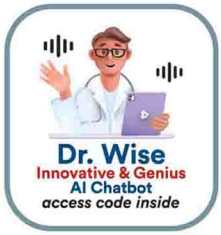
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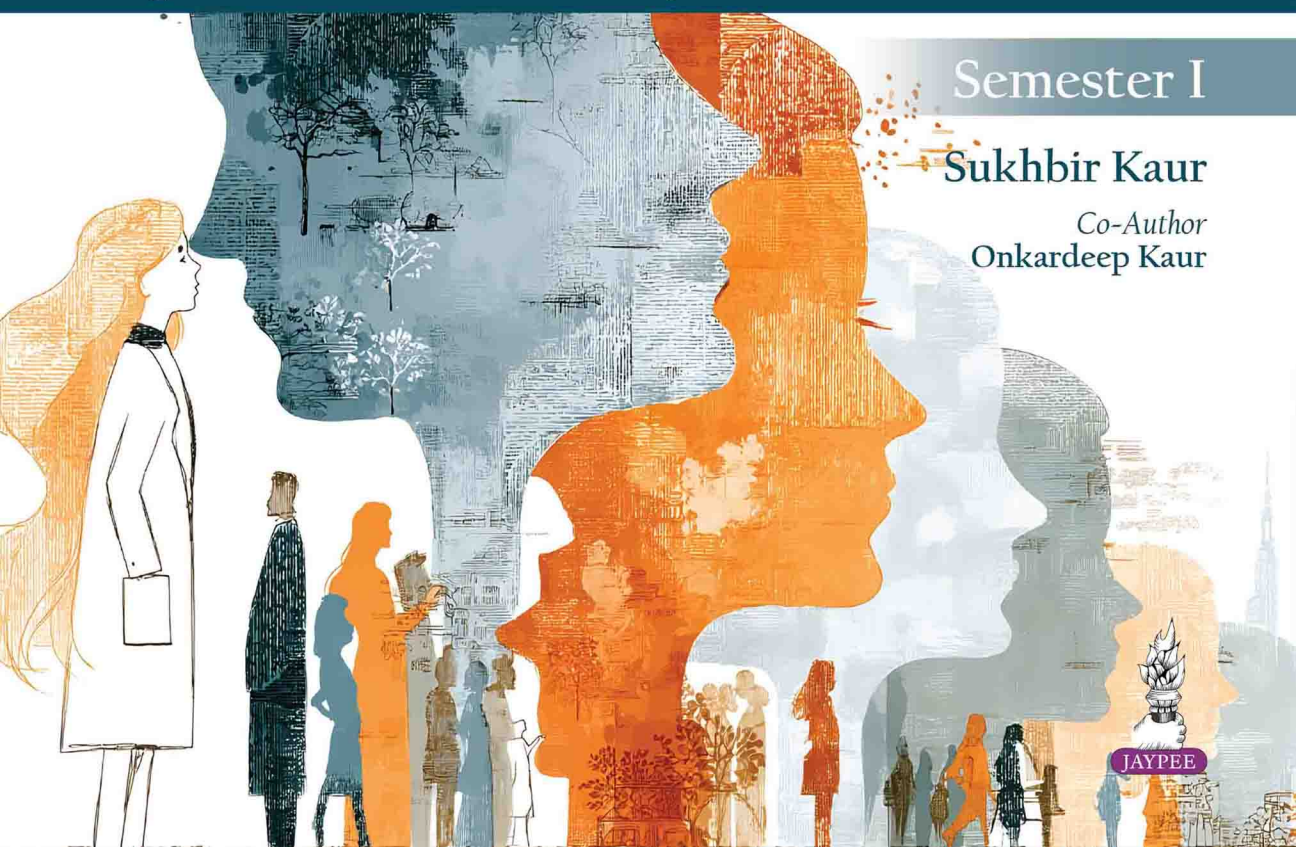
Textbook of Applied Psychology

As per the Revised INC Syllabus

Semester I

Sukhbir Kaur

Co-Author
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UNIT II

Biological Basis of Behavior

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- Introduction and Behavior
- Mind Body Relationship
- Brain and Behavior
- Muscular and Glandular Control of Behavior
- Genetics and Behavior
- Inheritance of Behavior
- Psychology and Sensation
- Normal and Abnormal Sensory Process

INTRODUCTION

Understanding human behavior is incomplete without an analysis of the biological process. It includes both mental and bodily reactions which may be external or internal. The behavior of an individual is based on certain physiological and psychological processes, the way in which one acts or conducts oneself, especially toward others. Various parts of the body form the basis of all behaviors such as how people talk, how they walk, read, or do all the actions. Psychologists nowadays, are widely focusing on the role of bodily process on behavior and also the effect of psychological process on the body. The behavior is closely related to both physical and mental activity. Behavior means all the covert and overt activities of human beings that can be observed.

BEHAVIOR AND ITS COMPONENTS

Definition of Behvaior

Behavior can be broadly defined as any reaction, response, or action of any individual. It can also be defined as the way in which an animal or a person behaves in response to a particular situation or stimulus, person, or environment **(Fig. 2.1)**.

There are three components which determine behavior which are discussed below:

Cognitive (thinking): It is related to the intellectual process—how the individual thinks as he gets the information through various sensory processes, how it is interpreted by our brain to produce a particular kind of response in the form of behavior. For example, a hardworking student hears the news of failing in the examination and starts thinking of the reason for the failure.

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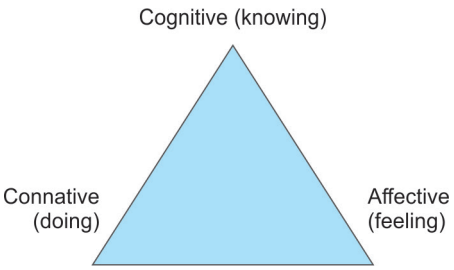


Fig. 2.1: Constituents of behavior.

Affective (mood): It is the emotional tone associated with the information interpreted and will be shown in the form of actions or behavior of an individual. For example, on hearing news about failure in examination, the student becomes sad.

Conative (psychomotor activity): These are the actions or reactions shown after interpreting the information and can be seen in the form of a person's behavior toward a particular situation. For example, a student after hearing the news of failure felt sad and started crying and wanted to be alone for some time.

A process is called cognitive, affective, or conative depending on the element that predominates in it.

Biological explanations of behavior fall into four categories:

1. Physiological—relates a behavior to the activity of the brain and other organs.
2. Ontogenetic—describes the development of a structure or behavior.
3. Evolutionary—reconstructs evolutionary history of a behavior or structure.
4. Functional—describes *why* a structure or behavior evolved as it did.

Therefore, human behavior is a result of both the psychological and physiological processes taking place in the body which depend on each other. Early philosophers, therefore, focused more attention on understanding this relationship which they called as mind–body relationship.

MIND–BODY RELATIONSHIP

Modern psychologists view the relationship between mind and body as interrelated. Mind–body relationship dated back to several years ago and is being studied since ancient times.

History of Mind–Body Relationship

From the earliest times, the mind and body were generally thought of as one unit and was widely explored by the pioneers such as Plato, Aristotle, Buddha, and ancient Greek and Eastern thinkers. They have solved the question in many ways—how the mind or soul is related to the body.

Disease was understood as resulting from some type of divine (supernatural) cause or possession, punishment from God(s), etc. Greeks and Arabs were among the first to suggest natural causes of illness, e.g., Hippocrates' humoral theory. Galen was the first to attribute disease to a specific pathogen. This emphasis on natural causation was lost with the fall of the Roman Empire and the subsequent rise in power of the Church. This view became less tenable; however, with the contributions of Sigmund Freud, work on hysterical patients had obvious, profound physical symptoms, with no apparent organic cause.

