风暴式医学教程 MOSBY'S CRASH COURSE (原版英文医学教程)

神经系统及特殊感觉

Nervous System and Special Senses

Daniel Lasserson ⊙ Carolyn Gabriel ⊙ Basil Sharrack
with Daniel Horton-Szar as Series Editor

国际医学畅销书

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科学出版社
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科学出版社
Harcourt Asia
Mosby
2002

Daniel Lasserson, Carolyn Gabriel, Basil Sharrack: Mosby's Crash Course: Nervous System and Special Senses

Reprint ISBN 981-4095-36-2

图书在版编目(CIP)数据

神经系统及特殊感觉/(英)雷斯森(Lasserson, D.)编.-影印版.-北京:科学出版社,2002.2
风暴式医学教程
ISBN 7-03-009697-5

Ⅰ.神… Ⅱ.雷… Ⅲ.神经系统-教材-英文 Ⅳ.R322.8

中国版本图书馆 CIP 数据核字(2001)第 063342 号

科学出版社 出版
北京东黄城根北街16号
邮政编码:100717
http://www.sciencep.com
新蕾印刷厂 印刷

科学出版社发行 各地新华书店经销

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2002年2月第一版 开本:787×1092 1/16
2002年2月第一次印刷 印张:16
印数:1—5 000 字数:359 000

定价:39.00元

(如有印装质量问题,我社负责调换〈新欣〉)

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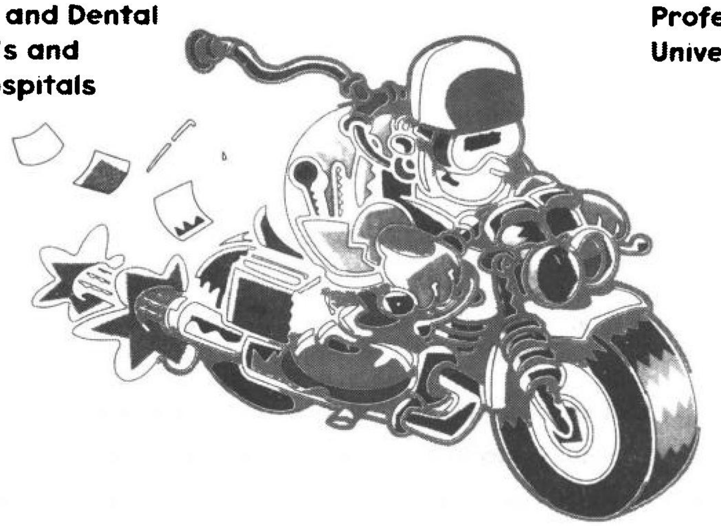

Nervous System and Special Senses

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Science Press
Harcourt Asia
Mosby

SCIENCE PRESS
A division of China Science Publishing Group
16 Donghuangchenggen North Street,
Beijing 100717
China

HARCOURT ASIA PTE. LTD
A Harcourt Publishers International Company
583 Orchard Road #09-01 Forum
Singapore 238884

Distribute in the Mainland China by Science Press,
16 Donghuangchenggen North Street, Beijing 100717, China.

This Edition First Printed in China in 2002.
ISBN 7-03-009697-5/R · 766
Reprint ISBN 981-4095-36-2

Printed in China

Preface

Understanding the function of different biological systems is at the heart of medicine and medical exams. This book has been written with the aim of presenting the key facts necessary for a thorough understanding of how the nervous system functions, how it is tested clinically, and how it is affected by disease.

The basic medical science is presented first where the different functional units are described with their clinical relevance. Following this, the neurological history, examination, and methods of investigation are described. In the third section we outline pathology as it relates to clinical practice. In each section we give you the facts needed to understand the core of the subject with plenty of explanatory diagrams and with a focus on areas that have traditionally been difficult to understand.

The author combination of student and doctor brings together experience of undergraduate neuroscience and exams, clinical neurology, and postgraduate research. This balance of authors has enabled us to create a valuable and unique educational tool.

