aligning with these methodologies, though substantial development in laboratory infrastructure, access to cutting-edge technologies, and international collaborations remains critical for advancing the field.

Cognitive neuroscience

Cognitive neuroscience is a subfield of neuroscience focused on understanding the biological processes underlying human cognition—how brain structures and activities relate to cognitive functions such as thought, memory, language, perception, and decision-making (Pereira, 2007). It integrates theories from cognitive science with neurobiological evidence and advanced brain imaging techniques to explore the neural basis of cognitive processes (Pereira, 2007). Several epidemiological studies have provided valuable insights into the neural and environmental factors influencing cognition in the Nepalese population, highlighting the roles of biological risk factors, socioeconomic conditions, and environmental stimulation in early cognitive development (Buckley et al., 2013; Kc et al., 2024; Pathak et al., 2021; Ranjitkar et al., 2019). Education and cognitive ability's impact on brain electrical activity in Nepalese medical students has been studied, revealing neural efficiency changes and stress responses via EEG across cognitive groups

and academic progression (Upadhayay, 2017).

A recent study on high-altitude exposure in Nepal reveals that frontal lobe functions, crucial for executive control and attention, are significantly impaired by hypoxia, highlighting the brain's adaptive challenges in Nepal's unique high-altitude environment (Dhungel et al., 2025). Together, these studies advance cognitive neuroscience in Nepal by addressing both educational brain function and environmental impacts unique to the country's geography and population. Dr. Lekhnath Pathak established Nepal's first Cognitive Science and Psycholinguistics Lab at the Central Department of Linguistics, Tribhuvan University, significantly advancing cognitive science by researching brain-language interfaces and building regional expertise in these fields (Pathak et al., 2024; Pathak et al., 2021).

At the molecular level, collaborative studies involving the analysis of Calbindin-D28k, NeuN, ATOH1, and EN2 expression in the human fetal cerebellum have been conducted in partnership with international laboratories (Poudel et al., 2025). Engagement in such cross-institutional molecular research has been instrumental in strengthening experimental skills, promoting the exchange of advanced methodologies, and expanding the research network focused on cerebellar development. The Nepal Center for Cognition and Society was founded to explore human and animal cognition and cognitive processes through behavioral, neuroimaging, electrophysiological, and computational approaches, fostering research across multidisciplinary and interdisciplinary collaborations.

Neurophysiology

Neurophysiological research in Nepal is still at a developing stage, yet it has gradually expanded over the past two decades with the growing interest in neuroscience and clinical neurodiagnostics. Early work in this field was primarily focused on the clinical application of electroencephalography (EEG), computerized tomography (CT) and MR imaging for the diagnosis of epilepsy and other seizure-related disorders, largely confined to major hospitals in Kathmandu (Ghimire et al., 2007; Pant et al., 2007; Pant et al., 2004). With time, several institutions began integrating electromyography (EMG), nerve conduction studies (NCS), and evoked potentials to evaluate peripheral and central nervous system functions (Dubey et al., 2022).

In recent years, academic and hospital-based

researchers have initiated efforts to explore the neurophysiological basis of sleep, cognition, and neurodegenerative diseases (Malla et al., 2023). The introduction of digital EEG systems and advanced analytic tools has enabled limited but meaningful investigations into brain oscillations, sleep architecture, and event-related potentials (ERPs). For instance, small-scale projects have examined EEG patterns associated with epilepsy, sleep deprivation, and psychiatric conditions, contributing to the foundation of clinical neurophysiology in Nepal.

Training and collaborative research have also played a vital role in strengthening the field. Nepali researchers, in partnership with international laboratories, have participated in capacity-building programs that introduced advanced neurophysiological techniques, including quantitative Electroencephalogram (EEG) and neurofeedback (Malla et al., 2023). Such collaborations have helped establish a bridge between clinical neurology and basic neuroscience, promoting skill development and knowledge transfer. Despite these encouraging steps, neurophysiological research in Nepal still faces limitations such as a shortage of trained personnel, inadequate laboratory infrastructure, and restricted access to modern electrophysiological equipment.

Computational Neuroscience

Computational neuroscience is an emerging discipline that applies mathematical models, computer simulations, and theoretical approaches to understand the structure and function of the nervous system. It helps explain how neural circuits process information, generate behavior, and adapt through learning (Erdi, 2015). A growing number of students and researchers in Nepal are interested in the computational approach for the delivery of different natural product extracts for targeting different brain regions for the treatment of different neurodegenerative diseases (Shrestha, Tamang, et al., 2025; Subin & Shrestha, 2024). Online resources on neuronal modeling are increasingly enabling students to access advanced concepts and making it easier for them to develop computational skills in neuroscience. Some Nepalese scholars with international collaboration are already engaging in projects related to EEG data analysis and cognitive modeling using computational tools.

