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ANATOMICAL COMPARISON OF THE SPINAL NERVOUS SYSTEM

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ARTICLE INFO	ABSTRACT

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The fundamental anatomical characteristics of the autonomic nerve systems of animals that are not mammalian in origin. In addition to this, it makes an attempt to describe the parallels between the autonomic nerve systems of fish and tetrapods, as well as the increasing complexity of the latter. The extraordinary resemblance that exists between the many classes of vertebrates, with the probable exception of the cyclostomes, is one of the most distinctive characteristics of the autonomic nerve systems of vertebrates. An increase in system complexity can be observed, as elasmobranchs have segmental ganglia that are only partially connected longitudinally, whereas teleost fish and tetrapods have well developed paired sympathetic chains in their nervous systems. This indicates that the complexity of the system has evolved over time. Some groups' sympathetic chains may be shorter than others (dipnoans and caecilians, for example), and sympathetic chains in snakes have not been adequately documented. Cranial autonomic pathways are present in the oculomotor (III) and vagus (X) nerves of gnathostome fish and the tetrapods, and with the evolution of salivary and lachrymal glands in the tetrapods, also in the facial (VII) and glossopharyngeal (IX) nerves. Cranial autonomic pathways are present in the facial (VII) and glossopharyngeal.

Keywords: vertebral nervous system, nervous tissue.

INTRODUCTION

Everyone will, at some point in their life, have the opportunity to observe animals, paying attention to how they move, chase prey or food, and react to both external and internal stimuli. This experience will come to each of us at some point. The individual cells that make up an animal's body respond in diverse ways to the many different stimuli that they are exposed to, and these responses are then integrated in a meaningful and coordinated manner. All of these procedures would not be possible without this enabling factor. This coordination happens in two distinct ways: electrically, via the neurological system, and chemically, via the endocrine system. Both of these systems are located in the body. In this lesson, you will learn about the arrangement of the nervous systems of vertebrates, and we will also go over the other integrating systems.

You have discovered in LSE-05 and LSE-09 how the neurons, which are specialised cells found in metazoan bodies, get organized into a nervous system, as well as the fact that the neurons of all animal species operate according to the same fundamental principles. You have also gained the knowledge that the functions that these neurons are accountable for are the same. If you recall correctly, the function of the nervous system is to take in any stimulus or sensory information that is offered to it and then to send ripples of that information to other regions of the body. This is the work that the nervous system is supposed to do. In this way, it is able to regulate an animal's behaviours by integrating incoming sensory input with knowledge stored as a consequence of prior experience, and then transforming information from both the past and the present into action via effectors. In this way, it controls an animal's behaviours. Additionally, the nervous system is responsible for the processing of each and every conscious experience. By the time you reach the conclusion of this course, you will have a fundamental

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comprehension of the anatomy of a vertebrate nerve cell, which functions as both the structural and functional unit of the nervous system.

A. NERVOUS TISSUE IN VERTEBRATES

You have realised that the third unit of the Developmental Biology Course (LSE-06) taught you that the origin of any and all nerve tissue may be traced back to the ectoderm. This was something that you did not know before. The layer of ectoderm that is flattened along the mid-dorsal side of the gastrula expands throughout the embryonic development of vertebrates. This occurs on the dorsal side of the gastrula. This layer is known as the neural plate or the medullary plate, and it is this layer that is responsible for the development of the neural tube as well as the neural crest.

You should be able to recall this structure. These processes include the dendrites, which are normally rather numerous and highly branching, as well as the axon, which is a single long process but includes branches at the end of it. Although it is theoretically feasible for the axon to give rise to collateral branches, in practise this seldom does place. A synapse is formed when the terminal of one neuron's axon comes into close proximity with the dendrites of another neuron. This type of contact is conceivable. When this takes place, neurotransmitters are discharged from the terminals of the axons, and these neurotransmitters transfer information to the other neuron across the synapse in the form of impulses. In the vast majority of instances, there is just one possible outcome. One neuron is capable of communicating with thousands of other neurons at the same time.

B. CENTRAL NERVOUS SYSTEM

During this stage of development, the neural tube will begin to differentiate into the neural plate. El± There is a possibility of having connected areas known as foramen of noniron in the centre of the brain as well as in the central canal of the spinal cord. Both of these locations are included in the definition of the nervous system.

There are three distinct embryonic zones that may be seen in the front end of the neural canal. These areas can be identified from one another. The prosencephalon, mesencephalon, and rhombencephalon can each be further subdivided into the following major subgroups. These components, as they mature into adults, come together to form the forebrain, the primitive vertebrate midbrain, and the hind brain.