Later in the 1920s, psychosomatic medicine concept came up which led to an emphasis on the autonomic nervous system. In the Middle Ages, the Church was the guardian of medical knowledge—the functions of the priest and physician merged. This began to change during the Renaissance, however, especially due to the influence of René Descartes who theorized Cartesian dualism. Descartes proposed that mind and body be considered as two separate entities. A different explanation can be given about mind–body relationship and mind refers to all the mental processes of the brain.

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Concept of Mind and Body (Fig. 2.2)

Mind is used synonymously with terms such as soul, brain, or consciousness. Mind is a common term used casually and is considered an abstract component.

It is the element of a person that enables him/her to be aware of the world and his/her experiences, to think, and to feel; the faculty of consciousness and thought; the element or complex of elements in an individual that feels, perceives, thinks, wills, and especially reasons.

Mind is the sum total of various mental processes such as observing, knowing, thinking, reasoning, feeling, wishing, imagining, remembering, and judging.

Mind the 'psyche' by which one is aware of surroundings and able to experience emotions, reasons and make decisions.

—Miller and Keane

The mind arises out of central nervous system (CNS) and it develops along with other body parts. Therefore, it has two components, i.e., organic or physiological component which is made of tissues and cells and the psychological components, i.e., emotions and perception.

The brain is a body component. Body works mechanistically and, thus, can be understood scientifically.

It is defined as the physical structure, including the bones, flesh, and organs of a person or an animal; the entire material or physical structure of an organism, especially of human or animal.

Biological psychology is the study of the physiological, evolutionary, and developmental mechanisms of behavior and experience.

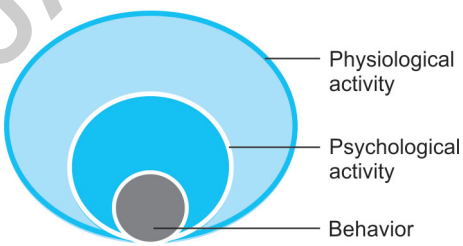


Fig. 2.2: Mind–body interaction.

For the next 200 years, physicians looked exclusively at organic and cellular changes and pathology to understand and treat illness, until physical evidence became the only basis for diagnosis and treatment of disease.

Mind or mental process is always connected to a body and more intimately connected with the brain or cortical processes. According to earlier psychologists, mind was regarded as a conscious part or the processes which one is aware of at times. It was the sum total of conscious mental processes only. But later on, it was hypothesized by Sigmund Freud in his work "Iceberg of Mind" that it consists of three parts—conscious, preconscious or subconscious and unconscious part (**Fig. 2.3**).

At the conscious level, we are aware of our mental activities, such as what we are going to learn for tomorrow examination, at the unconscious level, we are not aware of mental processes; example things come randomly or slip of tongue, etc., and the subconscious level acts like a filter that selects which processes to bring into awareness, such as childhood memories, birth dates, phone numbers, etc.

Theories of Mind–Body Relationship (Table 2.1)

Broadly, theories of mind–body relationship are categorized into two:

1. **Monistic theories:** This theory emphasizes that mind and body are not separate substances. Aristotle, Hobbs, Hegel, and various behaviorists stated that mind is not separate. It is one of the bodily functions and involves mental processes just like other physiological processes. It is generally thought to be a substance other than physical substance and body is just a mental representation.
2. **Dualistic theories:** Various theorists such as Descartes, Locke, and James who belong to the school of thought known as interactionism theorized that mind is a different substance from other physical substances. Sometimes, the mind affects

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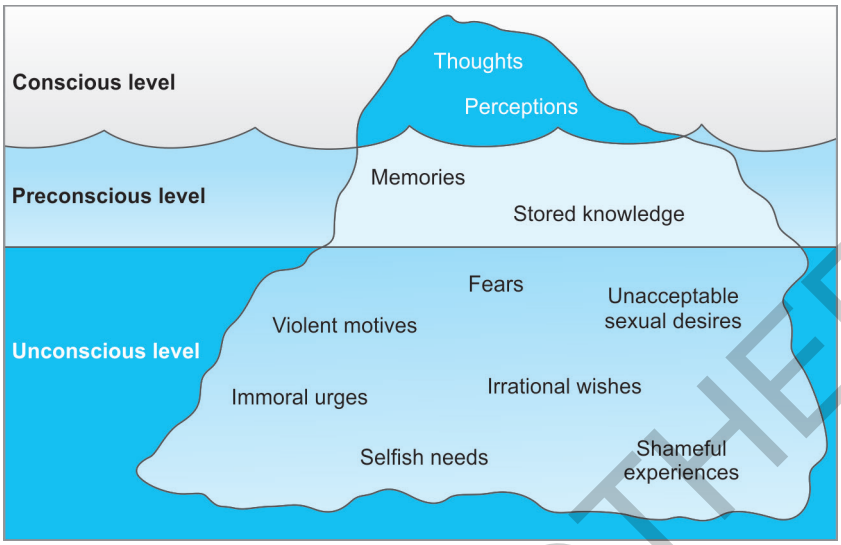


Fig. 2.3: Freud's iceberg of mind.

TABLE 2.1: Theories of mind–body relationship.

Name	*Proponents*	*Concepts*
Monism	Aristotle, Hobbs, Hegel, and various behaviorists	Mind is a bodily function and generally thought to be of substance other than a physical substance
Dualism (Cartesian)	René Descartes	Mind is not a physical substance. Mind affects the body and body affects the mind. They are separate and they affect each other
Idealism	Plato	Emphasizes on asserting that all entities are composed of mind or spirit
Materialism	Greeks, Democritus, and Aristotle	Only physical matter is real. Mind is an organic process, characteristics of highly evolved organisms
Phenomenalism	Berkely, Hume, and Condillac	Matter does not exist and thus knowledge of the external world is always through sensory experience of phenomena

the body and sometimes body affects the mind. We are physical as we extended in space and mental beings because we can think. Mind is not a physical thing; it exists separately from the body. The arguments between psychologists and various thinkers are still controversial whether the mind governs body or body governs mind.

Psychosomatic medicine and mind–body interactions also emphasize the intimate relationship that exists between the body and mind. Both neural and chemical processes are important to our understanding of the relationship between the brain and behavior.

Effect of Body on Mind

Mind and body interact with each other. Our nervous system and various glands are responsible to a great extent for our ways of thinking, feeling, and wishing. Various bodily functions affect mental functioning which we can analyze through various identifiable changes in the body.

Our nervous system and glands are responsible, to a great extent, for our ways of thinking, feeling, and wishing. Below are few examples depicting the effect of body on mind:

- Increase in blood pressure or heart rate increases the mental activity or mental alertness.

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- When we feel tired or fatigued we are not able to concentrate on particular work.
- Any bodily discomfort or illness causes irritability and feelings of sadness which can lead to certain mental illnesses such as depression.
- Certain bodily glands such as thyroid overactivity lead to mental restlessness and overexcitability whereas decreased inactivity of thyroid gland leads to fatigue and lethargy.
- Drugs that effect our mood or behavior are used to treat various psychological symptoms like relieving from anxiety, etc., study of drugs' effects is widely researched to study about mind–body interaction.

Certain drugs such as stimulants (nicotine, cocaine) increase central nervous system activity by increasing dopamine activity. Anti-anxiety drugs such as benzodiazepines, diazepam, and lorazepam cause depression of central nervous system by reducing serotonin and norepinephrine secretions and increasing gamma-aminobutyric acid (GABA) activity.

