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PSYCHOLOGY
for Nurses

M Basavanna

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3 CHAPTER

Biological Foundations of Behavior

PREVIEW

We have seen in the first chapter that psychology has had its roots in philosophy and physiology. Philosophers discussed extensively about the structure and functions of the mind and physiologists studied the anatomy and physiology of the body and its parts. It is unfortunate that the early thinkers considered the body and mind as two independent entities and studied them separately. Today, people think of the whole organism, not its body or mind. They believe that it is not possible to think of mind without the body or the body without mind. It is often said that the concept of body or of mind is only an academic abstraction. One cannot exist without the other and the two are systemically related. Today, there is a growing tendency to look upon the individual as an organized system who should not be analyzed into body and mind. Body and mind are the two sides of the same coin. In spite of all this talk, the fact remains that the exact nature of the relationship between body and mind is still an unsettled issue. We need not go very deep into the mind-body relationship. Whatever be the relationship between body and mind, there is research evidence to show that many of our behaviors arise from the activities of the brain—not just mundane things such as breathing, heart rate, temperature and coordinated movements of the body, but also our inner thoughts and intimate feelings as well. Every time you think, act or feel, the activities in your brain play crucial, if not primary role. It is believed that psychological disorders such as schizophrenia or depression have their roots in the functioning of the brain. There are glaring instances in which brain impairment has produced psychological disturbances as is seen in the case of organic mental syndromes such as delirium, senile dementia and Alzheimer's disease. Therefore, it is necessary for every psychology student to have an understanding of how physiology influences psychological activities. Try to remember (in chapter one) what Johannes Müller, the father of physiology, said with regard to the relation between physiology and psychology: "One cannot be psychologist without being a physiologist."

In this chapter, we discuss certain structures and functions of the body, especially the brain, the nervous system and the endocrine system so far as they are related to psychological functions. The human brain is regarded as the most remarkable feat of engineering ever achieved. Brain is a living super-computer, which is far more elegant than any machine that a modern scientist could hope to create. In fact, it may be wrong to compare the brain to a computer. However, complicated computer may be, it is after all the creation of the human brain. You should not equate the creator with his or her creation. The human brain, along with the rest of the nervous system, provides solutions to the problems created by the constantly changing and sometimes hostile environment, both physical and social.

You have learned that psychologists who are interested in the study of the biological bases of behavior and mental processes are called physiological psychologists, biopsychologists, or psychobiologists. The new name to this branch of knowledge is behavioral neuroscience. Without going into the details of neuroscience, we shall study in this chapter, the structure and working of the basic units of the nervous system, the nerve cell or neuron. We then examine the workings of the two major divisions of the nervous system: the central nervous system comprised of the brain and the spinal cord and the peripheral nervous system, which connects the central nervous system to various parts of the body such as sense organs, muscles and glands. Of special interest to psychologists is that branch of the peripheral system called autonomous nervous system. We will also discuss elements of endocrinology and genetics. As you read through the book, you will realize how important the knowledge of biology is in understanding human behavior, thought, feeling and motivation.

Chapter Outline

Neurons
- Nerve impulse
- Synaptic transmission
- Neurotransmitters

Nervous System
- Organization of the nervous system
- Cortical areas and their functions
- Speech centers
- Lateralization of cerebral hemispheres
- Autonomic nervous system

Endocrine System

Immune System

Genetic Influence on Behavior
- Chromosomal anomalies
- Behavior genetics
- Studies of family and kinship
- Adoption studies
- Twin studies
- Gene manipulation

The human organism is a psychophysical system. The psychical and the physical part of the system cannot be separated. Body and mind are two sides of the same coin; one cannot exist without the other; separating them is merely academic. Philosophers have always been discussing the way in which body and mind are related and have offered several theories about the relationship between the two. Some of them advocated that only body exists. Others said only mind exists. Another group asserted that both exist. Among the latter group, some said that body and mind interact and others proposed that they run in parallel course without interacting. Still another group of philosophers said that the two are aspects of the same phenomenon. There is a joke about mind-body relationship. It appears that after listening to a series of lengthy lectures from a learned teacher on mind-body relationship, one student stood up and asked: Sir, "What is mind?" The teacher replied: "No body!" Then, the student asked "What is a body?" The teacher replied "Never mind!" Although humorous, the conversation throws some light on the present state of mind-body relationship. However, the fact remains that psychology and physiology are intimately related. Therefore, it is necessary that a student of psychology is acquainted with elementary physiology, especially with the area pertaining to brain and nervous system. The brain and the nervous system control our behavior—our movements, hopes, aspirations, emotions, perceptions, learning—and the very awareness that we are human beings. Because of its importance, an interdisciplinary science called neuroscience has emerged in recent years. As a group, neuroscientists include neurologists, zoologists, medical experts, computer scientists and psychologists. Psychologists who study the biological structures and functions underlying behavior are often called biopsychologists, behavioral neuroscientists or physiological psychologists.

