



# TEXTBOOK OF The Nervous System

*A Foundation for Clinical Neurology*

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TEXTBOOK OF  
The Nervous System

*To innumerable friendly critics, both students and personnel, whose interest has sustained and guided my efforts, but above all to*

DR. A. M. LASSEK

DR. J. C. B. GRANT

DR. A. W. HAM

DR. G. McL. WILSON

*this book is gratefully dedicated.*

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# Introduction

Neuro-anatomy is a complicated and difficult subject for the beginner, but he will find in it a rich reward for his labor. It is the basic science to which clinicians must continually return for explanation of the mechanisms of health and disease and for clues to the solution of new problems.

This textbook is so constructed that the completely uninitiated student can read its opening chapters without bewilderment and master its final descriptions without confusion. The ground is covered twice. In Part One, the descriptions are brief and simple so that the beginner may gain an integrated conception of the whole subject with a minimum of detail. In Part Two this conception is fully elaborated.

Throughout the text, the reader will find references to the functions of structures and to the disabilities that must of necessity be associated with injury to those structures. Thus, it is truly a functional neuro-anatomy. It provides the curious student with adequate references for collateral reading, while to the instructor it offers guidance in the study of original writings.

Increasing knowledge of certain neurone systems enables the neuro-anatomist of today to link description of structure with discussion of purpose. But there remain many mechanisms that are obscure, and the teacher does well to make frank statement of doubts and of theories so that the student himself may begin to weigh the evidence, sharing with us the privilege of honest doubt, and even indulging in the joys of minor investigation.

The nervous system is alive in a peculiar sense, for its ultimate units, the ganglion cells, have the capacity of positive discharge. When impulses are conducted to them they are capable of actively contributing energy to the further propagation of the impulse until the goal, whatever it may be, is reached. The patterns of neurone connection, the means of insulation, of inhibition, and perhaps of initiation of the nervous impulses, all these are problems to the functional neuro-anatomist.

A scientist may be classified according to what he is curious about, if he is a scientist. A medical student, of course, must be fired with curiosity about the structure and function of the human body, if he is a student. But he should realize that truth and further insight are to be sought in the dissecting room or under the microscope or in the physiological laboratory. Final authority in the field of medicine lies, not in the printed word, but in the living body.

For my own part, I have learned that a neurosurgeon must always be a student of neuro-anatomy. But I have played no part in the preparation of this volume and so I can neither claim any credit for its many virtues nor accept responsibility for its opinions. However, I share the author's conviction that with description must go an understanding of the meaning and the purposes of things. Knowledge to which has been added understanding has life in it. The seeds of growth are in it.

WILDER PENFIELD

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## Preface to the Second Edition

This edition differs from the first in features recommended by the author's own teaching experience, by other teachers, and by what is, after all, the final court of appeal, the students themselves.

The major alteration has been in the Atlas: The number of sections shown has been more than trebled. They now include, besides a greatly increased series of cross-sections, sagittal and coronal cuts; these are deservedly popular with students and they undoubtedly tie details together in a way otherwise impossible. Coronal sections are especially useful but peculiarly difficult to obtain; as far as the author knows, they appear elsewhere only in Riley's exhaustive reference Atlas. Certain plates, notably XXXIV to XLII are cut somewhat obliquely from side to side; thus their two sides might well qualify as separate cross-sectional levels, further enlarging the series.

In addition, some of the old plates and keys which failed to measure up to the standard of the new material, have been replaced.

The method of photograph-and-key has been retained. We feel it superior to any other. The best drawing does indeed show relations clearly but it is still an idealization and is therefore an unreliable guide in dealing with slides. On the other hand, a photograph alone, while realistic, is almost as formidable a subject of study as the slide itself and is not easy to label clearly. We have tried to have the best of things both ways, and to break the gap between pure diagram and actual material by not one but two carefully selected and prepared steps—key and photograph.

A running commentary on Plates XVII to L has been added. As far as possible, this has been made progressive, stressing development of features from one level to the

next. It is calculated to provide a thorough practical review if read consecutively, as well as to facilitate and illuminate incidental reference.

Finally, with regard to the Atlas, several hundred cross-references have been provided, from Atlas to text and text illustrations, from the latter to the Atlas, and from one part of the Atlas to another, thus integrating the various departments of the book. These references have not been made where correlation is obvious, but have been placed at points where, perhaps, a gentle reminder may not be amiss that other resources are available in dealing with difficult problems.