Effect of Mind on Body

Our mind also affects our bodily function or physical states. Mind activates all the physical and motor activity. Our behavior can affect our health. Psychosomatic medicine is the branch that deals with the effect of mind on body. It can be traced back 2000 years ago as there were traditional healers and Ayurveda. Psychosomatic medicine focuses on the study and treatment of diseases believed to be caused by emotional conflicts, e.g., asthma, peptic ulcers, and hypertension. Certain examples are given below showing the effect of mind on body.

- Unpleasant emotions like fear, anger, and worry cause headaches, insomnia, indigestion, etc.
- Emotional conflicts are responsible for various neurotic illnesses such as hysteria, neurasthenic and gastrointestinal troubles such as peptic ulcer, ulcerative colitis, or flatulence.
- Overthinking or negative thoughts cause physical fatigue.
- Meditation or relaxation techniques have been found to be more effective in concentration and attention and also increase in overall productivity as confirmed by functional magnetic resonance imaging (fMRI).
- Chronic stress affects both neural and hormonal pathways and also affects the immune system and makes our body prone to physical illness. This also leads us to a new area of research and study that is "**Psychoneuroimmunology**" (**Fig. 2.4**)
- Stress is the result of various factors which can be physical, psychological, or environmental and in turn there is secretion of stress hormone cortisol as a result of bodily response to stress. These stress hormones suppress the immune cells and natural antibodies making the body at risk of getting various diseases such as rheumatoid arthritis, asthma, and various types of infections.

Mind–Body Interventions

There is huge amount of data that reveal that there is relationship between mind and body. Therefore, various techniques or modalities

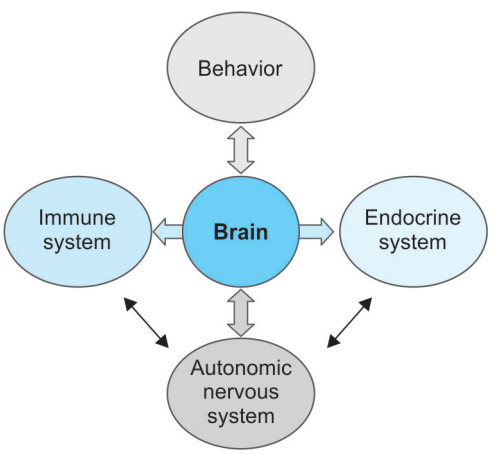


Fig. 2.4: Concept of psychoneuroimmunology.

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have been developed based on this fact and that is called mind–body interventions. Various relaxation therapies, guided imagery, mindfulness meditation and hypnosis have been found to have profound effect in treating coronary artery disease, reducing pain in cancer patients, and these can be used pre- and postsurgery to reduce anxiety symptoms. Psychological intervention has been found to be very effective in reducing distress in daily life, improving mood, quality of life, and certain physical disease-related symptoms such as chemotherapy-induced nausea, vomiting, pain, etc.

Therefore, psychosomatic medicine and mind–body interventions emphasized the intimate relationship between mind and body.

BRAIN AND BEHAVIOR

Behavior of an individual involves the interaction between mind and body. As already discussed mind–body interaction has two aspects, physical or bodily and mental or psychological. The physical aspect involves the nervous system.

Nervous System

The behavior of an individual is regulated and formulated by the nervous system. Nervous system interprets and regulates our thoughts, emotions, perception, learning, and various other mental processes. The brain is the central processor of the nervous system. The nervous system is composed of a network of nerves which transmits messages and the nervous system is classified as follows:

- Central nervous system
- Peripheral nervous system

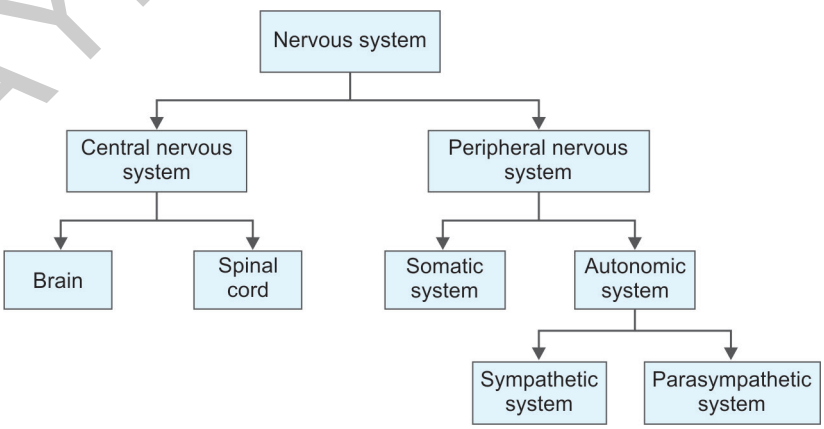
Central Nervous System (Flowchart 2.1)

The central nervous system is composed of brain and the spinal cord. Both brain and the spinal cord are composed of neurons and glial cells that control various bodily functions. The brain is the central processing unit of nervous system as it collects information via sense organs and interprets it and then sends information through various muscles and body parts.

Brain

The brain is the highest nerve center in the nervous system where a large amount of nerves meet each other. The brain is situated in the cavity of skull. Its average weight is 1.3 kg and volume is approximately 1.3 L. It is composed of 180 million nerve cells, 50 million of which are processing the information. It is divided into four lobes, i.e., frontal lobe, parietal lobe,

Flowchart 2.1: Central nervous system.



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temporal lobe, and occipital lobe. The brain is divided into three main parts—forebrain, midbrain, and hindbrain (**Figs. 2.5 and 2.6**).

1. **Forebrain:** It consists of cerebrum, thalamus, hypothalamus, and diencephalon.
2. **Midbrain:** It consists of mesencephalon, tectum, and tegmentum.
3. **Hindbrain:** It consists of pons, medulla, and cerebellum (together known as the brainstem).

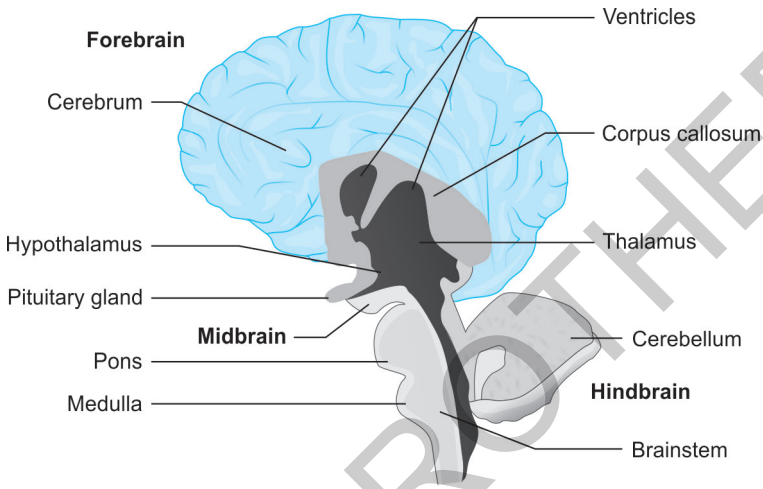


Fig. 2.5: Parts of brain.

