神经生理学纲要

吕国蔚 编著

ESSENTIALS OF NEUROPHYSIOLOGY

人民卫生出版社

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Foreword

Neurophysiology constitutes more than one fourth of the whole content of medical physiology. It has been known for two distinct characteristics: the extreme importance for understanding the control of body function and mental activities, and the unbelievable complexicity which makes its study a most difficult one. One could thereby imagine how difficult the task would be when it is being taught in English as a second language.

The author of this book, however, has succeeded in dissecting the whole complex into well defined, easily understandable units, which are then integrated into a well organized frame. With these guide lines in mind, the readers will be able to go into the maze of neurophysiology without being afraid of getting lost.

The book will be of benefit not only to students being taught in English, but also to students who are taught in Chinese yet would like to broaden their scientific vocabulary in English. Reading the book, medical people, especially those who are interested in basic biomedicine, will also find it helpful in sharing new information on neurophysiology with the author.

I appreciate the simple and clear cut description in the text, completed with the attachment of a glossary. These will help the readers to go directly into the essentials of neurophysiology without being barricaded by the language problems.

The book could be even more useful should it be provided with illustrative figures and diagrams necessary for the understanding of complicated issues. I am looking forward to seeing them in the next edition.

Han Ji-Sheng
Professor & Chairman
Department of Physiology
Beijing Medical College

Preface

This bok is written as an introduction to neurophysiology for the medical student, dental student, graduate student, physician, surgeon, physical therapist and others who require a review of the essentials of neurophysiology.

The material in the notes is presented in a simplified, concise, and outline form, but it is, nevertheless, complete. Extensive and detailed coverage of the entire field of neurophysiology is, however, beyond the scope of the notes since "neurophysiology" covers subjects which range from basic membrane phenomena to psychophysiology.

Experience has shown that principles remain with readers long after isolated facts have been forgotten and, in fact, have become obsolete. Accordingly it has been the author's intent to emphasize the principles of neurophysiology that are important to the readers working in the field of biomedicine. The reader who assimilate the basic knowledge contained herein will then have the background needed to delve into the more detailed factural information in scientific articles on a special topic in this ever-expanding field of neurophysiology.

The format of the book is meant to be adaptable to several learning and teaching modes. Students are often overwhelmed by excess explanations, references, and minute details and thereby lose sight of the real essentials. The notes serve to identify the "core material" which is considered the basic, essential information that every student should know. Non-core information is also included in the lecture notes to broaden those intellectual horizons.

Those seeking to review the knowledge of neurophysiology are often astounded by progress in the field and the lack of time to study the mass of material that is available. The notes are designed to be clear at a glance and to gain new insights through reviewing the information concerning control and function of the nervous system presented in the notes.

With the appearance of the book, the anthor would like to express his appreciation to the many colleagues in my department. I am particularly grateful to professor Han J.S. who reviewed the whole context of the notes and was very supportive of the entire project. I wish especially to thank Dr. Zhang S. for excellently preparing the glossary of the notes. My gratitude is extended to all the authors whose books I have taken passages and made extracts from. I am greatly indebted to all the students who labored long hours typing the manuscript. Finally, I am deeply indebted to the medical students whom I have instructed this year. Although I have never found teaching neurophysiology in English to them an easy task, I have always found it challenging and personally rewarding. I have learned very much from them.

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Part I

Neuromorphological Overview

Organization of the Nervous System

I. Major Division of the Nervous System

For the purpose of study and description, the nervous system is parcelled as follows:

A. The central nervous system (CNS), composed of the brain and spinal cord.

B. The peripheral nervous system (PNS), includes the nerves of the body, their ganglia and terminal processes (sensory receptors and effector terminals). The nerves of the body are constituted from the 31 pairs of spinal nerves and the 12 pairs of special cranial nerves.

C. The autonomic nervous system (ANS) is a functional, rather than an anatomical division of the nervous system. It is subdivided into:

1. The sympathetic nervous system.
2. The parasympathetic nervoussystem.

II. Regional Anatomy of the CNS

A. The CNS, based on anatomical and developmental points, may be divided into six regions.

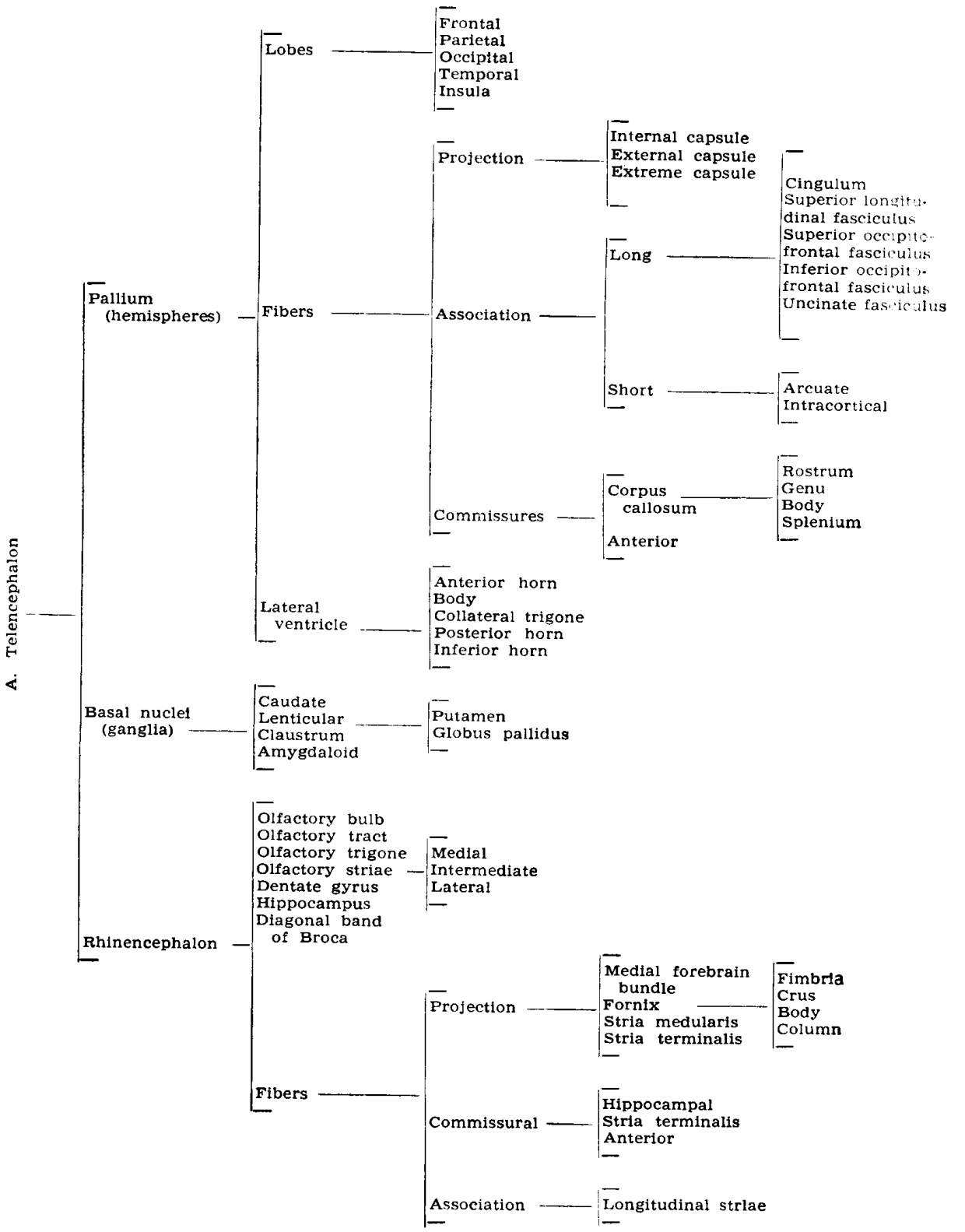
1. The Telencephalon-includes the cerebral hemispheres.
2. The Diencephalon-buried, but visible on the base of the brain.
3. The Mesencephalon-a causeway between higher and lower brain regions.
4. The Pons-a bridge of nerve fibers crossing the CNS axis. Also the region of the cerebellum.
5. The Medulla oblongata-a transition zone between the bain and spinal cord
6. The Spinal cord-a sensory-motor reflex center and a transmission pathway for ascending (sensory) and descending (motor) information.