An attempt has been made to bring the book abreast of current literature in significant points. An assimilation of the enormous flood of communications is, of course, impossible, but we have adhered to the principle that this is primarily a textbook for students, not a reference work for the specialist; hence, only those findings have been added that are explicit and of direct medical interest; and from these, a further elimination has been made to leave only those that are most definitive, readily available, and interesting to the student.

Chapter 9 has been rewritten, considerably expanded, and more fully illustrated, to summarize this enormous field more satisfactorily. The reticular formation has been given consecutive treatment at the end of Chapter 17. Certain new developments in the study of cortex have been reviewed at the end of Chapter 19.

On repeated student request, the table of contents has been expanded to include section headings, for convenient reference.

Besides new additions mentioned above, a number of text figures have been redrawn entirely in the light of teaching experience.

Figure 82, the dermatomes, has been revised in accordance with the work of Drs. J. J. Keegan and F. D. Garrett; and the author wishes to acknowledge the generous expenditure of time devoted by Dr. Keegan to assuring the authenticity of this feature.

His appreciation also goes to the following: To this college and department for the unstinted time and facilities allowed him for the work; to his colleagues, and particularly to Dr. John S. Latta and Dr. Edward Holyoke, for careful inspection of the new material and many valued suggestions; to Mrs. C. E. Evans, not only for skilful and patient work on the interminable revisions of figures and keys, but

for alert detection of many shortcomings; to Dr. James Papez for permission to use so many of his magnificent series of brain-stem photographs; to Dr. A. W. Ham for permission to use a number of unique figures from his textbook of histology; to Mr. Wm. Wiltse for his undaunted and ingenious efforts which resulted in a number of the most valuable Atlas plates; to J. B. Lippincott Company and particularly to Mr. Walter Kahoe, for their confidence in the future of this book and the generously free hand they have given with this revision; and to Mr. Brooks Stewart of Lippincott's for the thought and detailed care he has taken in editing the work.

H. C. E.

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## Preface to the First Edition

The study of the nervous system ought to be one of the most interesting subjects in the medical curriculum, for it borders on several vital fields of human interest. Yet, if the reactions of many students and practitioners and my own student and graduate experience are any indication, it seems particularly hard to grasp and easy to forget.

I have long wondered why this should be so, and have given much regretful thought to the matter. In the course of my teaching, I discovered a few devices that have proved useful to students but found no fundamental solution to the problem. Finally, however, the idea struck me that perhaps the fault lay in the conventional approach. Perhaps the traditional presentation, chiefly concerned as it is with mere structure, is now outgrown. In the past this was the only approach available to neurologists, but with the accumulation of new knowledge, particularly the advances in neurology of the past quarter-century, other methods have become possible and should, perhaps, be worked out in practice.

I have attempted in this book to present the subject of neuro-anatomy and neuro-physiology in a way suggested by the psychology of learning. With this aim in view I have departed from convention in three important ways.

Psychology teaches us that the most effective learning is through the formation of a mental outline, which is then filled in and elaborated much as an artist first sketches and then fills in a drawing. Now in such subjects as anatomy and physiology, an outline exists in the student's mind even before he begins his study; he already has a rough working knowledge of the body, its organs and their functions. This knowledge has been gained for the most part unheedingly, through general experience, but it is firmly

fixed in the mind and forms a sturdy scaffolding for further study. In neurology, on the contrary, there is usually no such framework of common knowledge on which to build; what the average beginner knows about the brain can be written in a few lines. To the student the subject is an uncharted jungle of facts. This book attempts to meet the difficulty by covering the ground twice. Part One surveys the whole subject as briefly and simply as possible; it aims to present a concise outline (comparable with the beginner's common knowledge of gross anatomy) emphasizing general principles and basic facts yet brief enough to be grasped as a whole. In Part Two the outline is filled out with the useful, detailed information the student should have. In such a condensed account as is given in Part One many statements must, of course, be made in a rough or approximate form; for example, the vestibule is described as the organ of "equilibration," and only the major components of the cranial nerves are given. The rule followed was to offer convenient short cuts, yet to make sure that these will not be misleading or confusing. Part Two gives a more completely accurate, technical account.

At the same time, if the story is to be consecutive as well as compact, a certain amount of nonobjective comment is almost unavoidable; this, however, has always been emphatically labelled as such and based on sound authority.