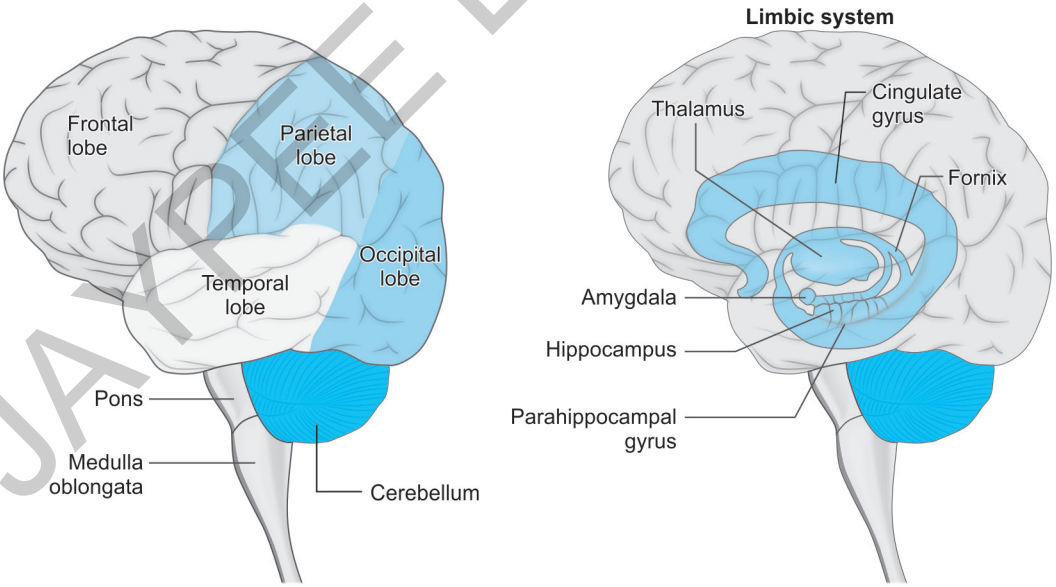


Fig. 2.6: Anatomy of the brain.

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Cerebrum

Cerebrum is also known as telencephalon. It is a higher processing unit of brain. It is composed of two hemispheres—the left hemisphere and the right hemisphere separated by a deep groove that houses a band of 200 million neurons called the corpus callosum which attaches to the two hemispheres. The outer part of the cerebrum is called cortex and the inner part is the medulla part. The left hemisphere controls the right part of the body and is dominant in most of the population. It controls various mental functions such as speech, comprehension, rationality, and cognition. The right hemisphere controls the left part of the body and is nondominant in most population. Each hemisphere is divided into four lobes.

Frontal lobe: It controls voluntary body movement including that permits speaking, thinking, and judgment formation. The frontal lobe may also play a role in the emotional experience. The alteration includes fear, aggressiveness, depression, rage, euphoria, irritability, and apathy and is probably related to a frontal lobe in connection with the limbic system.

Parietal lobe: It controls perception and interpretation of most sensory information including touch, pain, taste, body position; language interpretation is associated with the left hemisphere of the parietal lobe.

Temporal lobe: The upper anterior temporal lobe is concerned with the auditory functions while the lower part is dedicated to short-term memory. It also plays a role in the expression of emotions through an interconnection with the limbic system.

Occipital lobe: It is located in the cerebral hemisphere in the back of the head and it helps to control vision. It is the primary area of visual perception and language interpretation. Visual perception gives individuals the ability to judge special relationships such as distance and to see in three dimensions. Language interpretation is influenced by the occipital lobes through an association with the visual experience.

Thalamus: It is a small structure located just above the brainstem between the cerebral cortex and the midbrain. It mainly receives sensory impulses. It also regulates the actions of many of the higher centers of sensation and movement.

Hypothalamus: It is located in the lower central area of the brain which regulates body functions such as temperature, hunger, and thirst. It also holds the higher centers which control mental behavior, consciousness, moral sense, intellect, speech, language, etc. It also receives all incoming sensory nerve impulses including those of touch, pain, pressure, temperature, texture, shape, size, etc.

Diencephalon: It is situated between the telencephalon and the midbrain and it acts as a primary relay and processing center for secondary information and autonomic control and it is functionally a diverse area.

Midbrain

Mesencephalon: It is located above the pons and adjoined rostrally to the thalamus. Its functions include particular movement of the eyes, important functions in motor movement, and also in auditory and visual processing. It is the connection point between the forebrain and the hindbrain.

Tectum and tegmentum: These are the dorsal and the ventral parts of the midbrain respectively. It is a network of multisynaptic neurons that are involved in many subconscious homeostatic and reflexive pathways.

Hindbrain

Pons varolii: It forms the middle portion of the brainstem and contains ascending and descending pathways. It acts as a relay center between the cerebellum and cerebral hemispheres. It helps in regulating breathing, sleeping and the rapid eye movement (REM) sleep cycle.

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Medulla oblongata: It is the lower portion of the brainstem which connects to the spinal cord. It provides a pathway for all ascending and descending pathways. It contains vital centers of control which regulate heart rate, blood pressure, respiration, and reflex centers for swallowing, sneezing, coughing, and vomiting.

Cerebellum: It is the largest part of hindbrain. It is separated from brainstem by the fourth ventricle but has connection to brainstem through bundles of fiber tracts. It is concerned with involuntary movements such as muscular tone and coordination and the maintenance of posture and equilibrium.

The Limbic System

This is not a specific area but the most important area which influences human behavior. It is a circuit covering many areas and their interconnections. It includes the hypothalamus, the amygdala, portions of the cerebral cortex such as the hippocampus, and a number of other nuclei and pathways (**Fig. 2.7**). The amygdala is also called "emotional brain" and is associated with feelings of fear and anxiety, anger and aggression, love, joy, happiness, sexuality, and social behavior. The limbic system has been implicated in a number of functions including motivation and emotion. Stimulation of certain parts of the limbic system may produce eating, drinking, or emotions. Damage to certain areas may produce automatic obedience, submissiveness and other emotional changes. Stimulation of certain areas of the limbic system and some areas connected with it can produce an extremely pleasurable sensation. Recent theories postulated that certain types of abnormal behavior, particularly depressive states, may result from the functional abnormalities in these pleasure centers.

Neurons

The human brain is estimated to contain at least 150 billion nerve cells called neurons. Neurons are linked to one another in a long chain. Each neuron receives messages from other neurons and sends its own messages to others. There are different types of neurons for different functions, such as motor neuron, sensory neuron, and interneuron. Cell division, a feature common to most other kinds of cells, does not occur in most adult cells. Nerve cells lost are never replaced. Speculation is that an average of 10,000 neurons die each day.

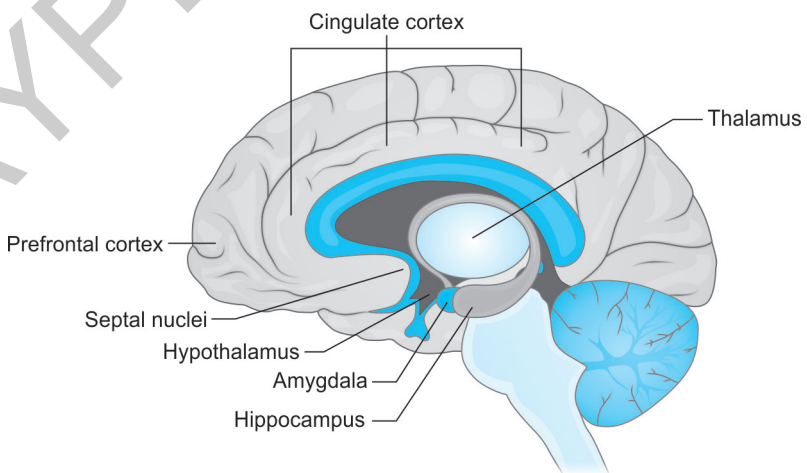


Fig. 2.7: Limbic system.