Several aspects of behavior and experience cannot be understood without the knowledge of biological processes underlying them. Our nervous system, sense organs, endocrine system, and muscles help us to understand and adjust to our environment. Our understanding (perception) depends on sensory reception of the stimulus and its interpretation by the brain. Large chunks of our behavior are triggered by needs such as hunger, thirst, sex and avoidance of pain; how we walk, talk, think, solve problems and plan our activities are controlled by our brain. Our emotions such as fear, anger,

grief and love are mediated by complex neurophysiological functions.

In this chapter, we deal with the biological structures of the body, especially the brain and nervous system that are of interest to biopsychologists. First, we learn about the building blocks of the nervous system called the **neurons**—their structure and functions. Later, we deal with the various subdivisions of the nervous system. Finally, we discuss elements of endocrinology and genetics. As you read through the book, you will realize that our understanding of human behavior cannot be complete without the knowledge of the fundamentals of the brain and the nervous system.

NEURONS

Neurons are the basic units, the building blocks of the nervous system. These are specialized cells, which transmit the nerve impulses throughout the brain and body. It is estimated that there are as many as 100 or even 200 billion neurons in the brain alone (there may be a trillion neurons in the body). Like all other cells of the human body, the neuron has a **cell body**, which contains the **nucleus** (Fig. 3.1). The nucleus contains the inherited substance that determines how the cell functions. All activities of the brain hinge on the working of neurons. There are three types of neurons:

1. **Sensory neurons** that respond to input from the sense organs.
2. **Motor neurons** that send signals to the muscles to control movements.
3. **Interneurons** that are connecting neurons, which stand between sensory and motor neurons.

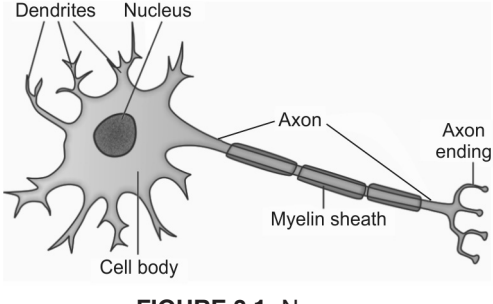

FIGURE 3.1: Neuron

Most of the neurons in the brain are interneurons and most of them are connected to other interneurons. Interneurons are also called internuncial neurons. As a specialized structure that communicates with other cells, the neuron consists of two more parts: the dendrites and the axon.

Dendrites are short fibers projecting from one side of the cell body. They receive messages from the axons of other neurons. The **axon** is a single, slim, long fiber extending from the other side of the cell body. The axon carries messages to other neurons, muscles and glands. The length of axon varies from a few millimeters to about a meter. Normally, nerve impulses move in one direction only, from dendrites through the cell body and along the axon to the dendrites or the cell body of the next neuron, or to a muscle or gland. A nerve is a bundle of axons belonging to hundreds or thousands of neurons. Although each neuron has only a single axon, most axons divide into small branches called terminals. At the end of the terminals are **terminal buttons** (or boutons or axon endings), little knob-like structures that release certain chemicals called **neurotransmitters** that help in the transmission of messages to other neuronal cells.

Axons have a protective covering called the **myelin sheath**. Myelin sheath serves to increase the velocity with which the nerve impulses travel through the axon and prevent messages from short circuiting with one another. The axons that carry emergency messages generally have the maximum covering of myelin. In certain diseases, such as multiple sclerosis, the myelin sheath degenerates exposing the axon that is normally covered. This condition may

produce a kind of short-circuiting causing disturbance in the passage of messages between the brain and muscles, which in turn may give rise to symptoms such as visual disturbances, difficulty in walking and difficulty in muscular coordination.

Generally, nerve impulses move in one direction—from dendrite to the cell body to the axon. But in some instances certain chemicals travel through the neuron in the opposite direction carrying some nourishments (nutrients) to the nucleus. When such movement of chemicals in the reverse direction is disturbed, the neuron may die from starvation causing a disease called **amyotrophic lateral sclerosis (ALS)**. Rabies is also caused by the reverse flow of rabies virus along the axon.

Nerve Impulse

The formation and transmission of nerve impulses are the products of complex electrochemical processes. The thin cell membrane is not equally permeable to different types of electrically charged ions that float in the protoplasm of the cell and the liquid surrounding it. During the resting state of a neuron, the cell membrane keeps out positively charged sodium ions and allows in potassium ions and chloride ions. As a consequence, there is a small electrical potential across the membrane. The inside of the cell is slightly more negative than the outside. This is its **resting potential**. When stimulated, the electrical potential is reduced and the cell membrane allows the sodium ions to enter the cell. Now the outside of the cell membrane is negative with respect to the inside. This change influences adjacent part of the axon, allowing the inflow of sodium ions. This process of quick changes from negative to positive and vice versa along the axon is the nerve impulse. This electrical shift takes just a millisecond (one-thousandth of a second). That is why often a nerve impulse is referred to as a wave of negativity. The nerve impulse is also called **action potential** in contrast to the resting potential. In short, for a neuron to function properly, sodium and potassium ions must enter and leave the membrane at just the right rate. Certain drugs that alter the transit system can decrease or prevent neural transmission.