Daniel Lasserson
Carolyn Gabriel
Basil Sharrack

This book offers an innovative approach to the education of medical students combining, in one text, the basic science required to understand the nervous system together with the neurological examination itself.

The first part has been written by a senior medical student and represents the knowledge that a student at the top end of the academic spectrum sees as the essential neuroscience for exam success. The reader will be able to use this part as a revision source or, alternatively, as a useful basis from which to explore the subject further. The essentials necessary to proceed to the clinical part of the medical curriculum are presented.

The second and third parts cover neurological aspects and have been written by neurology registrars. This book is sufficiently comprehensive to allow any medical student to become conversant with the essential knowledge needed to understand how the nervous system functions and how it can become upset in the various disease processes to which it can be subjected.

Anthony Angel
Faculty Advisor

Preface

OK, no-one ever said medicine was going to be easy, but the thing is, there are very few parts of this enormous subject that are actually difficult to understand. The problem for most of us is the sheer volume of information that must be absorbed before each round of exams. It's not fun when time is getting short and you realize that: a) you really should have done a bit more work by now; and b) there are large gaps in your lecture notes that you meant to copy up but never quite got round to.

This series has been designed and written by senior medical students and doctors with recent experience of basic medical science exams. We've brought together all the information you need into compact, manageable volumes that integrate basic science with clinical skills. There is a consistent structure and layout across the series, and every title is checked for accuracy by senior faculty members from medical schools across the UK.

I hope this book makes things a little easier!

Danny Horton-Szar
Series Editor (Basic Medical Sciences)

Acknowledgements

Daniel Lasserson would like to thank Professor Angel for his detailed and perceptive comments, Helena Malhomme de la Roche for turning words into pictures, and the staff at Mosby for turning this into a book.

Carolyn Gabriel is currently funded by the British Brain and Spine Foundation.

Basil Sharrack is funded by a grant from Ares-Serono.

Figure Credits

Figures 4.24 and 7.1 (adapted from *Integrated Pharmacology* by Professor C Page, Dr M Curtis, Dr M Sutter, Dr M Walker, and Dr B Hoffman, Mosby International, 1997).

Figures 8.1 and 8.2 (adapted from *Human Histology 2e*, by Dr A Stevens and Professor J Lowe, Mosby, 1997).

Figures 12.3, 11.6, 11.9, 12.7, 12.8, 12.20, 12.24, and 12.25 (courtesy of *Clinical Examination 3e*, by Dr O Epstein, Dr D Perkin, Dr D de Bono, and Dr J Cookson, Mosby International, 1997).

Figures 13.11A, 13.11B, and 13.19 (courtesy of *Imaging Atlas of Human Anatomy 2e*, by Dr J Weir and Dr P Abrahams, Mosby International, 1997).

Dedication

To Jane, as it made her summer miserable **DL**

To Isobel, who arrived with the proofs, and to Nick **CG**

To Sawsan, Noor, and Sana **BS**

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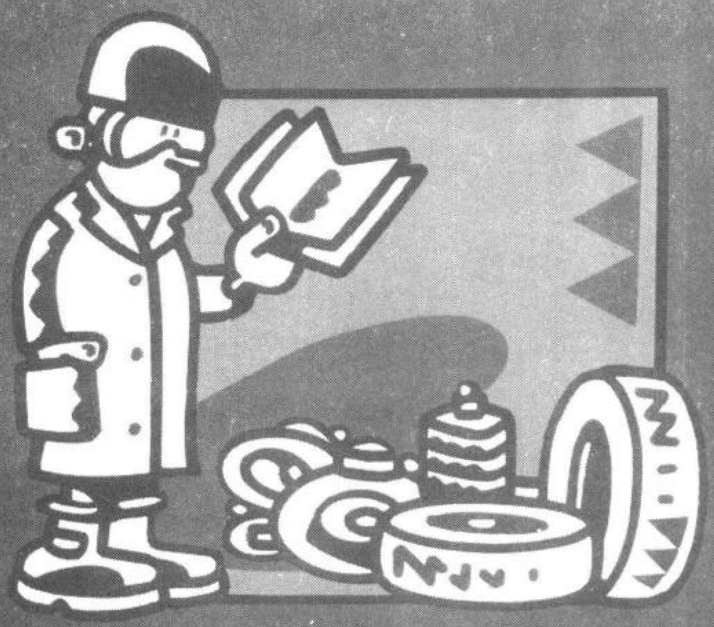