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Parts of Neuron

On the basis of its structure, it can be divided into three parts (**Fig. 2.8**):

1. **Cell body:** It is the topmost part of neuron which is filled with a fluid called cytoplasm. In the center of cell body, a dense substance is present called nucleus. It controls all the cellular activities of nerve cells such as oxygen utilization and energy production. For example, energy synthesis occurs in organelles that are known as mitochondria and protein synthesis on structure known as ribosomes. Certain short fibers or processes extend from the cell body called dendrites. These dendrites are the receiving centers which pick up the signals from other neurons.
2. **Axons:** Each neuron has a single long fiber that extends away from the cell body. Its length varies in different neurons. These axons construct nerve fibers and nerve pathways in association with the axons of other neurons. Axon is covered with a white membrane called myelin sheath. This membrane is not continuous on axon; some gaps are present in between at regular intervals called nodes of Ranvier. It helps the conductance of nerve impulse received from cell body across the axon. Myelin sheath increases the cell's rate of conduction and its action potential.
3. **Terminal:** The axon at the end is divided into various small branches called telodendrion that are connected with dendrites of other neurons. These telodendrion terminate in small swellings which are termed synaptic terminals. The terminal of one neuron is attached with the dendrite of another neuron at a gap observed microscopically called synapse.

Therefore, synapse contains a physical space that separates two cells which is referred to as synaptic space or cleft. The synaptic membrane toward the terminal of neuron is called presynaptic membrane and the other toward the dendrite of the other cell is called postsynaptic membrane.

Information transfer along the neurons is a chemical process. It involves the release of chemical neurotransmitter molecules by

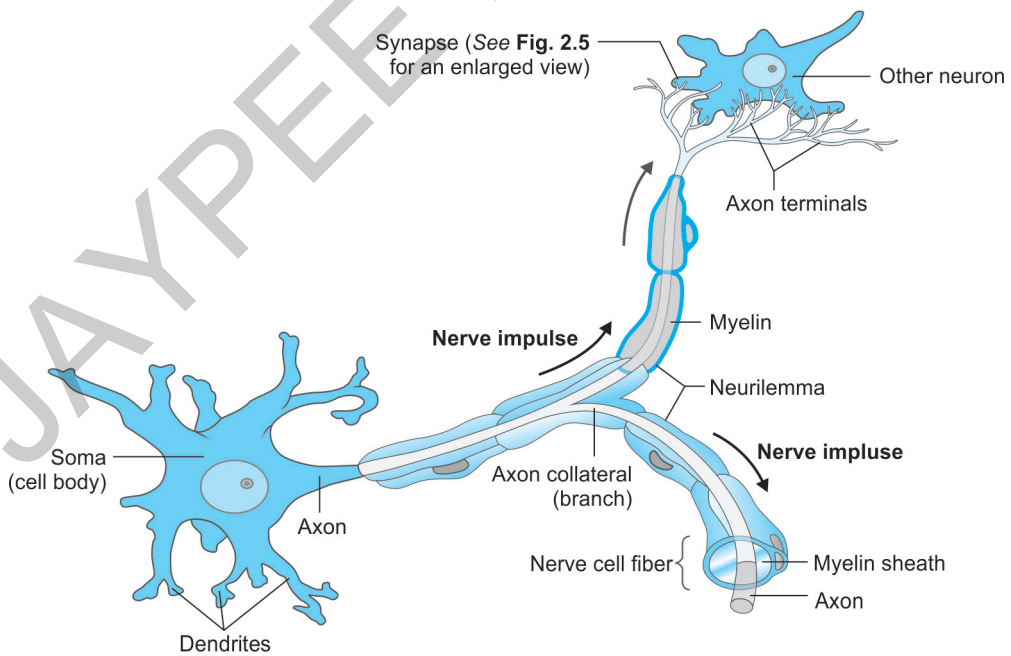


Fig. 2.8: Structure of neuron.

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the presynaptic membrane which fills the space of synapse to help in nerve impulse transmission from one neuron to another neuron. These neurotransmitter molecules are stored in synaptic vesicles. Synaptic transmission is a process that requires energy and for this transmission, energy is supplied with mitochondria.

Therefore, the connection between nerve cells is known as synapse and the chemicals that pass information from one neuron to another are known as neurotransmitters.

Nerve Impulse Conduction (Fig. 2.9)

When stimulation is received by a neural cell, the right end of the top axon is at rest. Thus, it has a negative charge inside. An action potential begins when ion channels open and sodium ions (Na^+) rush into the axon. The action potential would travel from left to right along the axon. In the lower axon, the action potential has moved to the right. After it passes, potassium ions (K^+) flow out of the axon. This quickly renews the negative charge inside the axon, so it can fire again. Sodium ions that enter the axon during an action potential are pumped out more slowly. Removing them restores the original resting potential.

Neurotransmitters

Neurotransmitters are chemicals located and released in the brain to allow an impulse from one nerve cell to pass to another nerve cell **(Table 2.2)**.

Description

There are approximately 50 neurotransmitters identified. There are billions of nerve cells located in the brain, which do not directly touch each other. Nerve cells communicate messages by secreting neurotransmitters. Neurotransmitters can excite or inhibit neurons

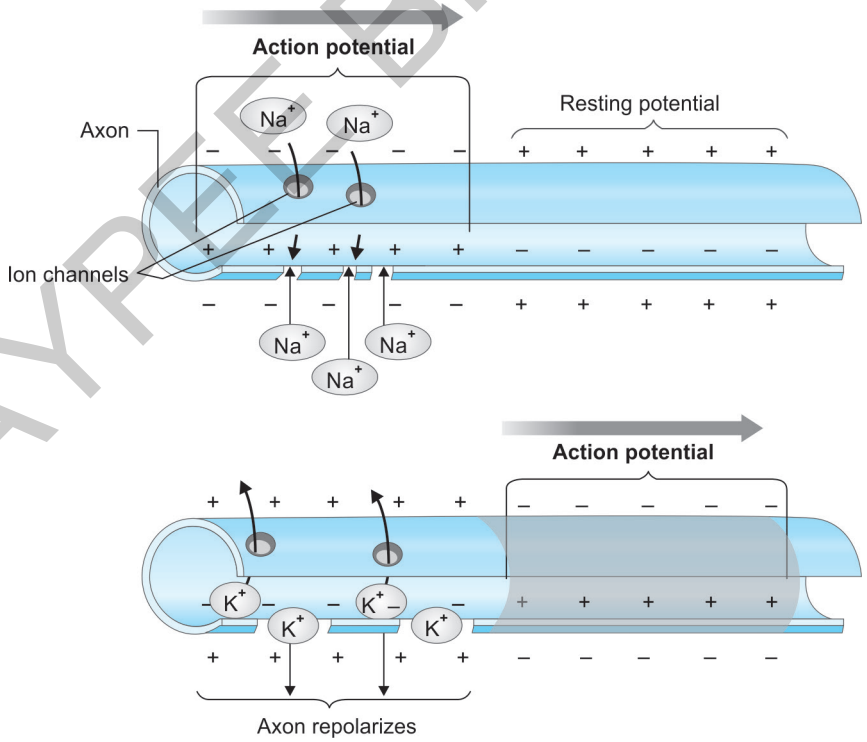


Fig. 2.9: The nerve impulse.

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TABLE 2.2: Various types of neurotransmitter and their description.