The first outline of a subject, psychology tells us, if it is to fulfill its purpose, must be a bold but simple sketch, not an over-conscientious summary loaded with detail. In neurology this is especially true, for to all but the neurosurgeon, the brain must remain an abstraction, rarely seen, much less manipulated and known almost entirely

by its workings. It is for this reason that this book does not begin with an account of the brain as it appears in the dissecting room but, throughout Part One and preponderantly in Part Two, it uses and discusses diagrams of the brain. A detailed description of the form and cross sections of the brain is given only in the concluding chapters; these may be used as a laboratory guide and can, of course, be referred to from the beginning of the students' work. This procedure does not disregard the tradition that science must be based on observation. But successful observation requires some comprehension of what is being observed; to this end diagrams and principles are placed before photographs and dissection—in order to give the latter their full value. Nevertheless, each diagram and each principle has been chosen and arranged with a view to building a practical dissector's and surgeon's grasp of the subject.

According to modern psychology, association is a vital factor in learning. If a subject is to be fully assimilated and confidently applied, association between its details must be close and accurate. Yet our study of the nervous system is dispersed among neuro-anatomy, neurophysiology, neuropathology, psychiatry and a smattering of psychology. Some of this division is necessary and desirable but some of it is not, especially the division between structure and function. Such cleavage was long made necessary by the labor of exploration, which was divided between different departments, and by the lack of enough knowledge to form a rounded picture. But increase in knowledge has made it merely a hardship, particularly in a subject in which functions are not known in advance and in which structure does not suggest function to the uninitiated. Moreover, the size of the nervous system, as compared with the rest of the body, does not make the division a practical necessity, as it is in general anatomy and physiology. This is not to suggest that the nervous system should be taken from the physiologist and

handed over to the anatomist, or vice versa; the physiologist does not wish to deal with the actions of individual muscles but with muscular contraction in general and the same distinction may surely be made between individual nerve tracts and nervous conduction in general. Accordingly, this book has tried to disregard traditional boundaries and to associate what can profitably be associated, as fully and thoroughly as possible. It attempts to explain structure by function rather than to describe structure and refer in passing, to purpose and reason. It makes free use of neuropathology whenever this is illustrative or illuminating but does not pretend to do more than touch on this field. It even draws here and there on psychology: Pavlov's work, for example, is based on as strict a discipline as any of the older sciences, and if such work contributes to a rounded picture of our subject, it would certainly be unscientific not to take full advantage of it.

The illustrations with their legends have been designed and arranged to form in themselves a consecutive narrative. By running through them the student should be able to refresh his memory quickly on the most important points in the book. To achieve continuity I have included a few items that might otherwise seem superfluous.

Originality can hardly be claimed for a developmental order of presentation as such. But this order does avoid descriptive treatment by regions, which entails learning masses of detail that are almost without significance until the final fitting together, and it equally avoids an approach through functional systems, wherein long pathways, such as the pyramidal, must be related to dimly understood regions of the brain. A presentation that begins with simple basic structures and adds the more complex is obviously attractive but when it is attempted it always involves much academic embryology and comparative anatomy that are of little practical use to the busy student. This book attempts to make a de-

velopmental presentation by means of a diagram—though with free reference to the embryo or lower animals when this appears to be truly useful. The result is entirely logical, at least, and in practice the method has proved illuminating to many students. This diagram or model, the “basic brain” sets the keynote of the earlier chapters and serves as a framework within which a more realistic picture is progressively built up. In this way the nervous system is presented as a whole almost from the start; tracts and systems are not disjointed but are related to standard, important landmarks throughout their extent and many otherwise puzzling relationships are simply explained. Hence the basic brain and the order or presentation that it makes practicable are submitted as something original.

Discussion of living research may seem to offend against economy; but it is to make room for just such material that I have saved space elsewhere. For by this means the student is most strongly made aware that he is entering on a living, growing adventure in knowledge and power, to which he himself may contribute, rather than collecting neatly packaged (but not always conclusive) facts to be peddled later on to the public. Certainly, experience with this book and the advice of my colleagues

will suggest many improvements, both in further eliminations and in restoration of what may prove to have been too drastically cut down. This is the sort of matter in which individual judgment is most fallible.

So much for major innovations and policies. Among the minor devices employed in this book, the following may be mentioned: A careful attempt is made to present the subject in such order that it can readily be correlated with laboratory work. The text presents progressive diagrams, as well as the “basic brain,” which are built up as new features are encountered in the work; among these is a simplified form of the “exploded diagram.” An attempt is made to derive the sensory systems from a common pattern and to vitalize technical words by showing their derivation from their roots (which, for some reason, seems to be unpopular with instructors and popular with students). Commentary on involved points of nomenclature is given. The concept of the four sensory correlation centers is discussed and, naturally, many analogies, illustrative examples and comments, such as any instructor will have found by experience to be useful have been included.

H. C. E.

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