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# Morphological Analysis of Individual Neurons

Ioannis MAVROUDIS[1, 2], Alin CIOBICA[3,4,5], Foivos PETRIDES[2], Vasiliki COSTA[2], Stavros J BALOYANNIS[2]

1. Leeds Teaching Hospitals, Leeds, UK
2. Laboratory of Neuropathology and electron Microscopy, Aristotle University of Thessaloniki, Greece
3. Department of Research, Faculty of Biology, Alexandru Ioan Cuza University, B dul Carol I, no 11, Iasi, Romania
4. Academy of Romanian Scientists, Splaiul Independentei nr. 54, sector 5, 050094 Bucuresti, Romania
5. Center of Biomedical Research, Romanian Academy, Iasi, B dul Carol I, no 8, Romania

**Corresponding Author:** Ioannis Mavroudis, **Email:** ioannis.mavroudis@nhs.net

**Abstract.** The ultimate, and arguably the hardest, challenge to human knowledge consists of understanding how neurons and their connections give rise to feelings, emotions, and logical thinking. Neurons are themselves complex computational machines. Theories of dendritic, somatic, and axonal functions have matured well beyond the traditional scheme of "input–integration–output". Single neurons and their arbors are now considered sophisticated time filters, coincidence detectors, internally distributed devices of local memory storage, and dynamic metabolic assemblies with high internal spatial specificity. The first step in the pathway of morphological analysis of individual neurons is the neuronal staining either with intracellular labeling techniques, or with the traditional silver staining methods. Another fundamental step is the tracing into a three-dimensional (3D) digital representation of the branching dendrites and/or axons, and the last and crucial step is the mathematical and statistical analysis of the acquired morphological parameters which can be classified in two main categories, the topological and geometric parameters.

**Keywords:** neurons, morphology, neuropsychiatry, memory

## Introduction

The modern scientific investigation of nervous systems started over a century ago with the revolutionary neuron doctrine, posted by Santiago Ramon y Cajal. Cajal showed that, like all the other organs in the body, the brain is constituted by cells and revealed the incredible complexity of the shape and potential connectivity of brain cells. Cajal's findings inspired the principal axiom of modern neuroscience: the key substrate for all the functions performed by nervous systems, from regulation of vital states, reflexes, and motor control, to the storage and retrieval of memories and appreciation of artistic beauty, lies in the structure and assembly of neurons [1].

The ultimate, and arguably the hardest, challenge to human knowledge consists of understanding how neurons and their connections give rise to feelings, emotions, and logical thinking and further on how the affecting on the CNS connectivity results in neuropsychiatric disorders and all the associated deficits that come along with that, as our groups previously showed in an extensive matter [2-9].

The establishment of neuroanatomical databases and the development of computer graphics have resulted in a plethora of high-level research projects focusing