DEVELOPMENT, STRUCTURE, AND FUNCTION

1. Overview of the Nervous System

INTRODUCTION

The nervous system can be divided into three parts:

- The central nervous system processing sensory, motor, and special-sense information, as well as thought, emotion, and regulation of the internal environment.
- The peripheral nervous system providing the sensory and motor innervation to skin, muscle, and bone.
- The autonomic nervous system innervating internal organ systems.

The smallest functional unit in all of these parts is the neuron. In the central nervous system, neurons are surrounded by many other cells with supportive functions. The processing systems of the nervous system are created by communication between neurons. Communication can occur because neurons are excitable cells with the ability to move electrical signals along their length and influence the activity of other neurons through specialized structures called synapses, described more fully in Chapter 2.

Neurons can change physical information into electrical signals. In Chapter 3, we show how the sensory system receives information and transmits it to the brain, and how this information is represented in the brain.

In addition, neurons can influence the activity of other types of excitable cell—smooth and skeletal muscle fibres. In Chapter 4, we describe the control of muscle activity at the different levels of the nervous system (from spinal cord segments to motor cortex) and the strategies of motor planning.

The reticular formation and autonomic nervous system regulate and control the internal environment. We look at these parts in Chapters 5 and 6, and describe how the reticular formation regulates the level of awareness, showing how this can be manipulated to produce general anaesthesia.

Reception and processing of information into the senses of vision, olfaction (smell), and taste are discussed in Chapters 7–9.

The central nervous system is responsible for cognitive functions (Chapter 10). Different thought processes can be localized to different areas of the brain and, to an extent, drug therapy can reverse disordered processing of thought and emotion.

OVERALL DEVELOPMENT OF THE NERVOUS SYSTEM

The fully developed central nervous system is shown in Fig. 1.1. The development of its component parts—the spinal cord, brainstem, and forebrain—follows from the formation of the neural tube by a process called neurulation.

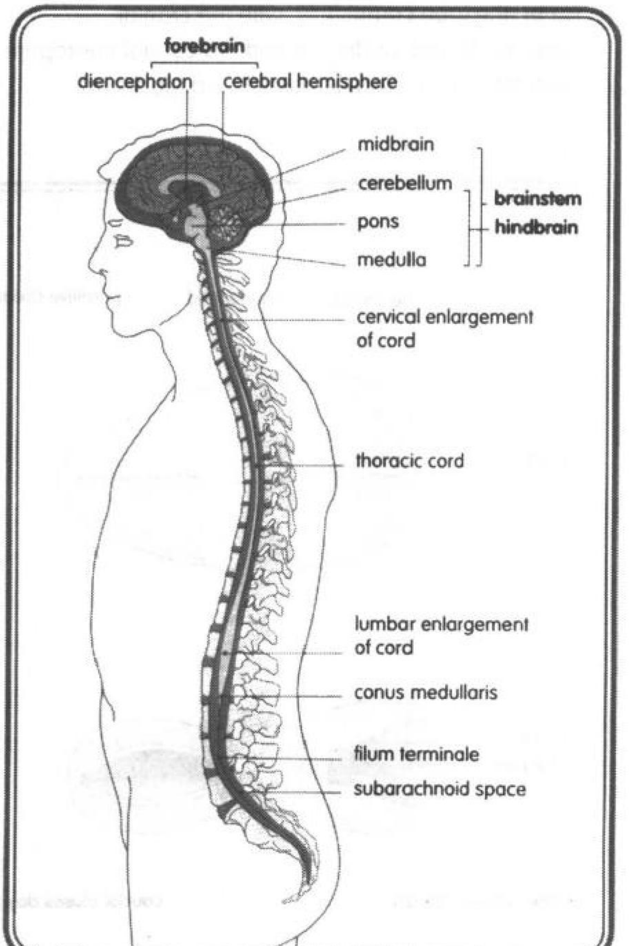

Fig. 1.1 Midsagittal section of the central nervous system *in situ*.