The action potential obeys an **all-or-none law**. That is, either the action potentials occur at a uniform and maximum intensity or they do not occur at all. Just after the action potential has passed, the neuron cannot be stimulated immediately whatever the strength of the stimulus. It becomes temporarily inactive. This phase is called the **absolute refractory period**. This is followed by a stage when only a very strong stimulus may be required to fire the neuron. This is called the **relative refractory period**. However, with the passage of time, the neuron is ready to be fired. Since, the nerve impulse is generated a new at each stage along the neuron, it does not diminish in size during transmission. In the myelinated fibers, the conduction of nerve impulses is faster. The myelin sheath insulating the fiber is interrupted approximately 2 millimeter by constrictions called *nodes*, where the sheath is thin or absent. Because the nerve impulse jumps from node to node, its velocity is increased. These electrochemical events occur too quickly. There is also variation in the velocity of nerve impulse among neurons; it depends on the diameter of the nerve and thickness of the myelin sheath. The longer and thicker fibers can carry messages at a speed that is around 225 miles per second. The neurons differ in their rate of firing. Some fire at the rate of 1,000 times per second, others at a much lower rate. The firing rate depends on the intensity of the stimulus.

The structure and functioning of the neuron illustrate clearly the importance of biological factors underlying psychological phenomena. Our understanding of the

universe around us, how we perceive, learn, remember, think, plan and make decision have been enriched by the discoveries made by neuroscientists about the neuron.

Synaptic Transmission

We have learnt so far how an action potential is conducted within a neuron. But what happens to a nerve impulse when it reaches the terminal point of an axon? How is it transferred to the next neuron? The neurons are not structurally connected; there is a gap between one neuron and the other. How is the gap between the neurons bridged for the transmission of nerve impulse to cross over? The gap between any two neurons is called the *synaptic cleft* (Fig. 3.2). When a nerve impulse comes to the end of a neuron and reaches the end button, the *synaptic vesicles* within the button release a chemical that helps in the transmission. These chemicals called neurotransmitters carry the message across the synaptic cleft to the dendrite of a receiver neuron. The chemical mode of transmission of nerve impulse between neurons is completely different from the way in which transmission takes place within the neuron. The movement of impulses within the neuron is electrical in nature, while it occurs through chemical means between neurons. The neurotransmitters carry messages across the synaptic cleft like a boat carrying passengers across a river.

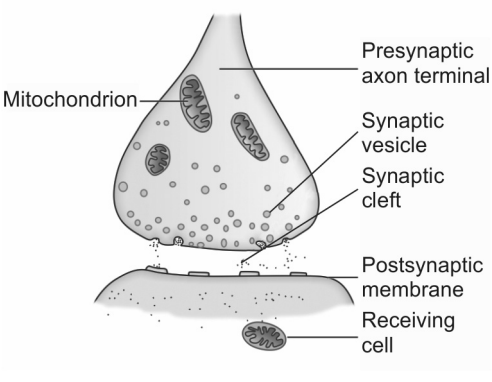

FIGURE 3.2: Synapse

Neurotransmitters

There are a number of neurotransmitters, and not all receiver neurons are capable of using the chemical message carried by a particular neurotransmitter. Each neurotransmitter can fit into a specific site on the receiving neuron. It is only when a neurotransmitter fits into a receptor site (a specific area of the membrane that is sensitive to a specific neurotransmitter) that successful communication is possible. When there is such a fit, the chemical message is delivered. There are two types of messages: excitatory and inhibitory. Excitatory message enables the receiving neuron to fire. Then an action potential will travel down the axon of the receiving neuron. Inhibitory message prevents the likelihood that the receiving neuron will fire.

The effect of neurotransmitters on behavior is tremendous. An abundance or deficit of a neurotransmitter can produce several behavioral problems. So far, some 50 neurotransmitters have been identified. Among them acetylcholine (ACh), norepinephrine (noradrenalin), gamma-aminobutyric acid (GABA), dopamine (DA), serotonin, and endorphin have been extensively studied (Table 3.1).