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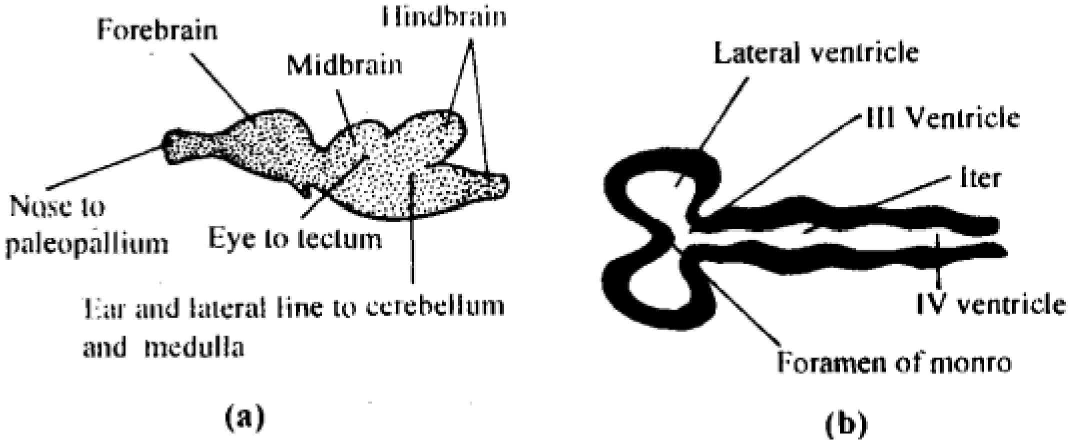

Figure 1 a) diagrammatic view of the major subdivision

C. CAVITIES OF THE BRAIN AND SPINAL CORD

The diencephalon is located near the base of the brain. The ventricles I and I1 are able to link with ventricle 111 thanks to a passageway called the interventricular foramen, which is also referred to as the foramen of Monroe. The cerebral aqueduct, which is a small canal, is the pathway by which the bird ventricle in higher vertebrates communicates with the mesencephalon. The cerebral aqueduct provides blood and other nutrients to the fourth ventricle, which is located posteriorly in the rhombencephalon. Myelocoele is the segment of the fourth ventricle that is linked to the canal that travels through the middle of the spinal cord and is found within the medulla oblongata.

1) The Spinal Cord

The region of the neural tube that will develop into the brain and spinal cord goes through a great lot less changes than the portion of the neural tube that will become the rest of the head. This is because the brain and spinal cord are more resistant to change. In most instances, it assumes the shape of a tube that is more or less cylindrical but appears to be considerably longer overall. In other words, it has an appearance of being somewhat extended. At its anterior end, when it also reaches its full breadth, it is attached to the medulla oblongata. This is also the point at which it reaches its complete length. The posterior end will typically shorten until it forms the filum terminal, which is a very fine thread. This occurs in the majority of instances. The lumbar enlargement is a structure that may be found in the back of the spinal cord and is responsible for the distribution of nerves to the lower extremities. In animals without limbs, such as snakes, it is possible to discern neither increase nor reduction in size.

Grey and white matter of the cord

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When the spinal cord is cut in half horizontally, both grey matter and white matter may be seen running along the centre of the segment. White matter is located in such close proximity to grey matter that it almost completely encapsulates the latter. When viewed from above, the structure of the grey matter in amniotes is reminiscent to the letter 'H' in its outline. The segments of the column that correspond to the lower bars are referred to as ventral columns, while the sections that correspond to the higher bars are referred to as dorsal columns since they extend dorsally and because they are called that. The connecting bar, inside which the central canal can be found, creates the dorsal and ventral grey commissures, which may be found above and below correspondingly.

D. PERIPHERAL NERVOUS SYSTEM

In common parlance, the term "peripheral nervous system" (or "PNS") refers to the collection of nerves and ganglia that, in addition to establishing connections.

E. Spinal News

Two roots connect each spinal nerve to the spinal cord. These roots are found on both sides of the nerve. Within the embryo, there is a band of neural-crest cells that may be found on each side.

F. AUTONOMIC NEWS

However, the comparative architecture in other vertebrates is not as well understood as it is in mammals, which makes the functional components of the sympathetic and parasympathetic nervous systems in mammals crystal clear.

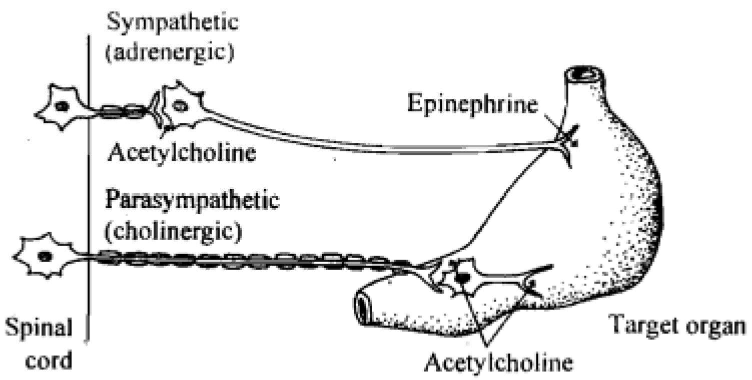

Figure 2: Neurotransmitters of the autonomic system.