Neurulation

The nervous system develops from a specialized area of embryonic ectoderm called the neural plate. The neural plate forms a longitudinal groove with a ridge on either side.

Neurulation is the process by which the groove fuses at its dorsal extreme to form a hollow tube—the neural tube—and the ridges join up and split off to form the neural crest.

- The neural tube becomes the brain and spinal cord.
- The neural crest cells migrate to form dorsal root ganglion cells, ganglion cells of the sympathetic system, Schwann cells, melanocytes, and musculoskeletal elements of the head and neck.

Neurulation starts on day 22 at roughly halfway along the neural plate (adjacent to the fourth pair of somites), leaving the cranial (head) and caudal (tail) ends open. Neurulation then spreads along the neural groove to close off the tube completely, with the cranial neuropore closing on day 25 and the caudal neuropore closing on day 27. (Somites are paired blocks of mesoderm, segmentally arranged alongside the neural groove of the embryo.) The stages of neurulation are shown in Fig. 1.2.

By the end of development, the segmental arrangement of the nervous system is retained only in the spinal cord.

As the central nervous system develops, an angle forms between the midbrain and forebrain so that the cerebral hemispheres and thalamus are rotated forwards at the top of the brainstem. This rotation explains why the ventral anatomical direction is used to describe both the part of the brain resting on the skull base and the anterior half of the spinal cord.

Embryology of the spinal cord

The spinal cord develops from the part of the neural tube that is caudal to the fourth pair of somites. After neurulation, the lateral walls of the tube (covered by neuroepithelium, which forms the neurons and glia of the cord) thicken, with cells forming two plates on each side, one anterior (basal plate) and one posterior (alar plate). These two plates are separated by a shallow