Acetylcholine (ACh) is found throughout the nervous system. It transmits messages relating to skeletal muscles (controlling all movements). There is growing evidence that ACh is related to memorization processes. It is also believed that decreased production of ACh is related to Alzheimer's disease. **Norepinephrine** is a hormone secreted by the adrenal medulla. It is a catecholamine that functions both like an excitatory and inhibitory neurotransmitter. It is found in some cells in the brainstem and on some sites of the sympathetic nervous system. It is believed to control learning, memory, wakefulness, and eating. Gamma-aminobutyric acid (GABA) is primarily an inhibitory neurotransmitter

Table 3.1: Major Neurotransmitters and Their Functions

Name of neurotransmitter	*Major functions*	*Symptoms and disorders*
Acetylcholine (ACh)	Excitatory at synapse, muscle control; memory	Alzheimer disease (shortage), delusions (shortage); convulsions, spasms, tremors (excess)
Dopamine (DA)	Excitatory; involved in emotional arousal, learning, memory, thinking, pain or pleasure, voluntary movement	Parkinson's disease; schizophrenia (excess); depression (shortage); attention deficit and hyperactivity disorder (shortage)
Norepinephrine (NE)	Excitatory and inhibitory; controls learning, memory, eating, wakefulness and dreaming	Depression (shortage); anxiety, panic, headache; schizophrenia (excess) distractibility (shortage)
Epinephrine	Orientation toward stimuli	Depression (shortage); arousal or apprehension (excess)
Serotonin	Inhibitory or excitatory; regulates mood, sleep, eating and arousal	Obsessive-compulsive disorder (excess); insomnia, depression (shortage); lack of motivation (excess)
Gamma-aminobutyric acid (GABA)	Inhibitory in motor system	Anxiety, epilepsy, sluggish, Huntington's disease (shortage) Lack of motivation (excess)
Endorphins	Inhibit transmission of pain impulses	Insensitivity (excess) or hypersensitivity (shortage) to pain

found in the brain and spinal cord. It is believed to moderate eating, sleeping and aggressive behavior. It also plays an important role in the way the brain inhibits anxiety in stressful situations. **Dopamine** is another catecholamine found in the brain, which functions both like an excitatory and inhibitory transmitter depending on the pathways and the properties of the postsynaptic receptors. It is implicated in a number of functions such as movement, attention and learning. Parkinson's disease is said to be due to dopamine deficiency in the brain. It also causes certain muscle disorders. Overproduction of dopamine seems to be a factor in the causation of schizophrenia and some other mental disorders. **Serotonin** functions both as an inhibitory or excitatory neurotransmitter. Found in the brain and spinal cord, it controls mood, arousal, sleep and eating. It is also involved in producing pleasure and pain. A great deal has been said about the serotonin's role in affective disorders, especially depression and bipolar disorders. **Endorphins** are inhibitory transmitters found in the brain and spinal cord. They inhibit transmission of pain impulses. Oversupply of endorphins produces insensitivity to pain and undersupply, hypersensitivity. They are implicated in the production of pleasurable feelings and appetite.

NERVOUS SYSTEM

As we have seen, the neurons are complex structures capable of intricate functions. If so, what should be the complexity of the nervous system that comprises some 100 to 200 billion neurons? Nervous system, its structure and functions, is a true marvel existing in the universe; it defies all human understanding. We are told that a single neuron may be connected to some 80,000 other neurons. The

total number of connections in the nervous system is mind-boggling; some investigators have estimated it to be in the neighborhood of one quadrillion (1,000,000,000,000,000) and some others say it is still higher. In spite of its complexity, it is surprising that the nervous system functions quite systematically, logically and elegantly.

Basically, we can think of the entire nervous system as made up of three types of neurons: sensory neurons, motor neurons and interneurons. The sensory neurons bring messages from the sense organs to the spinal cord and to the brain. The motor neurons carry the orders of the brain through the cord to various organs of the body. The interneurons perform the associative functions within the nervous system; they link the input and output functions. The number of interneurons is more than the other two types put together. For example, when you hear the voice of your favorite singer, the interneuron helps you to recognize it by linking the sensory information with the memory of the picture of the person singing, which is stored somewhere in the brain. In fact, the interneurons explain the complexity of our higher mental processes.

Organization of the Nervous System

The nervous system is like a highly organized, well-coordinated corporation. It works as a unit. Any division is for academic purposes. It is broadly divided into several interrelated subsystems. It is customarily divided into two parts: the peripheral nervous system and central nervous system (Fig. 3.3). The **central nervous system (CNS)** includes all the nerves in the brain and the spinal cord. The **peripheral nervous system (PNS)** consists of the nerves branching out of the brain and spinal cord and reaches out to other parts of the body. The PNS is further divided into the somatic system and the autonomic nervous system. The **somatic system** is involved in the control of voluntary movements and carrying information from and to the sense organs. They convey to us the sensation of pain, pressure and temperature. All the voluntary muscular movements, our walking, talking, handling things and the involuntary adjustments we make in balancing the body are controlled by the somatic nerves. The **autonomic nervous system (ANS)** is concerned with the functioning of vital organs, such as the heart, lungs, glands and blood vessels. The autonomic nervous system plays a very important role in determining human behavior and will be discussed in a later section.