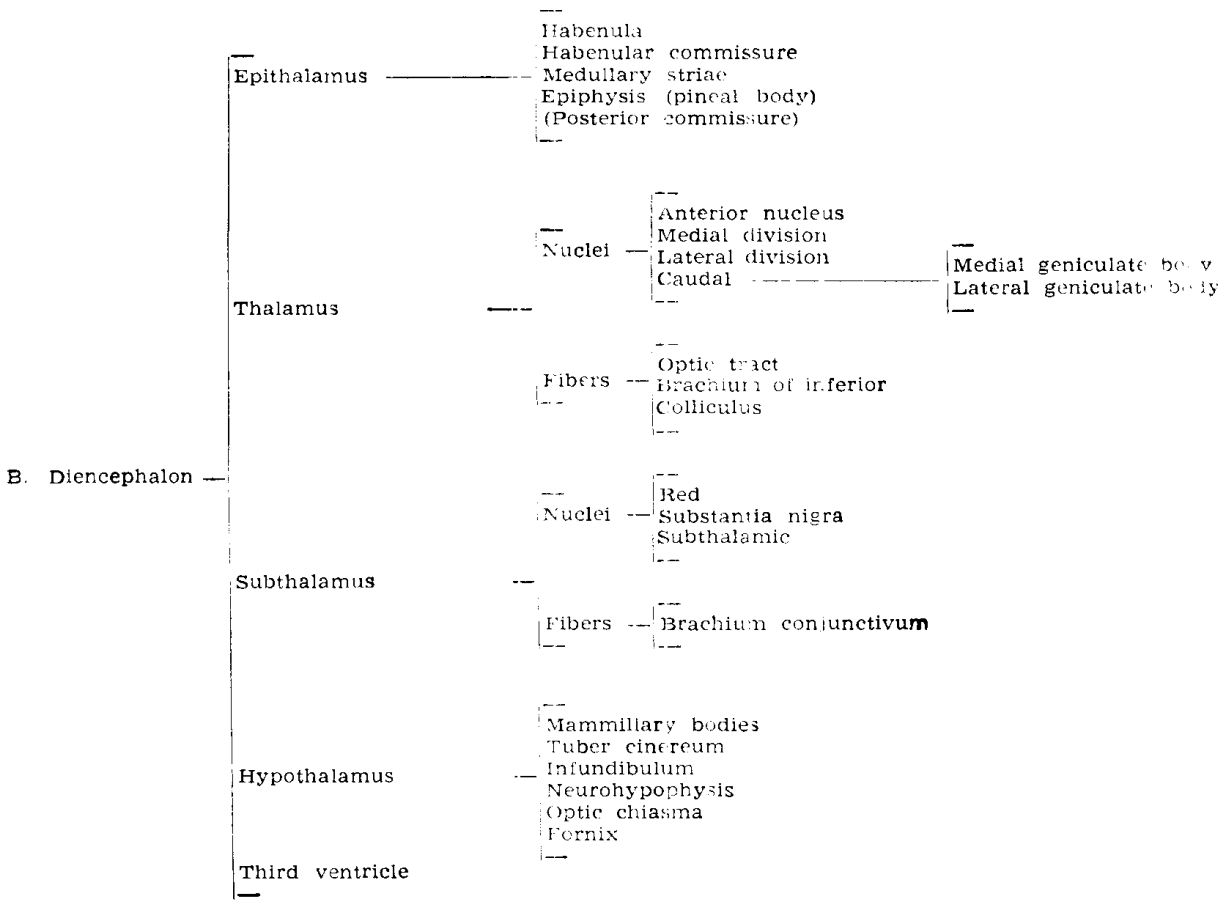
B. A simpler regional division of the CNS which is often used considers the forebrain, brainstem and spinal cord

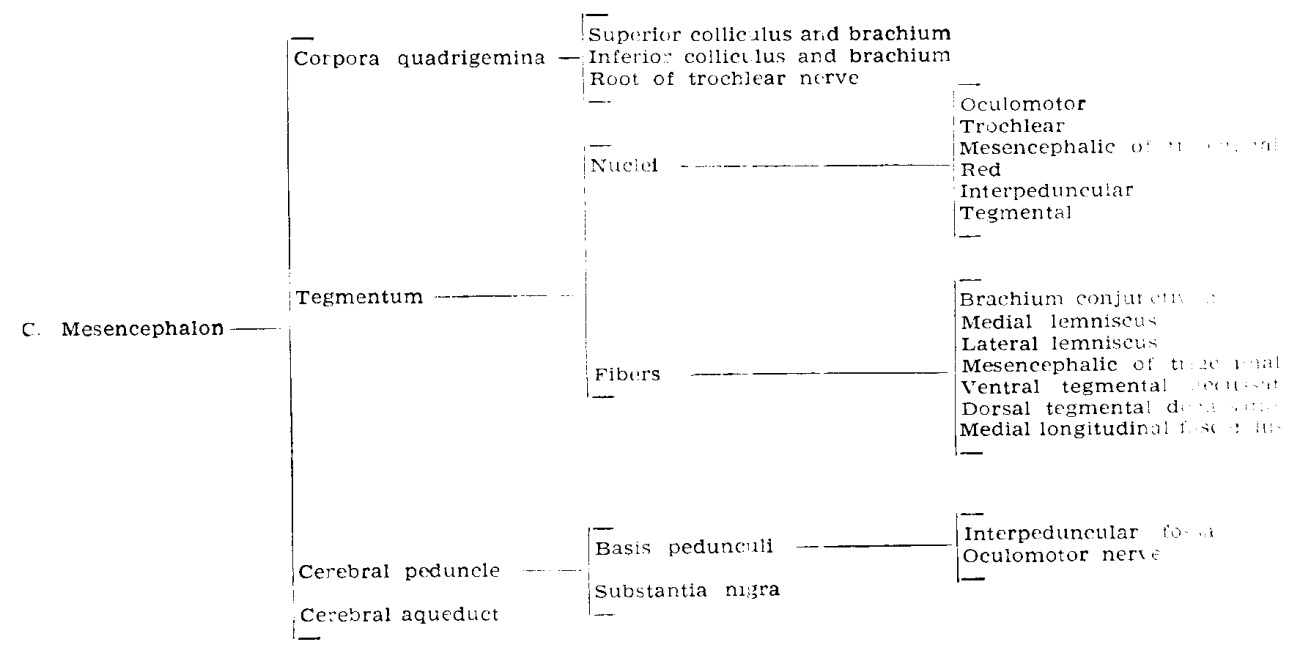
1. The forebrain is the telencephalon.
2. The brainstem includes the diencephalon, the mesencephalon, the pons and the medulla oblongata.