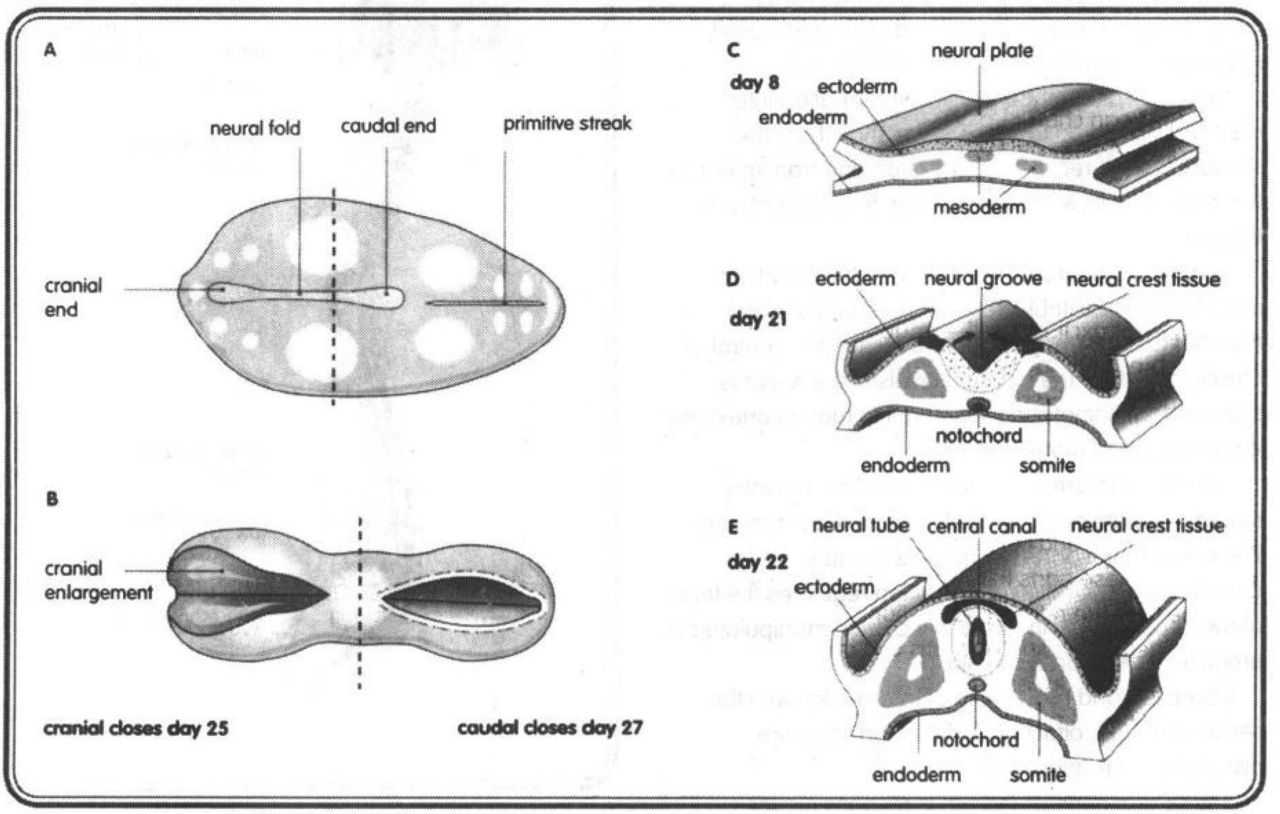

Fig. 1.2 Stages of neurulation. (A) Early stage of embryonic disc. (B) Later, showing formation of the definitive brain vesicles and spinal canal. (C–E) Transverse sections of neural tube taken at different stages of development.

groove—the sulcus limitans. By week 10, the lumen of the neural tube has become a very small central canal.

- The alar plate cells develop into ascending projection neurons and interneurons, which are involved in the sensory pathways and reflex circuits of the cord.
- The basal plate cells differentiate into motor neurons, which are involved with transmission of information out of the cord to muscles, and interneurons. Cells in the thoracic segments of this plate develop into sympathetic preganglionic neurons, whereas cells in the sacral segments develop into parasympathetic preganglionic neurons.

Fig. 1.3 shows the formation and development of the alar and basal plates.

The meninges around the spinal cord develop from mesenchymal tissue surrounding the neural tube, which forms a membrane. The inner layer of this membrane becomes the pia mater, and the outer layer becomes the dura mater.

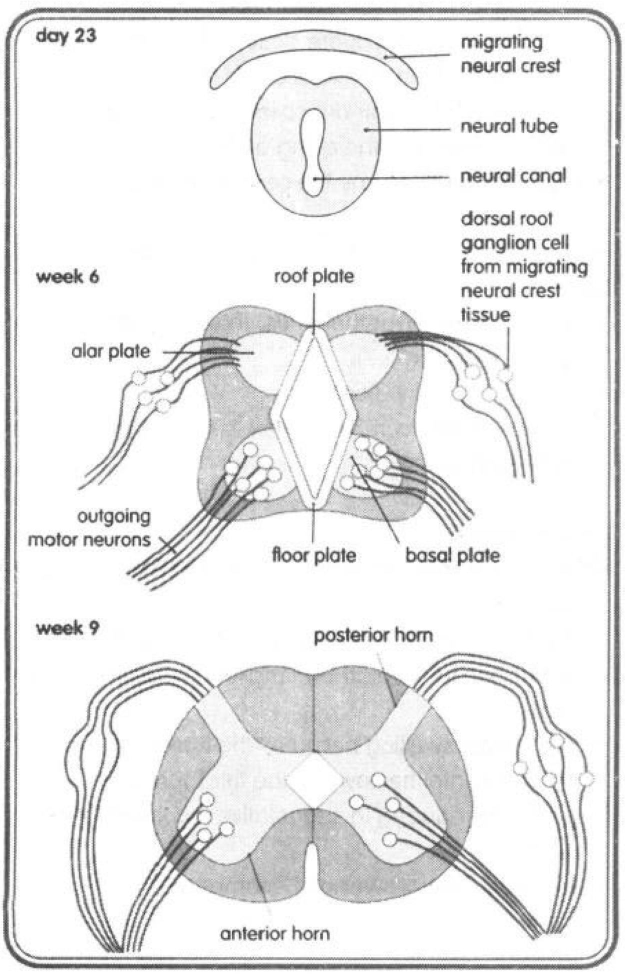

Fig. 1.3 Cross-sections through developing spinal cord.