The central nervous system (CNS) consists of the brain and the spinal cord. The CNS is the highly evolved structure, which distinguishes human beings from all other living beings. Given below is a brief account of the various parts of CNS.

Spinal Cord

The **spinal cord** consists of nerve fibers running from various parts of the body to the

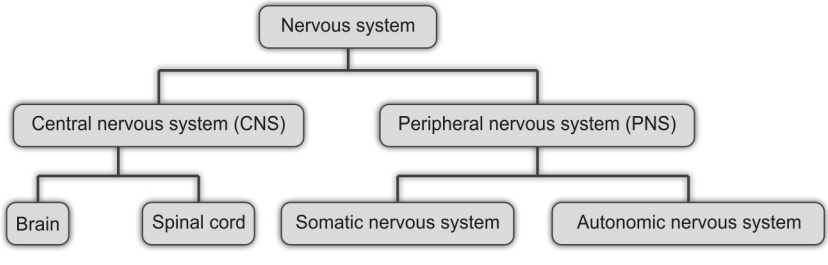

FIGURE 3.3: Divisions of nervous system

brain and back. It is about the thickness of a pencil (about 1 inch in diameter and about 17 inches in length) in an adult human being. The spinal cord runs through the bony spinal vertebrae, which protects it. The sensory nerves enter the cord from the back side (dorsal roots) and the motor nerves exit it from the front side (ventral roots). The main function of the cord is transmitting of the messages between the brain and the various parts of the body. It also controls some simple stimulus-response sequences called spinal reflexes without much involvement of the brain. Reflexes are involuntary, automatic responses to incoming stimuli. For example, the closing of your eyelid instantaneously when some foreign substance is about to strike your eye is a reflex action.

Brain

The **brain** is the most complex structure in the known universe and remains a challenge to all those who are engaged in studying it. It is the soft, spongy, wrinkled, pinkish-grey substance mostly consisting of protein, fat and fluid located in the hard bony protective case called the skull. It only weighs about 3 pounds (2 percent of the body weight), but consumes about 25 percent of oxygen, and 70 percent of glucose in the body. The brain, which is also called encephalon, works without rest all through your life and when it takes rest, it is death! In spite of innumerable impediments, the neuroscientists have made a lot of headway in unraveling this biological marvel, the brain, using techniques developed due to the great advances in science and technology. The complex procedures such as electroencephalography (EEG), computerized axial tomography (CAT), magnetic resonance imaging (MRI) and positron-emission tomography (PET) have made it possible to watch live the structure and functions of brain.

During embryonic development, the brain evolves into three separate portions called the hindbrain, the midbrain and the forebrain. The hindbrain differentiates into two parts called metencephalon and myelencephalon. The metencephalon includes the cerebellum and the pons, the myelencephalon includes medulla oblongata. The midbrain develops into tectum and tegmentum. Tectum consists of inferior and superior colliculi; the tegmentum contains the red nucleus, the substantia nigra and the nuclei and roots of oculomotor nerve (the third cranial nerve). The forebrain is subdivides into the telencephalon and diencephalon. The telencephalon (also called the end brain) develops into the cerebral cortex, the basal ganglia and the limbic system. The diencephalon becomes the thalamus and the hypothalamus. We shall study these three parts of the brain in some detail.

Hindbrain

From the evolutionary perspective, **hindbrain** is the most primitive part of the brain. It includes the medulla, pons and cerebellum (Fig. 3.4). As the spinal cord enters the skull, it enlarges into a structure called the **brainstem** which is the life-support system. The brainstem is the part of the brain left when both cerebrum and cerebellum are excluded. From the evolutionary point of view, the brainstem is the oldest and the most primitive part of the brain. The brainstem consists of structures

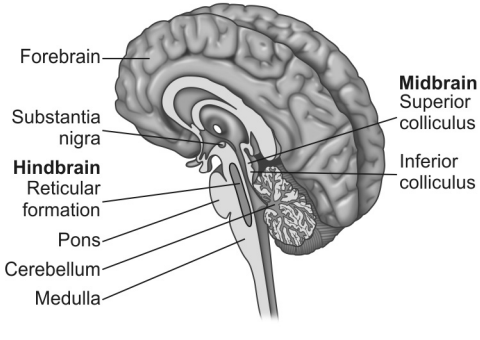

FIGURE 3.4: Hindbrain and midbrain

that are involved in the regulation of all vital functions of the body. The brainstem includes the **medulla oblongata** and the **pons**. The medulla (oblongata) is the first structure above the spinal cord; it controls the vital functions such as heart rate, respiration, appetite, body temperature and fluid balance. The medulla also contains all the ascending (sensory) and descending (motor) nerves that connect the body with higher brain structures. Damage to the medulla usually results in death. Appropriately, it has been called the 'vital knot'.

