ADVANCES IN ANATOMY, EMBRYOLOGY AND CELL BIOLOGY

Tjitske Heida
Enrico Marani
Kamen G. Usunoff

The Subthalamic Nucleus

Part II: Modelling and Simulation
of Activity

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Manuscripts should be addressed to

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e-mail: fb22@le.ac.uk

Prof. Dr. F. CLASCÁ, Department of Anatomy, Histology and Neurobiology,
Universidad Autónoma de Madrid, Ave. Arzobispo Morcillo s/n, 28029 Madrid, Spain
e-mail: francisco.clasca@uam.es

Prof. Dr. M. FROTSCHER, Institut für Anatomie und Zellbiologie, Abteilung für Neuroanatomie,
Albert-Ludwigs-Universität Freiburg, Albertstr. 17, 79001 Freiburg, Germany
e-mail: michael.frotscher@anat.uni-freiburg.de

Prof. Dr. D.E. HAINES, Ph.D., Department of Anatomy, The University of Mississippi Med. Ctr.,
2500 North State Street, Jackson, MS 39216-4505, USA
e-mail: dhaines@anatomy.umsmed.edu

Prof. Dr. N. HIROKAWA, Department of Cell Biology and Anatomy, University of Tokyo,
Hongo 7-3-1, 113-0033 Tokyo, Japan
e-mail: hirokawa@m.u-tokyo.ac.jp

Dr. Z. KMIĘC, Department of Histology and Immunology, Medical University of Gdansk,
Debinki 1, 80-211 Gdansk, Poland
e-mail: zkmiec@amg.gda.pl

Prof. Dr. H.-W. KORF, Zentrum der Morphologie, Universität Frankfurt,
Theodor-Stern Kai 7, 60595 Frankfurt/Main, Germany
e-mail: korf@em.uni-frankfurt.de

Prof. Dr. E. MARANI, Department Biomedical Signal and Systems, University Twente,
P.O. Box 217, 7500 AE Enschede, The Netherlands
e-mail: e.marani@utwente.nl

Prof. Dr. R. PUTZ, Anatomische Anstalt der Universität München,
Lehrstuhl Anatomie I, Pettenkoferstr. 11, 80336 München, Germany
e-mail: reinhard.putz@med.uni-muenchen.de

Prof. Dr. Dr. h.c. Y. SANO, Department of Anatomy, Kyoto Prefectural University of Medicine,
Kawaramachi-Hirokoji, 602 Kyoto, Japan

Prof. Dr. Dr. h.c. T.H. SCHIEBLER, Anatomisches Institut der Universität,
Koellikerstraße 6, 97070 Würzburg, Germany

Prof. Dr. J.-P. TIMMERMANS, Department of Veterinary Sciences, University of Antwerpen,
Groenenborgerlaan 171, 2020 Antwerpen, Belgium
e-mail: jean-pierre.timmermans@ua.ac.be

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Tjitske Heida, Enrico Marani,
and Kamen G. Usunoff

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With 54 Figures

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Tjitske Heida
Enrico Marani

Department of Biomedical Signals and Systems,
University of Twente,
7500 AE Enschede
The Netherlands

e-mail: t.heida@el.utwente.nl

e-mail: e.marani@utwente.nl

Kamen G. Usunoff

Department of Anatomy & Histology,
Medical University Sofia,
1431 Sofia
Bulgaria

e-mail: uzunoff@medfac.acad.bg

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Abstract

Part I of *The Subthalamic Nucleus* (volume 198) (STN) accentuates the gap between experimental animal and human information concerning subthalamic development, cytology, topography and connections. The light and electron microscopical cytology focuses on the open nucleus concept and the neuronal types present in the STN. The cytochemistry encompasses enzymes, NO, glial fibrillary acidic protein (GFAP), calcium binding proteins, and receptors (dopamine, cannabinoid, opioid, glutamate, γ -aminobutyric acid (GABA), serotonin, cholinergic, and calcium channels). The ontogeny of the subthalamic cell cord is also reviewed. The topography concerns the rat, cat, baboon and human STN. The descriptions of the connections are also given from a historical point of view. Recent tracer studies on the rat nigro-subthalamic connection revealed contralateral projections. This monograph (Part II of the two volumes) on the subthalamic nucleus (STN) starts with a systemic model of the basal ganglia to evaluate the position of the STN in the direct, indirect and hyperdirect pathways. A summary of in vitro studies is given, describing STN spontaneous activity as well as responses to depolarizing and hyperpolarizing inputs and high-frequency stimulation. STN bursting activity and the underlying ionic mechanisms are investigated. Deep brain stimulation used for symptomatic treatment of Parkinson's disease is discussed in terms of the elements that are influenced and its hypothesized mechanisms. This part of the monograph explores the pedunculopontine-subthalamic connections and summarizes attempts to mimic neurotransmitter actions of the pedunculopontine nucleus in cell cultures and high-frequency stimulation on cultured dissociated rat subthalamic neurons. STN cell models – single- and multi-compartment models and system-level models are discussed in relation to subthalamic function and dysfunction. Parts I and II are compared.