

**QUAIN'S ELEMENTS OF
ANATOMY. IN THREE
VOLUMES. VOL. III. - PART I.
THE SPINAL CORD AND BRAIN**

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by Edward Albert Schäfer & George Dancer Thane

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EDWARD ALBERT SCHÄFER & GEORGE DANCER THANE

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VOLUMES. VOL. III. - PART I.
THE SPINAL CORD AND BRAIN**

QUAIN'S
ELEMENTS OF ANATOMY

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THE SPINAL CORD AND BRAIN.

By PROFESSOR SCHÄFER.

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NEUROLOGY.

THE CEREBRO-SPINAL AXIS.

By E. A. SCHÄFER.

THE *cerebro-spinal axis* is divided into the *brain* or *encephalon*, the enlarged part within the skull, and the *spinal cord* within the vertebral canal. It is symmetrical in form, consisting of a right and a left half, separated to some extent by fissures and cavities, but united by various portions of white and grey nervous substance which cross from one side to the other, and

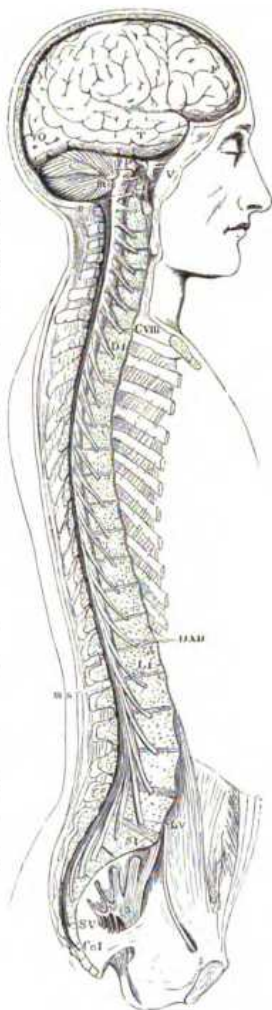
Fig. 1.—VIEW OF THE CEREBRO-SPINAL AXIS. (After Bourguery.)

The right half of the cranium and trunk of the body has been removed by a vertical section; the membranes of the right side of the brain and spinal cord have been cleared away, and the roots and first part of the fifth and twelfth cranial nerves, and of all the spinal nerves of the right side, have been dissected out and laid separately on the wall of the skull and on the several vertebrae opposite to the place of their natural exit from the crania-spinal cavity.

F, T, O, frontal, temporal and occipital lobes of cerebrum; C, cerebellum; P, pons Varolii; m o, medulla oblongata; m s, m s, point to the upper and lower extremities of the spinal marrow; c e, on the last lumbar vertebral spine, marks the cauda equina; v, the three principal branches of the nervus trigeminus; C I, the sub-occipital or first cervical nerve; C VIII, the eighth or lowest cervical nerve; D I, the first dorsal nerve; D XII, the last dorsal; L I, the first lumbar nerve; L v, the last lumbar; S I, the first sacral nerve; S v, the fifth; Co I, the coccygeal nerve; s, the left sacral plexus.

form the *commissures* of the brain and spinal cord.

The cerebro-spinal axis is enveloped within the skull and vertebral canal by three connective tissue membranes, between which are spaces occupied by a clear fluid (*cerebro-spinal fluid*). These envelopes, which will be described later, are, 1st, a firm fibrous membrane named the *dura mater*, which is placed most externally; 2nd, a delicate membrane called the *arachnoid*; and, 3rd, a highly vascular membrane named the *pia mater*, which is next to, and closely invests the surface of the brain and cord.



SPINAL CORD.

The **spinal cord** or **spinal marrow** (*medulla spinalis*) is about 18 inches (45 centimeters) long, and extends from the margin of the foramen magnum of the occipital bone to about the lower part of the body of the first lumbar vertebra. Above, it is continued into the bulb (*medulla oblongata*); below, it tapers conically and ends in a slender filament, the *filum terminale* or *central ligament* of the spinal cord.

Although the cord usually ends near the lower border of the body of the first lumbar vertebra, its termination is sometimes a little above or below that point, as

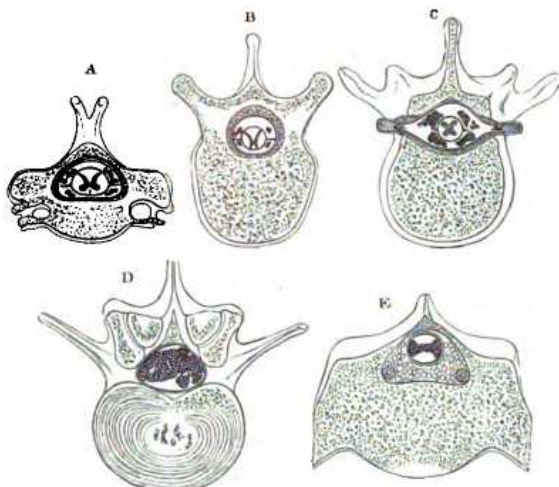


Fig. 2.—SECTIONS SHOWING THE GENERAL RELATIONS OF THE SPINAL CORD TO THE INCLOSING AND OF THIS TO THE VERTEBRAL CANAL. (Key and Retzius.)