On the ventral side of the brainstem, just above the medulla, there is a rounded prominence called the pons. In Latin, 'pons' means 'bridge' and it carries nerve impulses between higher and lower levels of the nervous system. The **pons** connects the two halves of the cerebellum. It also transmits motor information, coordinating muscles and integrating movements between the right and left halves of the body. It has a cluster of neurons that help regulate sleep. Like the medulla, pons control several vital functions and damage to the pons can cause death.

Attached to the rear of the brainstem, slightly above the medulla and behind the pons, is the so-called "little brain" the cerebellum. It is called little brain because it just looks like a miniature brain. The **cerebellum** is involved in the regulation of motor coordination. Complex activities, such as walking, talking, writing, cycling and driving automobiles, seem to be programmed into the cerebellum and occur automatically without our consciously planning each step. Any damage to cerebellum results in uncoordinated movements. For instance, when one takes too much of alcohol, there is a depression in cerebellar activity leading to a wobbling movement that is characteristic of drunkenness. In addition to muscular movement coordination, it is also believed that the cerebellum plays a role in learning and remembering.

Midbrain

The **midbrain** is located just above the hindbrain (refer Fig. 3.4). It consists of a group of sensory and motor neurons. The sensory portion of the midbrain contains important relay centers for visual and auditory systems. The motor neurons in the midbrain control eye movements.

A very important part of the midbrain, extending from the medulla through the pons, is the **reticular formation**. It extends from the hindbrain up into the lower parts of the forebrain. Since, it appears like a net (reticulum) under microscope, it is called reticular formation. Reticular formation consists of groups of nerve cells that activate other parts of the brain to produce general bodily arousal. It plays an important role in regulating consciousness, attention and sleep. If somebody taps your door when you are asleep, it is this part that arouses you. It acts like a watchman; alerts higher brain centers that messages are coming; it may either block messages or allow them to go forward. Reticular formation has two parts: an ascending part and a descending part. The ascending part sends messages to higher regions of the brain to alert them and the descending part may either admit or block out sensory input. It can be said that the reticular system acts like a "consciousness switch," which turns on or off signals to various parts of the brain involved in consciousness maintenance. In this way, it plays an important role in the attention process. When a number of messages enter the nervous system at the same time, reticular formation decides which of them should be allowed to enter depending on its importance. When we are asleep, it filters out background stimuli and allows us to sleep without disturbance.

Forebrain

From the evolutionary point of view, the **forebrain** is the most advanced, highly

evolved part of the brain. Its major structure is the cerebrum. It also includes important structures such as the thalamus, hypothalamus and the limbic system (Fig. 3.5).

Thalamus: Just above the midbrain (brainstem), there are two egg-shaped structures called the **thalamus**. One part of the thalamus acts as a relay station for information coming from sensory receptors and directs them to appropriate areas of the cerebrum. The other part plays an important role in the regulation of sleep. This region of the thalamus is considered as a part of the limbic system. When there is damage to an individual's thalamus, he/she may experience perceptual confusion. It is reported that among schizophrenics there are specific damages in their thalamus and as a consequence they experience garbled sensory experience causing confusion and hallucinations.

Hypothalamus: Just below the thalamus, there is a small (size of a fingertip) structure, consisting of tiny groups of neurons, called **hypothalamus** (the word means under the thalamus). In spite of its size, the hypothalamus plays a cardinal role in the regulation of many aspects of emotion and motivation, including sexual behavior, eating, drinking, sleeping, aggression and temperature regulation. It maintains a steady internal environment for the body (homeostasis). Damage to specific areas of hypothalamus may disrupt some or all of the above functions. The hypothalamus also plays an important role in the functioning of the endocrine system. Because of its connection with the pituitary gland, the hypothalamus controls many hormonal secretions that are involved in sexual behavior, metabolism and reactions to stress. Some researchers of the brain suggest that certain areas of the hypothalamus regulate the experience of pleasure and displeasure.

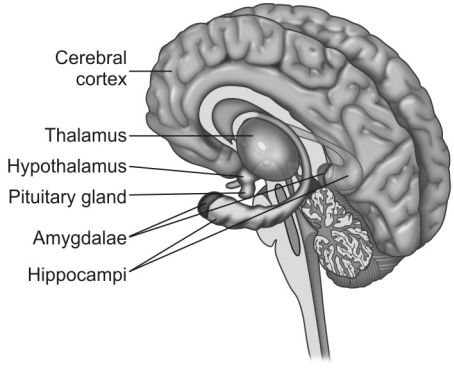

FIGURE 3.5: Forebrain

Limbic system: Lying deep within the cerebral hemispheres, there is a set of structures collectively called the **limbic system**. The limbic system is involved in coordinating behaviors necessary to satisfy motivational and emotional urges that arise in the hypothalamus. Two important structures of the limbic system are hippocampus (the term is derived from Greek hippokampos, which means sea horse) and amygdala (in Greek, almond). The **hippocampus** is involved in forming and retrieving memories. Damage to hippocampus causes memory disturbances especially for recent events. The **amygdala** is believed to organize motivational and emotional behavior patterns, especially those relating to fear and aggression. Hippocampus and amygdala play crucial roles as bridges between CNS and PNS. Stimulation of the amygdala is necessary for hippocampus's creation of emotional memories. It has been demonstrated that stimulation of certain areas of the amygdala produces aggression or fear in animals depending on the area stimulated. Just like the hypothalamus, the limbic system also contains areas that are implicated in the reward and punishment functions of motive.