During development, the spinal column lengthens more than the spinal cord. In the early embryo, the spinal cord runs the length of the column; in neonates (newborn infants), the cord stops at the level of L3; in adults, the cord stops at L1.

Failure of the caudal neuropore to close results in disruption of the lumbar and sacral segments of the cord. Structures that lie superficial to the cord are also involved (e.g. meninges, vertebral arch, paravertebral muscles, and skin), because their development relies upon closure of the neural tube.

Malformations involving the vertebral arch and the cord are called spina bifida.

Embryology of the brain

General arrangement

The brain develops from the part of the neural tube that is cranial to the fourth pair of somites.

When the cranial neuropore closes (by week 4), three vesicles are formed. Fig. 1.4 shows how the three vesicles develop.

Development of the brainstem

The brainstem has the same basic structure as the spinal cord, except that it has to accommodate the large motor and sensory tracts that run between the spinal cord and the brain.

Medulla

The medulla is structured like the spinal cord, with posterior sensory cell groups and anterior motor cell groups. As the medulla flattens out, forming the floor of the fourth ventricle, the posterior (sensory) cell groups move laterally, with some migrating to form the olivary complex.

This means that nuclei dealing with incoming information are found lateral to those sending information out of the medulla (e.g. to skeletal muscle or smooth muscle in the gut, eye, etc.).

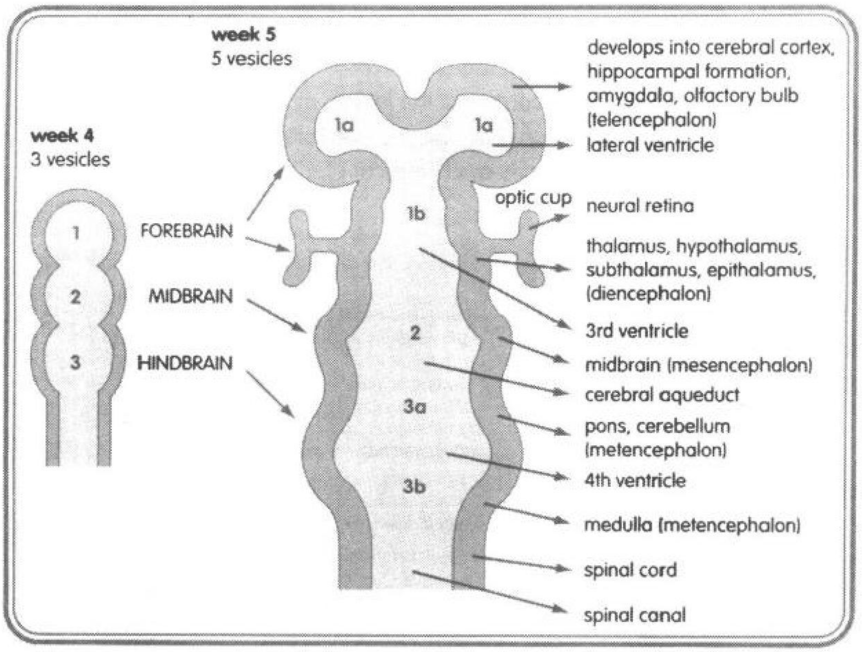

Fig. 1.4 Development of the brain.

Fig. 1.5 shows that the cell groups are further subdivided according to whether they innervate body wall structures (somatic nuclei) or organs inside the body cavity (visceral nuclei). Columns of cells are formed with a common pattern that can involve several cranial nerve nuclei.

Pons and cerebellum

The cerebellum develops from the most posterior parts of the alar plates, above the level of the medulla. The cerebellar growths on either side fuse in the midline and migrating cells from the alar plates become the cerebellar cortex.

The pons is formed by the thick band of fibres that connect the frontal lobes, basal ganglia, and thalamus with the cerebellum in a motor processing loop.