As the global focus on brain research expands, computational neuroscience could become an important area for Nepal's scientific growth. Building expertise in this field can support studies on neurological disorders, mental health, and cognitive function while al-

so contributing to international research collaborations. Continued investment in training, interdisciplinary education, and digital infrastructure will be essential to strengthen this area. In Nepal, computational neuroscience is still in its early stages and has received limited attention, primarily due to the lack of experts and specialized training in this area. However, with the growing interest in computational mathematics, artificial intelligence, and neural network research, this field holds significant potential for future development. As more students and researchers become engaged in data-driven and theoretical approaches to studying the brain, computational neuroscience in Nepal is expected to expand and contribute meaningfully to both national and global neuroscience research.

Overview of Neuroscience-Related Societies in Nepal

Neuroscience societies in Nepal play a crucial role in advancing the study, research, and education of neuroscience within the country. The Neuroscience Society of Nepal (NSN), for instance, is a prominent organization that brings together neuroscientists, clinicians, and students through various academic events such as conferences, workshops, and training programs (Bali, 2016; Sunil Dhungel et al., 2023). NSN works to foster collaboration both nationally and internationally, enabling members to share their research findings and develop scientific skills. These societies serve as vital platforms supporting the growth of neuroscience disciplines, encouraging interdisciplinary approaches, and strengthening Nepal's presence in the global neuroscience community. Nepalese Society of Neurosurgeons (NESON) focuses on neurosurgery while contributing to research and healthcare development in neurological sciences. Other organizations contributing to neuroscience research and healthcare in Nepal include the Nepal Center for Cognition and Society, the Nepal Epilepsy Society, and the Society of Neuro Critical Care, all of which are actively involved in promoting brain research, clinical care, and interdisciplinary collaboration within the country. Overall, such organizations significantly contribute to the promotion and progress of neuroscience research and education in Nepal, creating opportunities for professional development and scientific exchange.

Challenges in Neuroscience in Nepal

Neuroscience in Nepal faces several obstacles that slow its development. A key issue is the shortage of trained professionals and experts, which limits both research and teach-

ing opportunities in the field. Advanced laboratory equipment, neuroimaging facilities, and computational tools are scarce, making it difficult to conduct high-quality experimental or clinical studies. Funding for neuroscience projects is also limited, with most research relying on small-scale initiatives or international collaborations. Public awareness of neurological and mental health issues is low, which reduces engagement and support for research and healthcare programs. Additionally, collaboration between institutions and interdisciplinary networks remains weak, preventing the formation of a unified neuroscience community. Despite these challenges, growing interest in computational neuroscience, artificial intelligence, and brain research provides a promising path forward. Strengthening education, infrastructure, and collaboration will be essential to expand the field and enhance Nepal's contribution to global neuroscience.

Opportunities for Neuroscience in Nepal

Neuroscience in Nepal holds significant potential for growth despite current challenges. Many Nepalese students are pursuing neuroscience education and research in foreign countries, gaining exposure to advanced techniques, cutting-edge technologies, and international research standards. Once they complete their studies and return, they can play a key role in developing local expertise and strengthening research capacity. With improvements in infrastructure and the establishment of well-equipped laboratories and university programs, these trained professionals will be able to contribute significantly to advancing neuroscience in Nepal. The rise of computational tools, open-access datasets, and affordable neuroimaging technologies also provides cost-effective avenues for research. Furthermore, Nepal's unique population and cultural context offer opportunities to study region-specific neurological and cognitive patterns, which can enrich global neuroscience knowledge. As more universities in Nepal develop high-quality programs and research facilities, returning students and researchers will be in a position to apply their skills and experience, contributing directly to the growth of neuroscience in the country and helping to build a sustainable and collaborative research community.

Conclusion

Neuroscience in Nepal is a growing field with immense potential, yet it faces significant challenges including limited infrastructure, a shortage of trained experts, and insufficient funding. Despite these obstacles, there are clear opportunities for advancement through

international collaborations, the use of computational and neuroimaging tools, and the engagement of students and researchers studying abroad. By investing in education, developing well-equipped laboratories, and fostering interdisciplinary and collaborative networks, Nepal can build a strong neuroscience community. The return of trained professionals and researchers from foreign institutions will play a pivotal role in transferring knowledge, mentoring the next generation, and driving innovative research. With strategic support from universities, government, and research organizations, neuroscience in Nepal has the potential not only to address local health and cognitive challenges but also to contribute valuable insights to the global understanding of the brain.

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