Neurotransmitter	*Type*	*Location*	*Effect*	*Variations*
Acetylcholine	Both excitatory and inhibitory	Brain and peripheral neuromuscular junctions	Contracts smooth muscles, dilates blood vessels, increases bodily secretions, and slows heart rate, thinking and comprehension motivation, arousal, attention, learning and memory	Decreased levels cause dementia, Alzheimer's disease Increased level causes cramps, paralysis, muscarinic, and nicotinic toxicity
Norepinephrine (noradrenaline)	Both excitatory and inhibitory acts as both stress hormone and neurotransmitter	Cell bodies in the pons and the pons and medulla, whole body, produced by adrenal medulla	Alert, motivated, controls appetite, energy, sexual arousal, increases heart rate, blood pressure, and glucose levels	Decreased level causes depression and sleep disorders Increased level causes schizophrenia and mania
Dopamine	Excitatory Both hormone (feel good) and neurotransmitter	Produced in the substantia nigra, ventral tegmentum, and hypothalamus of brain	Pleasure, increased heart rate, thinking and planning, executive function, motor control, arousal, and reinforcement	Increased level causes anxiety, sleep disturbance, increased energy, mania, schizophrenia Decreased level causes depression, Parkinson's disease, psychosis
Serotonin	Inhibitory	Produced by neurons originating in the raphe nuclei located in the midline of brainstem	Modulates mood, cognition, reward, learning, memory Also aids in sleeping, eating, and digestion	Increased level leads to confusion, restlessness, headaches, high blood pressure, unconsciousness Decreased levels cause. depression, anxiety, and sleep trouble
Gamma-aminobutyric acid (GABA)	Inhibitory	Synthesized in cytoplasm of presynaptic neuron	Essential in normal brain function, information processing, calmness. Relieves anxiety, stress	Increased level causes decreased brain activity, hypersomnia, daytime sleepiness Decreased level causes attention deficit hyperactivity disorder (ADHD), anxiety, panic disorders, Parkinson's disease, and insomnia

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(nerve cells). Some common neurotransmitters are acetylcholine, norepinephrine, dopamine, serotonin, and GABA. Acetylcholine and norepinephrine are excitatory neurotransmitters while dopamine, serotonin, and GABA are inhibitory. Each neurotransmitter can directly or indirectly influence neurons in a specific portion of the brain, thereby affecting behavior.

Mechanism of Impulse Transmission

A nerve impulse travels through a nerve in a long, slender cellular structure called an axon, and it eventually reaches a structure called the presynaptic membrane, which contains neurotransmitters to be released in a free space called the synaptic cleft. Freely flowing neurotransmitter molecules are picked up by receptors (structures that appear on cellular surfaces that pick up molecules that fit into them like a "lock and key") located (**Fig. 2.10**).

Neurotransmitters are chemicals that transmit messages from one nerve cell (neuron) to another. The nerve impulse travels from the first nerve cell through the axon—a single smooth body arising from the nerve cell—to the axon terminal and the synaptic knobs. Each synaptic knob communicates with a dendrite or cell body of another neuron, and the synaptic knobs contain neurovesicles that store and release neurotransmitters. The synapse lies between the synaptic knob and the next cell. For the impulse to continue traveling across the synapse to reach the next cell, the synaptic knobs release the neurotransmitter into that space, and the next nerve cell is stimulated to pick up the impulse and continue it in a structure called the postsynaptic membrane of another nearby neuron. Once the neurotransmitter is picked up by receptors in the postsynaptic membrane, the molecule is internalized in the neuron and the impulse continues. This process of nerve cell communication is extremely rapid.

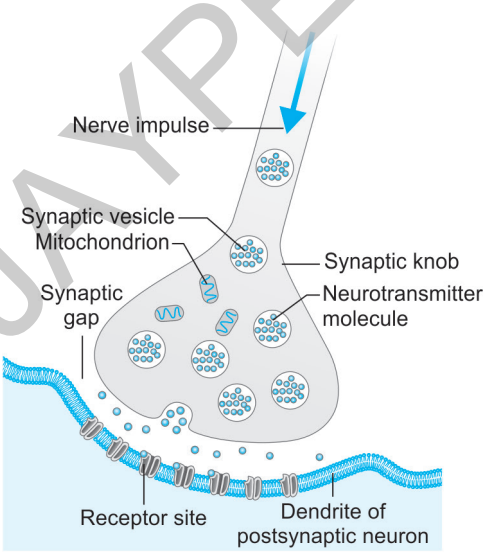


Fig. 2.10: Mechanism of impulse transmission.

Once the neurotransmitter is released from the neurotransmitter vesicles of the presynaptic membrane, the normal movement of molecules should be directed to receptor sites located on the postsynaptic membrane. However, in certain disease states, the flow of the neurotransmitter is defective. For example, in depression, the flow of the inhibitory neurotransmitter serotonin is defective, and molecules flow back to their originating site (the presynaptic membrane) instead to the receptors on the postsynaptic membrane that will transmit the impulse to a nearby neuron.

The mechanism of action and localization of neurotransmitters in the brain has provided valuable information concerning the cause of many mental disorders, including clinical depression and chemical dependency, and in researching medications that allow normal flow and movement of neurotransmitter molecules.

MUSCULAR CONTROL OF BEHAVIOR

Whether we engage our diaphragm muscle to improve oxygenation and immune function, move our limbs when we take bath, eat, dress, run or walk, or practice yoga while lying in bed, our ability to move is an essential aspect of our well-being. Thus, our muscles with bones are responsible for bodily movements, internal and external.

The term "muscle tissue" refers to all the contractile tissues of the body—skeletal cardiac, and smooth muscle. The skeletal muscle tissues and connective tissue make up individual muscle organs, such as the biceps brachia muscle. Cardiac muscle is located in the heart and is therefore considered part of the cardiovascular system. Smooth muscle of intestines is a part of the digestive system, whereas smooth muscle tissue of the urinary bladder is a part of the urinary system and so on.

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Integration of sensory input and motor output: Sensory systems provide the input that keeps the central nervous system informed of changes in the external and internal environment. Output from the central nervous system (CNS) is then conveyed to motor systems, which enables us to move about, alter glandular secretions, and change our relationship to the world around us.

As the sensory information reaches the CNS, it becomes part of a large pool of sensory input. Every bit of input the CNS receives does not elicit a response. Rather, the incoming information is integrated with other information arriving from all other operating sensory receptors. The integration process occurs not just once but at many stations along the pathways of the CNS and at both conscious and subconscious levels. It occurs within the spinal cord, brainstem, cerebellum, basal ganglia, and cerebral cortex.

As a result, a muscle contracts or a gland secretes with a motor response. Motor portions of cerebral cortex play a major role in initiating and controlling precise, discrete, and muscular movements. The basal ganglia largely integrate semi voluntary, automatic movements such as walking, swimming, and laughing. The cerebellum assists the motor cortex and basal ganglia by making body movements smooth and coordinated and by contributing significantly in maintaining normal posture and balance.

Motor Pathways in Brain

Most motor pathways extend from the cortex of the brain to the skeletal muscles.

- **Direct (pyramidal) pathways:** Voluntary motor impulses are propagated from the motor cortex to somatic efferent neurons that innervate skeletal muscles via the direct (pyramidal) pathways. The simplest pathways consist of upper and lower motor neurons.
- **Indirect (extrapyramidal) pathways:** These involve the motor cortex, basal ganglia, thalamus, cerebellum, reticular formation, and nuclei in the brainstem. The muscle control is lost when the nerve centers or fibers are injured or diseased. General muscular tension causes flaccid paralysis and spastic paralysis, respectively.