Development of the midbrain

The midbrain does not alter much from the basic alar/basal plate structure. The neural canal becomes much narrower forming the aqueduct of the midbrain (also known as the aqueduct of Sylvius).

- Fig. 1.6 shows that the colliculi are formed from migration from the alar plates; colliculi are involved in sensory processing in visual and auditory reflexes.
- The red nucleus and possibly the substantia nigra develop from the basal plates; these are involved in motor processing.

Development of the forebrain

Before the cranial neuropore closes, two pairs of lateral swellings appear on the sides of the forebrain.

- The most cranial pair are called the optic vesicles; these develop into the retina and optic nerve.
- The other pair become the cerebral hemispheres.

The forebrain section of the neural tube develops into the:

- Diencephalon (hypothalamus, thalamus, and epithalamus; Fig. 1.7).
- Posterior pituitary gland.
- Telencephalon (cerebral cortex, commissures, tracts, and basal ganglia).

Diencephalon

In the walls of the third vesicle, three swellings develop on each side:

- The most dorsal swelling becomes the epithalamus (which becomes relatively smaller as the brain grows larger).
- The middle swelling becomes the thalamus (which protrudes into the cavity of the third ventricle, gradually reducing in size relative to the rest of the brain).
- The most ventral swelling becomes the hypothalamus.

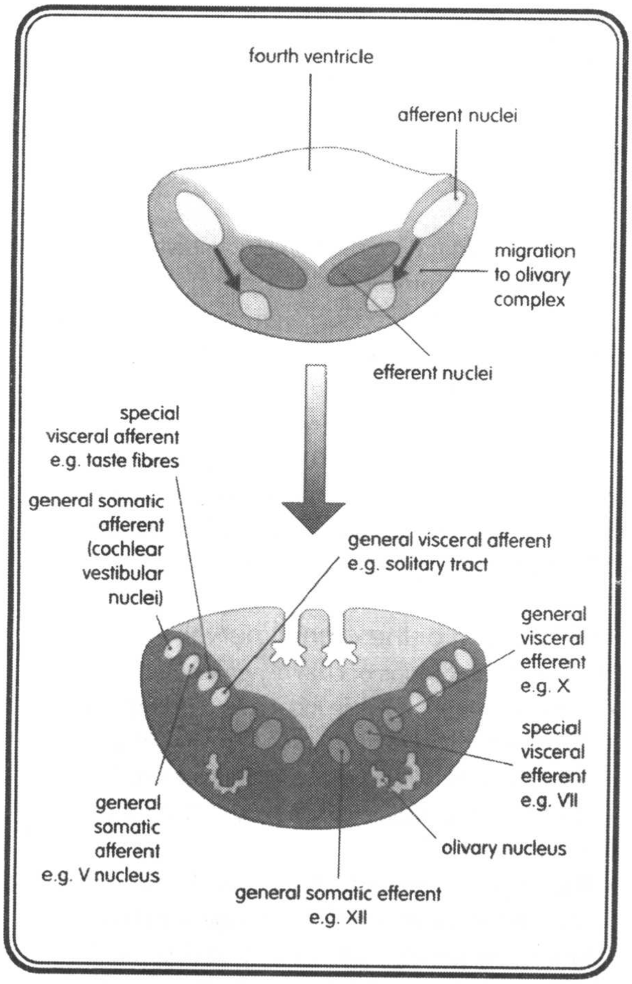

Fig. 1.5 Development of medulla with grouping of sensory and motor nuclei.