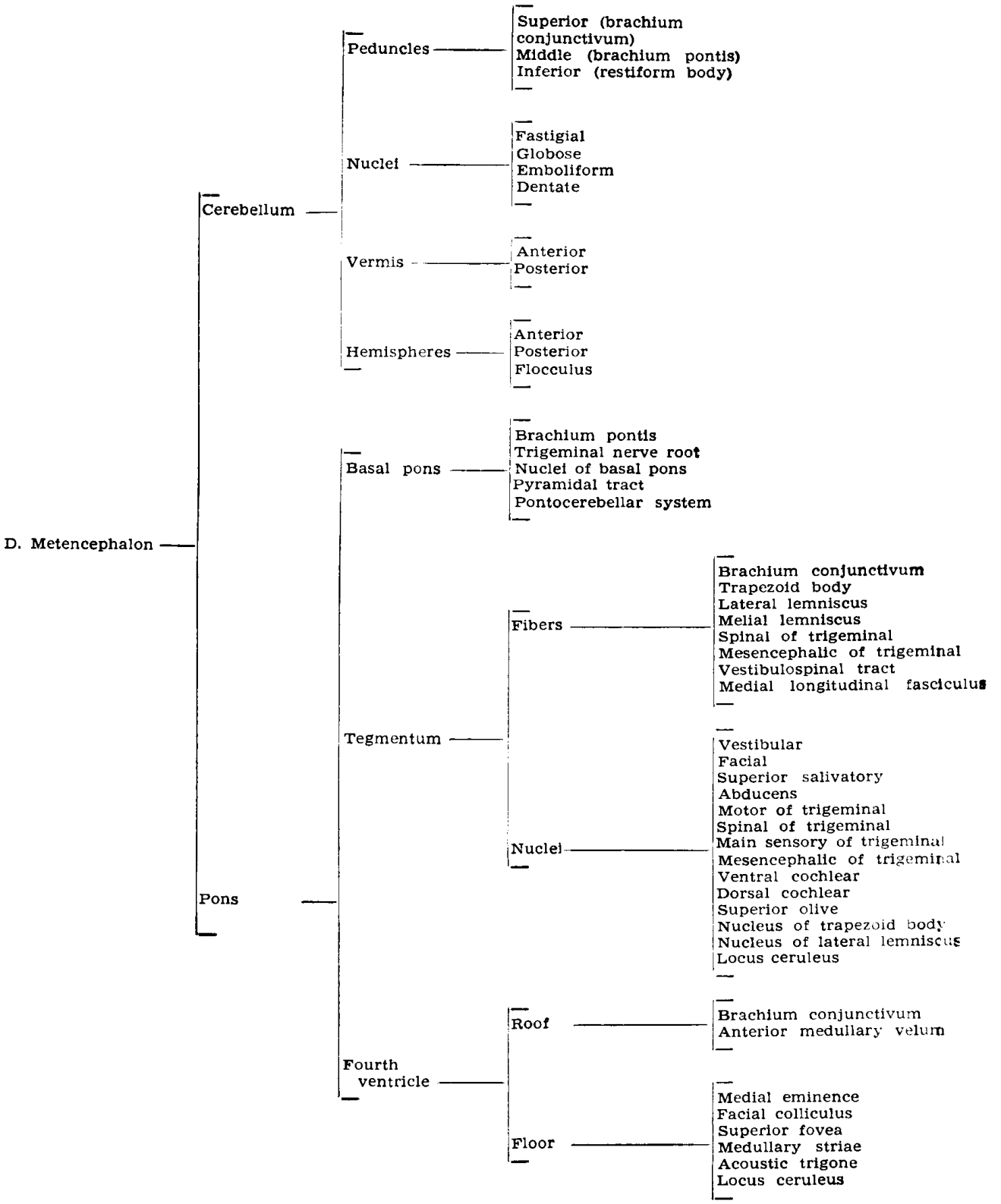
C. The neuraxis includes the spinal cord and brainstem. Because the neuraxis is organized in a segmental fashion, structures which are located anatomically above it in the forebrain or telencephalon, are said to be suprasegmental.