GLANDULAR CONTROLS OF BEHAVIOR (FIG. 2.11)

The endocrine glands secrete products called hormones which are chemical messengers that deliver stimulatory or inhibitory signals to the target cells.

Pituitary gland: The pituitary gland is a body 1.2 cm (1/2 inch) in diameter extending downward from the floor of the brain's third ventricle by a stalk (infundibulum). It is composed of an anterior lobe (adenohypophysis) and a posterior lobe (neurohypophysis). Many of the hormones respond due to hypothalamus. Pituitary regulation may have implication for behavioral functioning. The action of pituitary hormones is summarized in **Table 2.3**.

The adenohypophysis: The hypothalamus produces releasing hormones that pass through capillaries and veins of the hypophyseal portal system to the capillaries in the anterior pituitary, where they stimulate the secretion of specialized hormones. It includes growth hormone, thyroid-stimulating hormone, adrenocorticotropic hormone, prolactin, gonadotropic hormone, and melanocyte-stimulating hormone.

The neurohypophysis: The hypothalamus has direct control over the posterior pituitary through efferent neural pathways. Two hormones are found in the posterior pituitary, i.e., vasopressin or antidiuretic hormone (ADH) and oxytocin.

GENETICS AND BEHAVIOR

Both genes and the environment interact to shape human behavior. The fundamental issue is how much role genetics play in shaping human behaviors. Brain function involves thousands of genes. 30% of the genetic disorders are due

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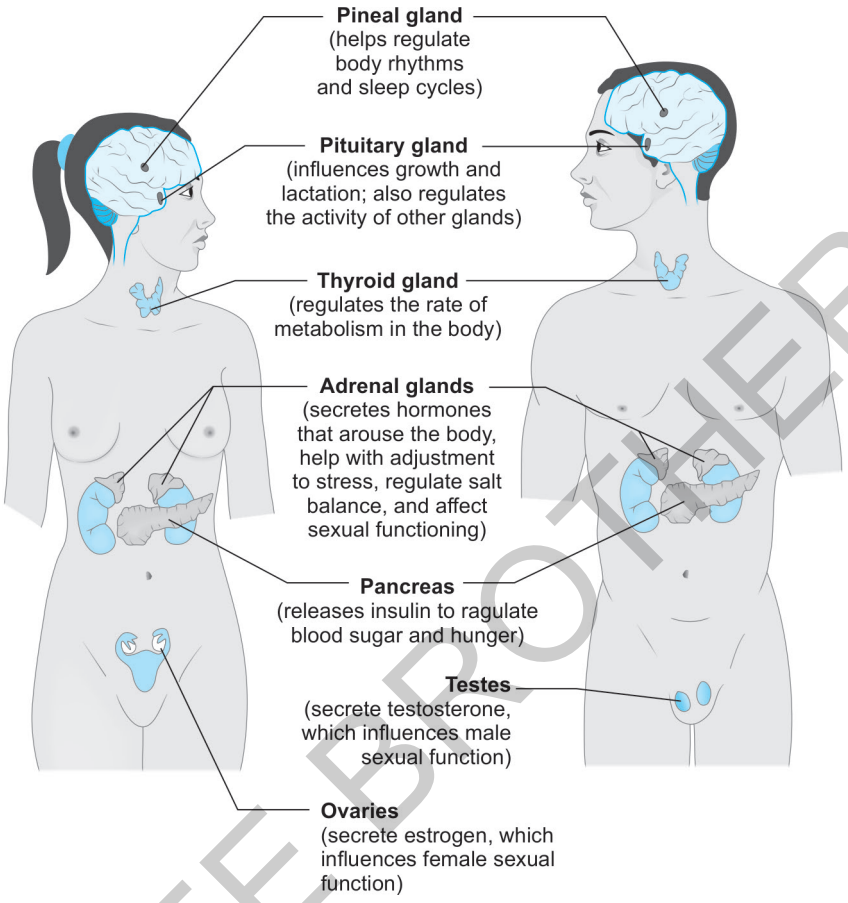


Fig. 2.11: Endocrine glands and their functions.

TABLE 2.3: Hormones and the behavior.

Hormone	*Location and stimulation*	*Target organ*	*Function*	*Possible behavioral correlation to altered secretion*
Growth hormone (GH)	Anterior pituitary; release stimulated by a thyrotropin-releasing hormone from hypothalamus	Bones and tissues	Growth in children and protein synthesis in adults	Anorexia nervosa
Thyroid-stimulating hormone (TSH)	Pituitary; release stimulated by thyrotropin–releasing hormone from hypothalamus	Thyroid gland	Stimulation of secretion of thyroid hormones needed for metabolism of food and regulation of temperature	Increased levels: Insomnia, anxiety, emotional lability, apprehension Decreased levels: Depression, fatigue, dull mental processes, apathy
Adrenocorticotropic hormone (ACTH)	Anterior pituitary; release stimulated by corticotrophin-releasing hormone from hypothalamus	Adrenal cortex	Stimulation of secretion of cortisol, which plays a role in response to stress	Increased level: Mood disorders, psychosis, increased libido Decreased levels: Depression, apathy, fatigue

Contd...

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Contd...

Hormone	Location and stimulation	Target organ	Function	Possible behavioral correlation to altered secretion
Prolactin	Anterior pituitary; release stimulated by prolactin-releasing hormone from hypothalamus	Breasts	Stimulation of milk production	Increased levels: Depression, anxiety, decreased libido, irritability
Gonadotropic hormone	Anterior pituitary; release stimulated by gonadotropin-releasing hormone from hypothalamus	Ovaries and testes	Stimulation of secretion of estrogen, progesterone, and testosterone; role in ovulation and sperm production	Decreased levels: Depression and anorexia nervosa
Melanocyte-stimulating hormone (MSH)	Anterior pituitary; release stimulated by onset of darkness	Pineal gland	Stimulation of secretion of melatonin	Increased testosterone: Increased sexual behavior and aggressiveness
Antidiuretic hormone (ADH)	Posterior pituitary; release stimulated by dehydration, pain, stress	Kidney	Conservation of body water and maintenance of blood pressure	Increased levels: Depression polydipsia, altered pain response modified sleep patterns
Oxytocin	Posterior pituitary; release stimulated by end of pregnancy, stress during sexual arousal	Uterus, breasts	Contraction of the uterus for labor; release of breast milk	May play in stress response by stimulation of ACTH

to neural tube defects during embryonic life. Various psychological disorders, weight gain, personality, and sexual orientation all involve genetics as one of the common etiological factors.

Various genes affect the behavior of a person through influence on the structure and pattern of genes and their anatomical configuration. Therefore, genetics is the study of how traits are inherited from parents to offspring's. In the 19th century monk Gregor Mendel first studied genetics scientifically and demonstrated that inheritance occurs through genes.

Genes

Genes are basic units of heredity that maintain their structural identity from one generation to another. Genes are aligned along chromosomes (strands of genes) and come in pairs. A gene is a portion of a chromosome and is composed of deoxyribonucleic acid (DNA). DNA serves as a model for the synthesis of ribonucleic acid (RNA). RNA is a single-strand chemical that can serve as a template/model for the synthesis of proteins. Living organisms are made up of proteins. Proteins determine the development of the body by:

- Forming part of the structure of the body
- Serving as enzymes and biological catalysts that regulate chemical reactions in the body
- Types of genes include:
  - Homozygous for a gene means that a person has an identical pair of genes on the two chromosomes.
  - Heterozygous for a gene means that a person has an unmatched pair of genes on the two chromosomes.
  - Genes are either dominant, recessive, or intermediate.
  - *Examples:* Eye color, ability to taste.
  - A dominant gene shows a strong effect in either the homozygous or heterozygous condition.