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a network of nerves that are sympathetic to the target This phenomenon is sometimes referred to as "thoracolumbar outflow"

This trunk reaches all the way down to the coccyx, all the way from the foramen magnum. Each sympathetic trunk will, at what may be thought to be somewhat regular intervals, bear enlargements that are referred to be chain ganglia (Fig. 10.8). However, it is conceivable for these ganglia to merge, which would obscure their segmental nature. The chain ganglia are assigned a number that corresponds to the vertebrae that are positioned on the opposite side of where they are located.

This would be the case if the ganglion is located at the beginning of the sympathetic trunk. Both the celiac superior mesenteric ganglia and the coeliac inferior mesenderic ganglia are examples of prevertebral ganglia that are connected to the coeliac plexus. Both of these ganglia are located in the coeliac region. Directly connected to the preganglionic fibres is the medulla of the adrenal gland, which is accessed by these fibres. This glandular structure of the ectoderm originates from cells of the neural crest and is made up of sympathetic ganglionic cells that have undergone some kind of transformation or specialisation. In addition to releasing adrenaline and noradrenaline, these cells, which are similar to postganglionic sympathetic neurons, also have the same gene.

It is conceivable for the adrenal glands, which produce hormones adrenaline and noradrenaline, to get confused. This is because adrenaline and noradrenaline are both hormones. As a direct consequence of this, there is an absence of postganglionic fibres.

Functions performed by the sympathetic branch of the nervous system

- The tightening of the muscles in the papillae, which gives the appearance of "goose flesh" and causes the hair to stand up in a vertical position.
- The process through which fluid is expelled from the sweat glands.
- An increase in the size of the pupil.
- A general reduction in the volume of saliva that is generated throughout the day.
- An acceleration in the rate at which one's pulse beats.
- An increase in the size of the bronchial tubes.
- Both a relaxing effect on the smooth muscles of the digestive tract and an inhibiting effect on those smooth muscles.
- The loosening of the muscles that make up the bladder's structure.

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- A constriction of the sphincter muscles that are found in the bladder; also known as a bladder spasm.
- A rise in the concentration of sugar in the blood as well as the visibility of red blood cells in the circulatory system
- A rise in the individual's current blood pressure readings.

The following reactions, when combined, are often associated with the sensations of pain, fury, and fear, and they prepare the body to react correctly to the situations listed above.

OBJECTIVES

1. To study comparative atomically review of the vertebral nervous system.
2. To study peripheral nervous system.

RESEARCH METHOD

Before the creatures could be weighed or photographed, chloroform was used to put an end to their lives. The three animals were then weighed. After that, an open injection of a 10% formol solution was performed directly into the heart, and this was immediately followed by the fixation of the brains. After that, dissection was employed to remove the brains from the cranial cavities so that they could be weighed. This was done so that the brains could be more accurately measured. There are macrophotographs that show both the dorsal and ventral sides of the complete brain. These images may be seen on the internet. These pictures were obtained by the use of a microscope. In addition, the forebrain, the midbrain, and the hindbrain were all measured and analysed independently of one another.

After having been knocked unconscious with chloroform, three separate animals had their sternums sliced through in order to have access to the thoracic cavity. In order to get access to the chest cavity, the pericardium had to be sliced, and then blood of up to 5 millilitres was taken directly from the heart. After that, the serum was obtained by separating it from the blood. In order to extract lipids, 1-3 ml of serum was mixed with 30 ml of a mixture of chloroform and methanol. This was done in a test tube (2; l). After giving the combination time to settle in a separating funnel for a whole day, the lipid that had been effectively separated was then taken out of the funnel and discarded. Evaporating the remaining mass after it had been removed, followed by applying the Peter and Vanslyke method to calculate the total lipid content of the sample (1946). After that step, the bulk that had been evaporated was dissolved in twenty

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millilitres of the same mixture of chloroform and methanol. Using the method that was developed by Chen, Toribara, and Warner (1956), aliquots were obtained, and the levels of phospholipid and cholesterol were determined using a modified version of the Sperry and Welby method. Aliquots were obtained using the method that was developed by Chen, Toribara, and Warner (1956), (1949).

DATA ANALYSIS

G. Observations concerning the weight of the animal in addition to the weights of its whole, fore, mid, and hind brains.

Table no. 1 Measurement of the Animal's Weight

Nos.	Weight in gms	Mean avg in gms
1	500	470
2	460	
3	450	

The weight, on average, comes in at 470 grammes.