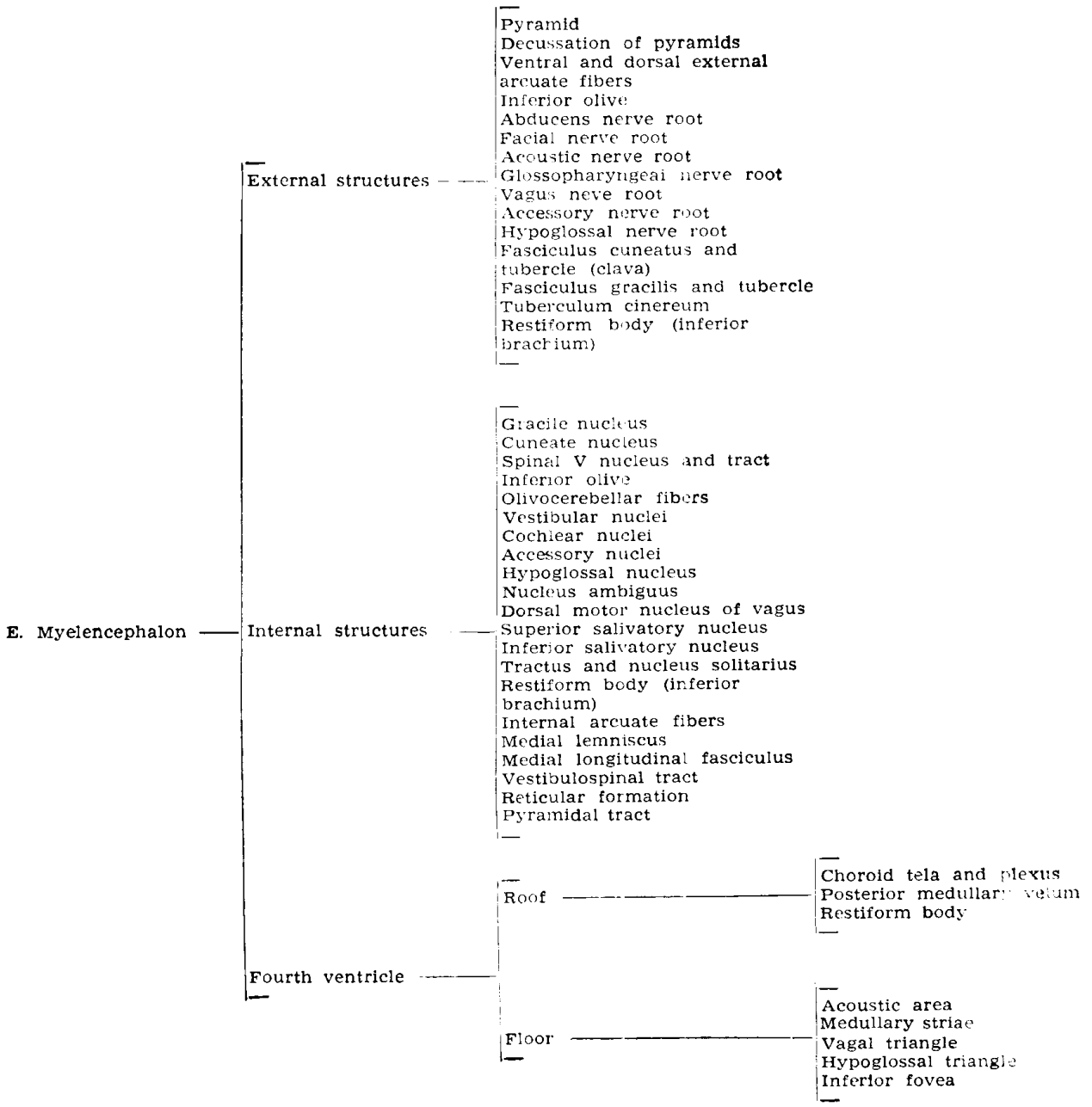
III. Anatomy of the Brain



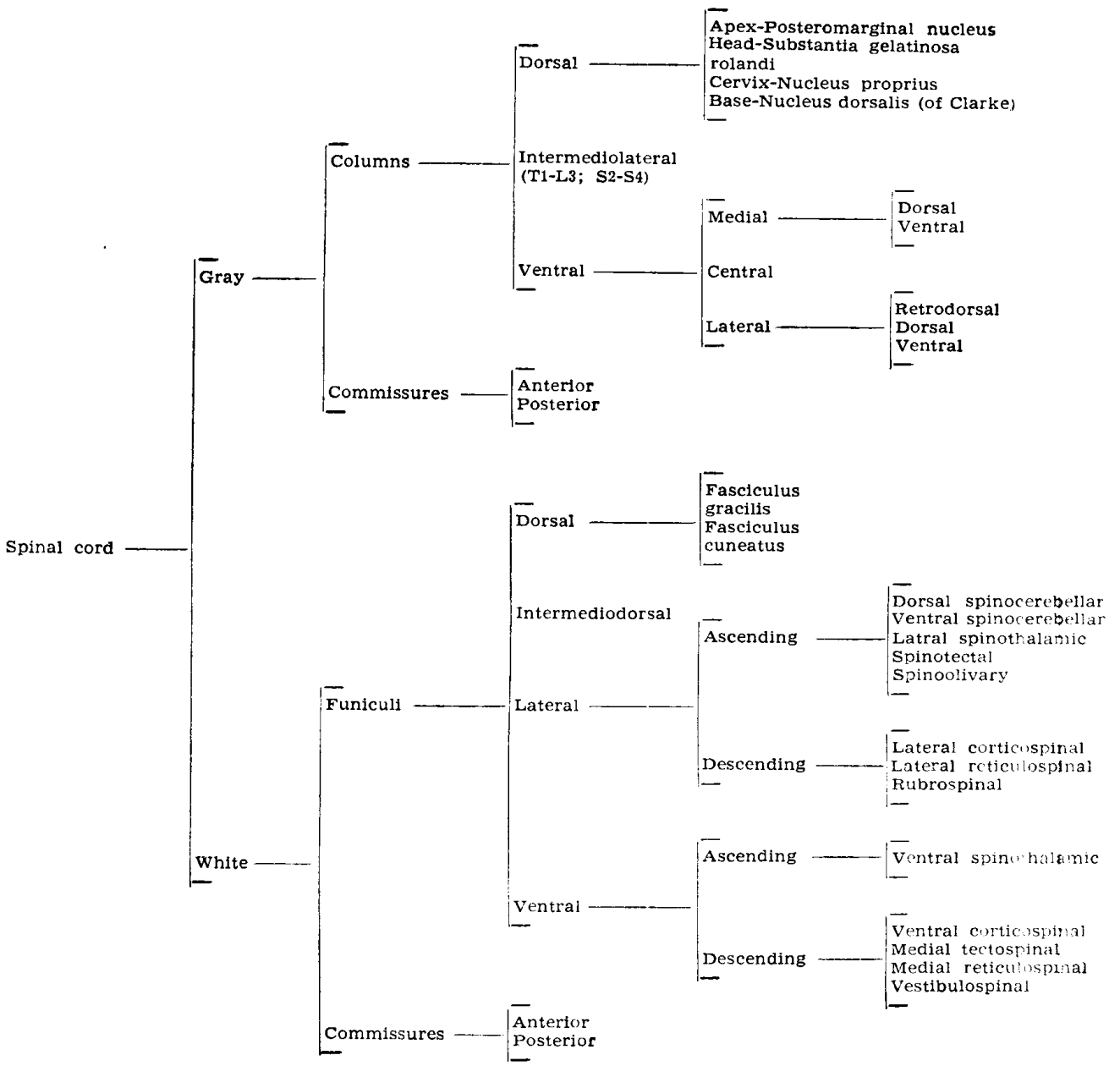




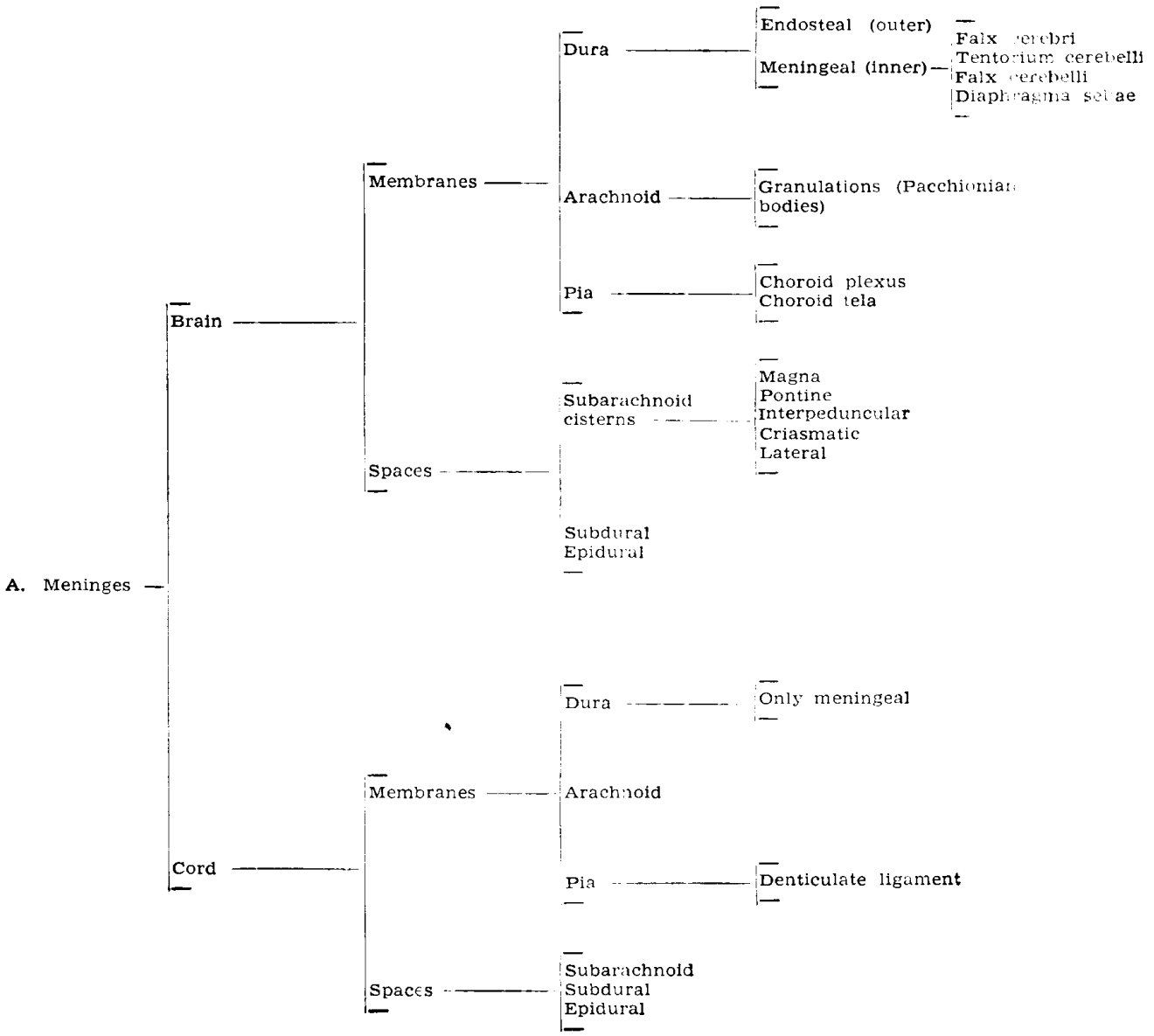

D. Metencephalon
Cerebellum
Peduncles
Superior (brachium conjunctivum)
Middle (brachium pontis)
Inferior (restiform body)
Nuclei
Fastigial
Globose
Emboliform
Dentate
Vermis
Anterior
Posterior
Hemispheres
Anterior
Posterior
Flocculus
Pons
Basal pons
Brachium pontis
Trigeminal nerve root
Nuclei of basal pons
Pyramidal tract
Pontocerebellar system
Tegmentum
Fibers
Brachium conjunctivum
Trapezoid body
Lateral lemniscus
Melial lemniscus
Spinal of trigeminal
Mesencephalic of trigeminal
Vestibulospinal tract
Medial longitudinal fasciculus
Nuclei
Vestibular
Facial
Superior salivatory