Cerebrum: The outermost layer of the brain is called the cerebrum or cerebral cortex. It is the most prominent structure of the brain consisting of two hemispheres separated by

the longitudinal fissure below which are the three **cerebral commissures** connecting the two halves. The inner core of the cerebrum is composed of white matter made up of myelinated fibers and the grey basal ganglia. The outer covering, the **cerebral cortex** (Fig. 3.6), is made up entirely of grey matter. From the evolutionary point of view, the cerebral cortex is the most advanced and the recent part of the brain. For this reason, often it is called the new brain. Cerebral cortex is not necessary for survival like the brainstem. Some lower animals like fish and amphibians have no cerebral cortex. The cortical tissues are found only among mammals. In humans, the cerebrum constitutes 80 percent of brain tissue. In fact, it is this portion of the brain that distinguishes humans from other organisms and enables them to think, plan and evaluate their actions.

The cerebrum consists of wrinkled, folded, rippled, convoluted and unmyelinated mass of grey cells. About 75 percent of the total cortical surface lies within canyon-like folds called **fissures**. Three of these fissures are important landmarks based on which the cortex is divided into lobes. The large **longitudinal fissure** divides the cerebrum lengthwise into left and right hemispheres. Within each hemisphere, a **central fissure** divides the cerebrum into the front and rear halves and the third one, the **lateral fissure**, runs front to rear along the side of the brain. The central fissure marks off the **frontal lobe**. The part of the cerebrum below the lateral fissure is called the **temporal lobe**. The area behind the central fissure is called the **parietal lobe** and at the back of the brain is the **occipital lobe**.

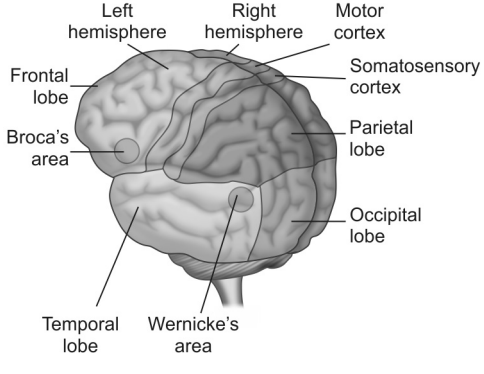

FIGURE 3.6: Cerebral cortex

Each lobe controls a specific function. In fact, one way of dividing the cerebrum is by considering the functions associated with a given area. Three major areas have been discovered. Roughly, we may think of some cortical areas to be largely sensory in function receiving messages from the sense organs. Others, called motor areas, are largely concerned with bodily movements. The third large area, called the association cortex, is engaged in higher mental functions such as learning, remembering, imagining and thinking. In addition, there are certain areas that are specifically controlling speech comprehension and speech production.

Although we talk about these areas as though they are separate and independent, we must remember that mostly behavior is influenced simultaneously by several structures and areas within the brain. Even within a given area, additional subdivisions exist. Further, when certain area is impaired, the unimpaired area may take over the functions that were earlier handled by the impaired area. Brain is extraordinarily adaptable. Having this in mind, let us learn about the functions of the cortical areas mentioned above.

Cortical Areas and Their Functions

Motor Area

The **motor area** (cortex) lies at the rear of the frontal lobe just adjacent to the central fissure. It controls all the voluntary movements (more than 600) of the body, the movements of the muscles, joints and tendons. Researchers have identified the amount and relative location of the cortical tissue associated with movement in the specific parts of the human body (Fig. 3.7).