Table no. 2

Nos.	Weight in gim	Mean avg in gms
1	0.319	0.306
2	0.303	
3	0.297	

H. The weight is calculated to be 0.306 g on average.

I. biochemical estimations of total lipid, phospholipid, and cholesterol in blood serum, whole brain, fore-brain, mid-brain, and hind-brain

Table no.3: Total lipid, phospholipid, and cholesterol in Blood Serum, in gm/100 ml..

No. of obser-vation	Total lipid gm/100ml	Mean t S*D*	Phospho-lipid gm/100ml	Mean ± S.D.	Choleste-rol gm/100mi	Mean ± S.D.
1	0.890	0.846 ±0.00004	0.127	0.132 ±0.00006	0.195	0.183 ± 0.00005
2	0.800		0.130		0.186	

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3	0.840		0.139		0.177	

According to the information presented in the table, the mean average concentration of total lipid in blood serum is 0.8460.00004 gm/100ml, the mean average concentration of phospholipid is 0.1320.00006, and the mean average concentration of cholesterol is 0.1830.00005 gm/100ml. All of these values are expressed as standard deviations from the mean.

Table no. 4 displays total lipid, phospholipid, and cholesterol in the entire brain, Fore-brain, Mid-brain, and Hind-brain.

Whole brain:

No .of observation	Total lipid gm/l00gm	Mean ± S.D.	Phospholipid gm/l00gm	Mean ± S.D.	Cholesterol gm/100gm	Mean ± S.D.
1	9.90	8.86 ±0.10	5.20	4.76 ± 0.40	0.878	0.769 ±0.01
2	8.90		4.70		0.769	
3	7.80		4.40		0.662	

The mean average concentration (standard deviation) of total lipid in the whole brain is 8.86 0.10 gm./100gms, the mean average concentration of phospholipid is 4.76 0.40 gm./100gms, and the mean average concentration of cholesterol is 0.769 0.01 gm./100gms.

J. Histochemical Observations of Total Lipid, Phospholipid, and Cholesterol in the Cerebrum, Tectum, Cerebellum, and Brain Stem

Taking a glance at the figures makes it abundantly evident that the Shole fish have a high level of total lipid content. Phospholipids and cholesterol are most heavily concentrated in the various functional fibre tracts that are found in the cerebrum, tectum, cerebellum, and brain stem. This can be seen by the increased depth of staining that occurs in these regions. Other regions of the brain that contain these functional fibre tracts include the cerebellum. On the other hand, none of the preparations provide evidence that such fibres are present in the cortical grey matter of either the cerebrum or the cerebellum.

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Additionally, it is clear from the photos that the degree of staining of the fibres in the phospholipid preparations is much more intense than that of the cholesterol preparations in each and every one of the places tested.

Because of this, the quantity of phospholipids contained in such fibres greatly exceeds the quantity of cholesterol found in the same.

The findings of recent scientific studies on phospholipids and cholesterol are entirely consistent with this observation.

K. Weight, Whole Brain, Fore-Brain, Mid-Brain, and Hind-Brain Observations.

Table no. 8 weight of the animal

Nos.	Weight in gms	Mean average in gms
1	310	253
2	250	
3	200	

253 gms is the mean weight..

Table no. 9 Brain weight:

Nos.	Weight in gm	Mean average in gm
1	0.273	0.230
2	0.224	
3	0.193	

The weight is 0.230 g on average, which is the mean.

Table no. 10 Weight of the Fore-brain:

Nos.	freight in gm	Mean average in gm
1	0.062	0.043
2	0.035	
3	0.032	

The weight is calculated to be 0.043 grammes on average.

Table no.11 Weight of the Mid-brain:

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Nos.	Weight in gm	Mean average in gm
1	0.098	0.083
2	0.085	
3	0.065	

The typical weight is 0.083 grammes on average.

CONCLUSION

The midbrain, and the hindbrain of typical vertebrate brains all produced results that were remarkably similar to one another. In each of the preparations (total lipid, phospholipid, and cholesterol), the lipids are most concentrated in the functional nerve fibres or fibre tracts, which exhibit the most intense staining. This is because these structures contain the highest number of phospholipids and cholesterol. This holds true regardless of the kind of preparation that is under scrutiny. Because phospholipid preparations have a larger concentration of phospholipids than cholesterol preparations do, the nerve fibres stained to a greater degree in the phospholipid preparations. This is because cholesterol preparations include a higher quantity of cholesterol. The cortex and the grey matter are both known as the substantia gelatinosa. The highest number of nerve fibres may be found in the brain's cortex, which is the outermost layer of the brain.

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