Abducens
Motor of trigeminal
Spinal of trigeminal
Main sensory of trigeminal
Mesencephalic of trigeminal
Ventral cochlear
Dorsal cochlear
Superior olive
Nucleus of trapezoid body
Nucleus of lateral lemniscus
Locus ceruleus
Fourth ventricle
Roof
Brachium conjunctivum
Anterior medullary velum
Floor
Medial eminence
Facial colliculus
Superior fovea
Medullary striae
Acoustic trigone
Locus ceruleus


E. Myelencephalon
External structures
Pyramid
Decussation of pyramids
Ventral and dorsal external arcuate fibers
Inferior olive
Abducens nerve root
Facial nerve root
Acoustic nerve root
Glossopharyngeal nerve root
Vagus neve root
Accessory nerve root
Hypoglossal nerve root
Fasciculus cuneatus and tubercle (clava)
Fasciculus gracilis and tubercle
Tuberculum cinereum
Restiform body (inferior brachium)
Internal structures
Gracile nucleus
Cuneate nucleus
Spinal V nucleus and tract
Inferior olive
Olivocerebellar fibers
Vestibular nuclei
Cochlear nuclei
Accessory nuclei
Hypoglossal nucleus
Nucleus ambiguus
Dorsal motor nucleus of vagus
Superior salivatory nucleus
Inferior salivatory nucleus
Tractus and nucleus solitarius
Restiform body (inferior brachium)
Internal arcuate fibers
Medial lemniscus
Medial longitudinal fasciculus
Vestibulospinal tract
Reticular formation
Pyramidal tract
Fourth ventricle
Roof
Choroid tela and plexus
Posterior medullary velum
Restiform body
Floor
Acoustic area
Medullary striae
Vagal triangle
Hypoglossal triangle
Inferior fovea