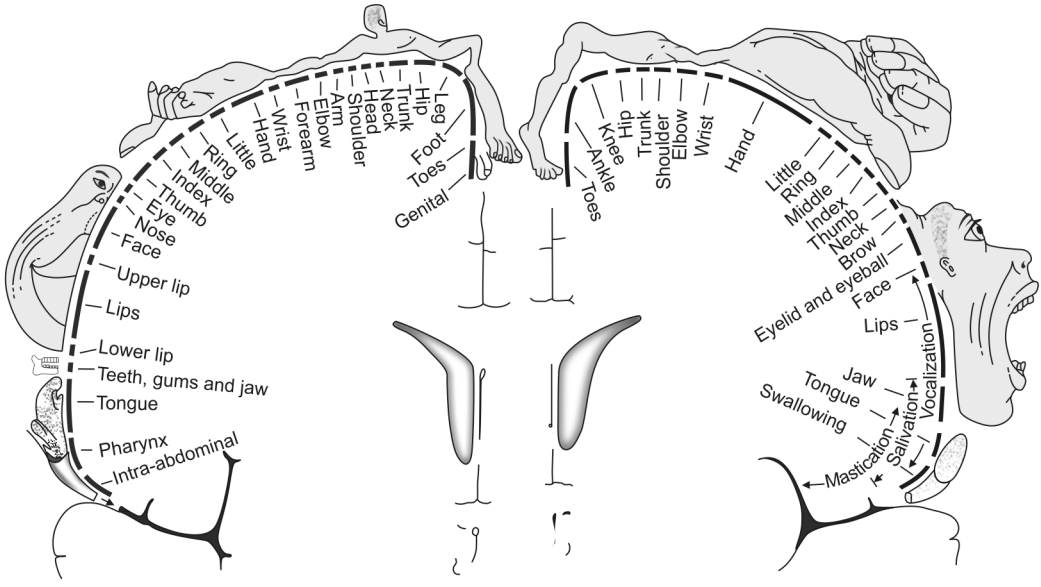

FIGURE 3.7: Motor and somatosensory cortexes

In the Figure 3.7, the specific body areas are represented in approximately upside down form. For example, movement of the toes is regulated by the part near the top of the head and movements of the mouth and tongue by the part near the bottom of the area toward the side of the brain. The amount of cortex devoted to each part of the body depends on the complexity of the movement carried out by that part. For example, the amount of cortical tissue devoted to the fingers that carry out precise and delicate movements is far greater than that devoted to the torso, whose movements are gross and imprecise, even though the torso is much larger than the fingers. When a particular point in the motor area is electrically stimulated, movements occur in the muscles governed by that part of the cortex. Because the nerve tracts from the motor area cross over at the level of the medulla, each hemisphere controls the movement of the opposite side of the body. Hence, damage to the right motor cortex produces paralysis in the left side of the body and vice versa.

Sensory Areas

There are specific areas of the cortex that receive input from different sense receptors. With the exception of taste and smell, at least one specific area has been identified for each of the senses. Sensory areas of cortex include three regions, one for the body sensations, and another for vision, and a third for audition.

Somatosensory area: The area that corresponds primarily to body sensations, including touch and pressure is called somatosensory area. This area is located at the front portion of the parietal lobe, just behind the motor area, separated from it by the central fissure. Electrical stimulation of this area gives rise to sensory experiences as though a part of the body was touched or moved. Temperature, pressure, touch, pain and experience of body balance and movements are represented in this area. As with the motor area, the amount of brain tissue allotted to a particular location on the body determines the degree of sensitivity of

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- Written in a simple readable language without sacrificing accuracy and relevance of the subject matter
- Provides you an elementary knowledge of what psychologists have learned in their quest to understand and explain the behavior of people around us
- Provides you with a broad and simple introduction to selected areas within the field of modern psychology; in addition to focusing on the core concepts of the subject, it tries to show the relevance of psychology in your everyday life
- Covers the basic theories and research findings as well as applications of psychology in 16 chapters, which deal with basic concepts of both traditional and applied areas; they give you a brief introduction to main topics such as biological foundations of behavior, learning, memory, forgetting, intelligence, thinking, motivation, emotion and personality
- It also gives a brief introduction to some of the major areas such as developmental psychology, social psychology, health psychology, abnormal psychology and treatment of mental disorders
- In short, the text gives you the essence of psychology as an initial introduction to the field
- To facilitate easy reading and comprehension every chapter starts with a preview highlighting what to expect in the chapter; after discussing the theme of the chapter, a brief summary is given at the end
- Most of the highlighted terms are also explained in the glossary at the end of the book; the readers may look into it as often as necessary
- In addition, the book contains illustrations, pictures, tables, special boxes and photographs of some of the pioneers in the field who made psychology what it is today.



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He was also the Founder Director of the University Counseling Center at Sri Venkateswara University. He has lectured in one capacity or the other in almost all universities South of the Vindhyas. He has lectured to participants in the UGC Academic Staff Colleges all over the Southern universities. He has presented papers at a number of national and international conferences, and published several research papers and books. His Dictionary of Psychology has become very popular and is being used all over India. He has written five books on psychological topics in Kannada. He was on the editorial boards of several Indian Journals of Psychology. He is a Fellow of the Indian Association of Clinical Psychologists and a life member of the Indian Psychological Association and Indian Science Congress Association, and several other academic and professional organizations.

He is a devoted teacher and is deeply committed to his profession. The issue of how best to teach psychology is one to which he has given much thought. Communicating psychological facts and theories in a language that could be easily understood by students and common people has been his major concern and he has attempted to the same in this book.

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