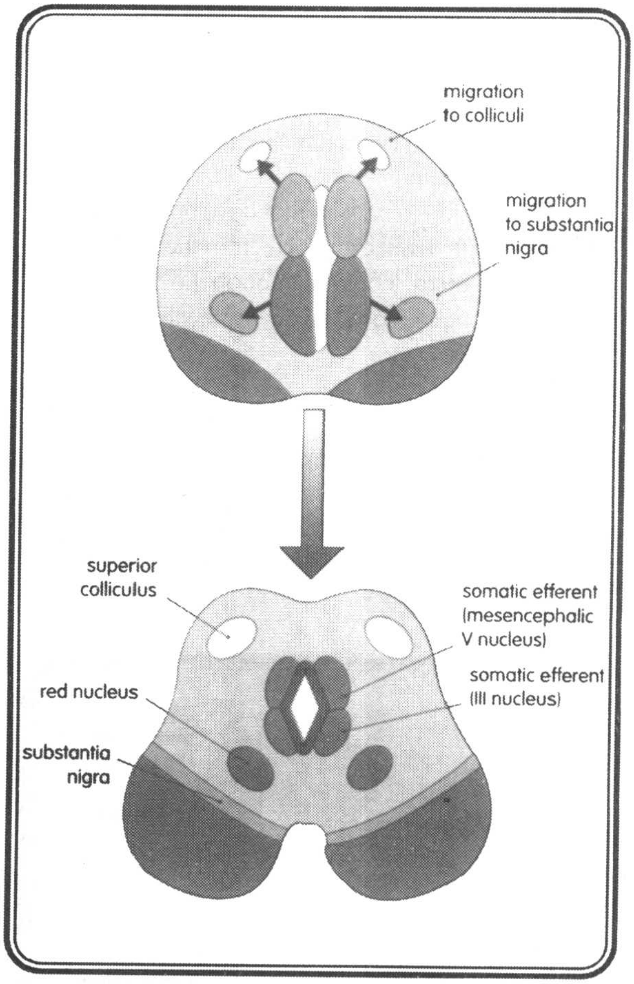

Fig. 1.6 Development of midbrain with grouping of sensory and motor nuclei.

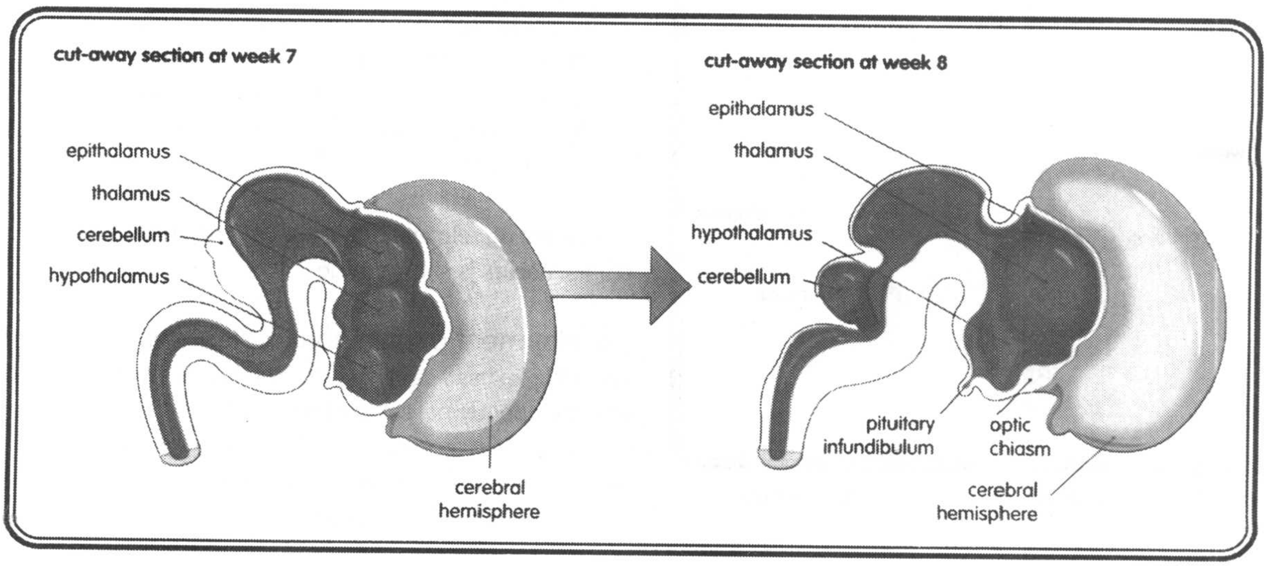

Fig. 1.7 Development of the diencephalon.