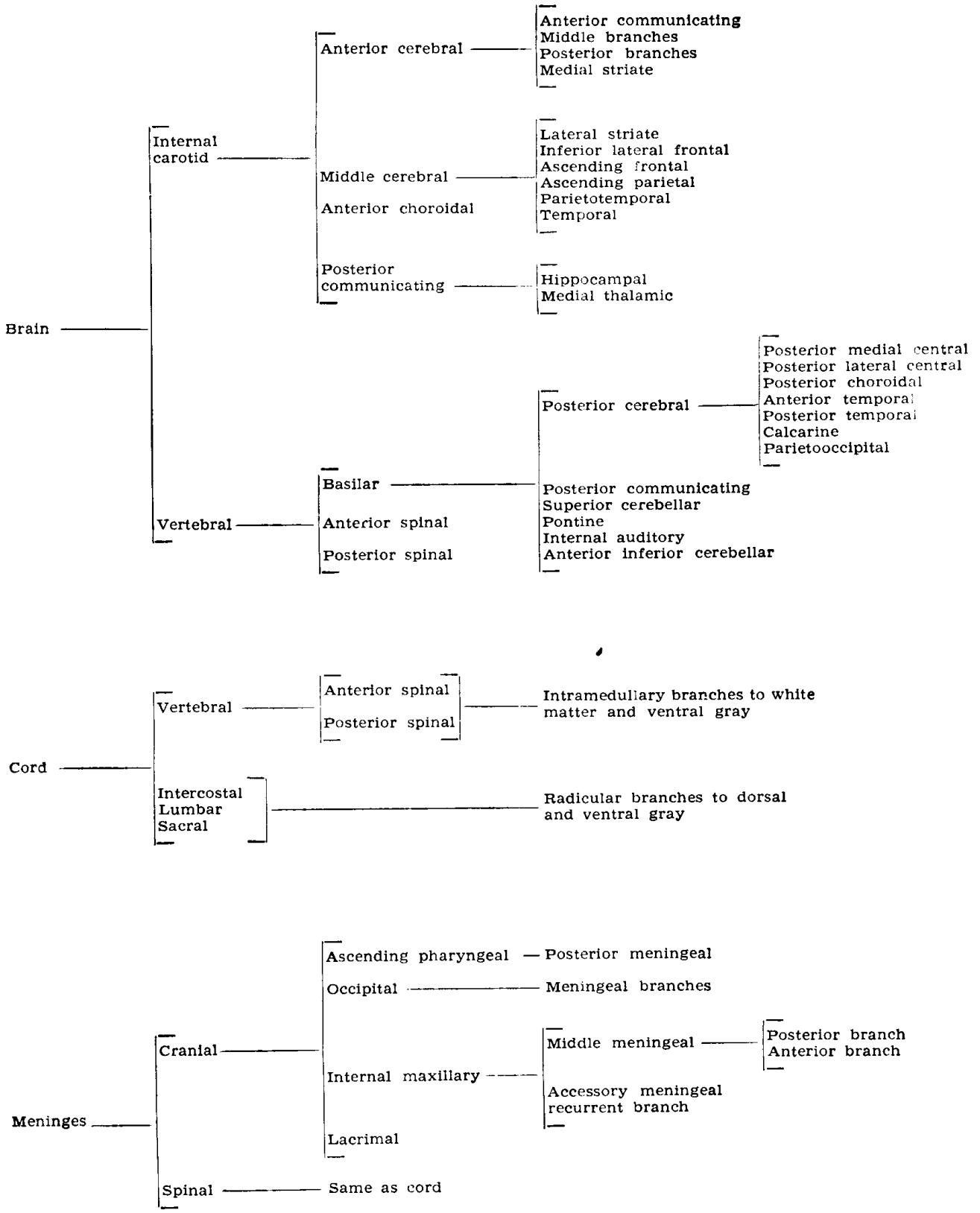
IV. Antaomy of the Spinal Cord



V. Coverings and Vascularization of the Central Nervous System



B. Arterial Supply



Histology of Nervovs Tissue

I. Properties of Nervous Tissue

A. Of the basic properties which characterize living matter, those of irritability and conductivity are especially developed in nervous tissue.

B. Nerve cells are structurally constituted to receive stimuli through the enormous surface presented by their dendrites, and to transmit the wave of excitation, so induced, over a considerable distance via their axons.

C. The neuron doctrine — the concept of the integrity of nerve cells. Nerve cells (neurons) are structurally independent trophic and functional units. Information transfer from one neuron to another is achieved through special cellular contacts or terminals- the synapse. The nervous system is not a syncytial tissue.

D. From a functional point of view, cells are also unique in that, unlike cells of other body tissues, neurons are not interchangeable one for another. Their precise location and connections make them functionally specific.

II. Nervous System Cell Types

A. Neurons—for general types, based on shape.

1. Multipolar — numerous dendrites projecting from cell body. Two subclasses:

a. Golgi Type I — long axons, large cell body, rich dendritic array.

b. Golgi Type II — short axons, small cell body, fewer dendrites.

2. Bipolar — one process projecting from either end of an elongated cell body.

3. Unipolar — nerve cell possessing only a single process.

4. Anaxonic — both receptor and effector region located on dendritic portion of cell. No conducting process (axon).

B. Neuroglia — considered as the interstitial tissue of the CNS. Two types, according to size and embryonic origin:

1. Macroglia — larger in size, are derived from the neurectoderm. Are classified according to shape into two subgroups: Astroglia and Oligodendroglia.

2. Microglia — much smaller cells with fewer protoplasmic processes. Origin not clear, but thought to be from mesoderm.

C. Ependymal Cells.

1. Derived from the neurectoderm.

2. Serve to line the cavities (ventricles and canal) of the CNS.

III. Nerve Cell Morphology

A. Neuron cell body (soma) The cell body, or soma, is also termed the perikaryon which refers to the region of the cell about the nucleus.

1. Cell membrane (plasma membrane).

a. Trilaminar structure, 70-80 Å thick.

b. Regional modification of structure for synapses.

2. The nucleus.

a. Generally large, round and centrally positioned.

b. Large, obvious nucleonus.

c. Sparse chromatin granules—stains lightly.

3. Cytoplasmic organelles.

a. Nissl substance — is characteristic of neurons and is especially obvious in the large cells. Found in perikarya and proximal dendrites, but not in axon. EM demonstrates Nissl substance to be granular or rough endoplasmic reticulum(ER).

b. Golgi apparatus — a feature of most plant and animal cells, this structure is especially prominent in many neurons, where it is often seen to surround the nucleus. A complex structure of smooth ER.

c. Lysosomes — membrane bound vesicles containing hydrolytic enzymes. With advancing age, often aggregate to form lipofuscin granules.

d. Mitochondria — distributed throughout the nerve cell cytoplasm.

e. Microtubules and Microfilaments — distributed in both the perikaryon and all process of neurons.

B. Nerve cell processes.

1. Dendrites

a. considered as extensions of the cell body;

b. serve to greatly increase the surface area of the cell body and thus the number of possible synapses;

c. dendritic spines — occur on secondary and tertiary dendrite branches. Serve to further increase surface area for synaptic contacts.

2. Axon (axis cylinder)

a. the conductive element of a neuron

b. composed of an axon hillock, initial segment, projecting segment (often with collateral branches) and terminal branches or teloden-