A, through the fifth cervical vertebra; B, through the tenth dorsal vertebra; C, through the first lumbar vertebra and the foramen of exit of the twelfth dorsal nerve-roots; D, through the disk between the second and third lumbar vertebra; E, through the first sacral vertebra. In A, B, and C, the cord, covered by *pia mater*, is seen in the centre, with the *ligamentum denticulatum* attached to it on either side; the nerve-roots on either side form small groups which, since they pass obliquely downwards to their foramina of exit, are cut across; the *dura mater* sheath is separated by a considerable space from the cord, and by a quantity of loose areolar and fatty tissue from the wall of the vertebral canal. This tissue is in smaller amount in C. D and E are below the termination of the cord, and show sections of the nerve-bundles of the *cauda equina* within the dural sheath, which is very large in D, but comparatively small in E, the vertebral canal in the latter being largely occupied by adipose tissue. In this are seen the sections of two large veins. The arachnoid is not represented in any of these sections.

opposite to the last dorsal or to the second lumbar vertebra. The position of the lower end of the cord also varies according to the state of curvature of the vertebral column, in the flexion forwards of which the end of the cord is slightly raised. In the *fœtus*, at an early period, the embryonic cord occupies the whole length of the vertebral canal; but, after the third month, the canal and the roots of the lumbar and sacral nerves begin to grow more rapidly than the cord itself, so that at birth the lower end reaches only to the third lumbar vertebra. After birth the thoracic part of the cord lengthens proportionately more than the other parts, so that in the infant the roots of the lower dorsal nerves come off relatively higher up than at a later age (Pfitzner).

The cord is enclosed in the vertebral canal within a sheath (*theca*) considerably longer and larger than itself, formed by the dura mater, and separated from the walls of the canal by venous plexuses, and much loose areolar tissue (fig. 2). The cavity of the sheath between the pia mater and the dura mater is occupied by cerebro-spinal fluid, and is divided by the curtain-like arachnoid into the spaces, subdural and sub-arachnoid, above mentioned. Within the latter the cord, covered closely by pia mater, is suspended, being kept in position by a ligament on each side (ligamentum denticulatum), which fixes it at frequent intervals to its sheath, and by the roots of the spinal nerves which pass across the space from the surface of the cord towards the intervertebral foramina.

The spinal nerves come off in pairs at intervals along the cord. The portion of spinal cord to which each pair of roots is attached is termed a "segment," but there is in man and mammals complete continuity from segment to segment, and not even a sign of constriction between them. Each nerve is attached to the surface of the cord by two roots, one of which is anterior or ventral and non-gangliated,¹ the other is posterior or dorsal and is provided with a ganglion. The uppermost two or three nerve-roots cross the subarachnoid and subdural spaces nearly horizontally (figs. 1 and 5), but the rest pass across with a more and more oblique downward inclination until their direction is almost vertical, and indeed the lower part of the theca below the termination of the cord (fig. 2, D, E), is occupied by the descending roots of the lumbar and sacral nerves, passing to the foramina between the corresponding vertebrae. This mass of nerve-roots, which conceals the delicate filum terminale, is named the *cauda equina* (figs. 4, 5, 6).

The relation between the spines of the vertebrae and the places of attachment of the nerve-roots to the cord is illustrated by the appended diagram (fig. 3) from Reid, which is founded upon observations made on six adult subjects. From this it will be seen that there is a much larger amount of variation than might have been supposed. This is especially the case with the dorsal nerve-roots, some of which show variations of their position of origin extending over a distance covered by as many as three spinous processes. Certain general facts can, however, be made out which are not without practical interest. Amongst these are the position of the second cervical nerve—opposite the arch of the atlas; that of the first dorsal or thoracic nerve, opposite the sixth or seventh cervical spine; that of the seventh thoracic nerve, opposite the fourth or fifth dorsal spines, and of the sacral nerves, the range of which extends from the eleventh dorsal to the first lumbar spine. The line of origin of the sacral nerves very nearly corresponds in vertical extent with the body of the first lumbar vertebra.

No doubt this variation is largely accounted for by the variations in length and obliquity of the spinous processes of the vertebrae, and accordingly we find that there is least fluctuation of relative position at the top and bottom of the series. The anterior and posterior (ventral and dorsal) nerve-roots belonging to the same segment of the cord leave it practically at the same level (Reid).

The cervical enlargement (see next page) about corresponds in vertical extent with the spines of the cervical vertebrae, while the lumbar enlargement corresponds with the spines of the tenth, eleventh, and twelfth thoracic and the interval between the last named and the first lumbar.

In section the cord is nearly circular, especially in the thoracic region, but it is somewhat flattened before and behind. In the thoracic region, it measures about ten millimeters (0.4 inch) from side to side, and about eight from before back. The

¹ Some animals (*e.g.*, cat) have a few ganglion-cells interpolated amongst the fibres of the anterior or ventral nerve-roots. Hoche finds that in the anterior roots of the lower lumbar and sacral nerves of man, just at their junction with the cord, ganglion-cells, like those of the posterior root, are almost constantly present, lying singly or in groups, and connected with some of the issuing nerve-fibres by a T-shaped junction.