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- A recessive gene shows its effect only in the homozygous condition.
- Autosomal genes—all other genes except for sex-linked genes
- Sex-linked genes—genes located on the sex chromosomes

- In mammals, the sex chromosomes are designated X and Y.
  - Females have two X chromosomes (XX).
  - Males have an X and a Y chromosome (XY).

The human Y chromosome has genes for 27 proteins. The human X chromosome has genes for approximately 1,500 proteins. Thus, sex-linked genes usually refer to X-linked genes (e.g., red-green color deficiency). Sex-limited genes are genes that are present in both sexes but mainly have an effect on one sex (chest hair, breast size, etc.)

Almost all behaviors have both a genetic component and an environmental component. Researchers study monozygotic ("from one egg") and fraternal ("from two eggs") twins to infer contributions of heredity and environment. Researchers also study adopted children and their resemblance to their biological parents to infer hereditary influences **(Fig. 2.12)**. Heritability refers to how much characteristics depend on genetic differences. Estimates of hereditary influences are often difficult to infer and are prone to error. Sources of error include the following:

- The inability to distinguish between the effects of genes and prenatal influences.
- Environmental factors can inactivate genes.

Genes do not directly produce behaviors. Genes produce proteins that increase the probability that a behavior will develop under certain circumstances. Genes can also have an indirect effect. Genes can alter your environment by producing behaviors or traits that alter how people in your environment react to you.

Inheritance of Behavior

Heredity

It is the transmission of mental and physical traits from parents to offspring. Heredity contains those traits that are present at the time of birth of the child. It is seen that

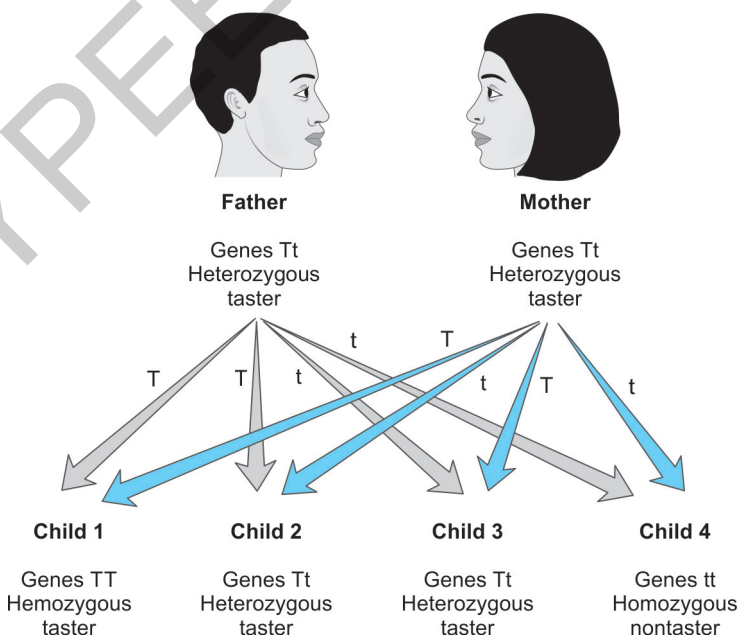


Fig. 2.12: Transmission of genes.

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through heredity, particular variations among individuals prevail and cause the species to exist. For example, traits such as intelligence and personality have evolved over time.

Genetic Diversity

It is the amount of variation seen in a particular population. The difference occurs in different communities, race, or ethnic groups that lead to individual differences among the population. Genes have a significant effect on human beings. For example, Japanese and Chinese have a significant appearance than the whites and the Indians.

For example, diabetes mellitus is inherited as a heterogeneous, multigenic trait. It carries a risk of 25–50% in identical twins, whereas siblings have a 6% risk and offspring a 5% risk.

Genetic variability: It is a measure of the tendency of individual genotypes in a population to vary from one another. Genetic variability describes the susceptibility of organisms to diseases and sensitivity to toxins or drugs. There are various sources of variability in population which are as follows:

- Genetic recombination is one source of variability—during meiosis, recombination of gene occurs causing more variability in a population.
- Immigration and translocation is movement of an individual into or out of a population which increases genetic variability in next generations.

Environment

Some of the changes in human behavior have not been explained by the genetic influence and its variability and many researchers believed the effect of environment on behavior and personality of an individual. The environment can be natural, built or artificial, social, or internal/external. It is any external force which influences us or our behavior. It refers to all those things which surround an individual.

The pollutants in the environment have been linked to chronic diseases such as cancer, asthma, and cardiovascular health problems. For example, relationship exists between global warming and malaria, ozone depletion and cancer.

Importance of Genetics in Nursing

- Nurses need to understand the language of genetics and its disorders, are able to take history over three generations, and recognize the possibility of a genetic disorder in an individual or family.
- Nurses often come in contact with children and adults with childhood genetic disorders and will have to deal with how these disorders will influence their future outcomes.
- Nurses plan, implement, administer, and evaluate the screening or testing programs and explain and interpret correctly the purpose, implications, and results of genetic tests.
- The nurse serves as an advocate for a client or family with genetic disorders.
- She monitors and evaluates clients with genetic disorder and works with families having children with genetic disorders.
- The nurse assesses the client and family's cultural and ethnic health beliefs and practices as they relate to the genetic problems.

PSYCHOLOGY OF SENSATION

Sensation is the process by which sensory organs collect information and send it to the brain. At a particular time, a large amount of information is being sensed by any one at one time such as someone talking, distant sound of a vendor, smell of perfume, temperature of room, and brightness of light. With lots of information coming through various sense organs, majority of our world never gets recognized or interpreted. We sense only that thing we are able to and what human beings can sense. Our threshold is different from each other and from other species too.

Sensation is our window to the world. It is the passive process of bringing information from outside world into the body.

Sensation is extension of the physiological aspect of the psychology and physiology of the

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sensory system provides an understanding of thresholds and psychophysiological concepts. This consists of neural pathways and the ways in which sensory information is processed within the nervous system.

Definition

Sensation is the process of informing the brain about some experience occurring outside the central nervous system. These experiences can be visual, auditory, somatosensory (touch, temperature, pain), olfactory, gustatory, kinesthetic (movement), and vestibular (orientation) senses.

Sensation occurs when special receptors in the sense organs such as the eyes, ears, nose, skin, and taste buds are activated allowing various forms of outside stimuli to become neural signals in the brain.

(This process of converting outside stimuli such as light into neural activity is called transduction.)

Attributes of Sensation

Quality: Sensation of sound differs from sensation of color in quality. Sensation through the same sense organs differs in quality.

Intensity: Strength of sensation depends on the objective strength of stimulus and the mental state of the individual.

Duration: It depends on the continuity of the stimulus or its effect.

Extensity: It means voluminousness or spread outness of sensation. As this increases, the sensation appears to be bigger. For example, the touch of a palm is more extensive than the touch of fingers.

Types of Sensation

Sensation is felt through sense organs. We receive sensation through the eyes, nose, tongue, skin, and ear—popularly known as five sense organs. Various types of sensation are as follows:

- **Visual sensation (sense of sight):** Visual sensations which are stimulated by light waves are experienced through the sense of the eye. The sense of sight is regarded as an evolution of the elementary sense of touch or feeling. The eye is comprised of complex sensory system; when light energy reaches photoreceptors (rods and cones), neural signs are sent through the visual system, providing sensations. There are two types of sensation—sensation of brightness and sensation of color (**Fig. 2.13**).

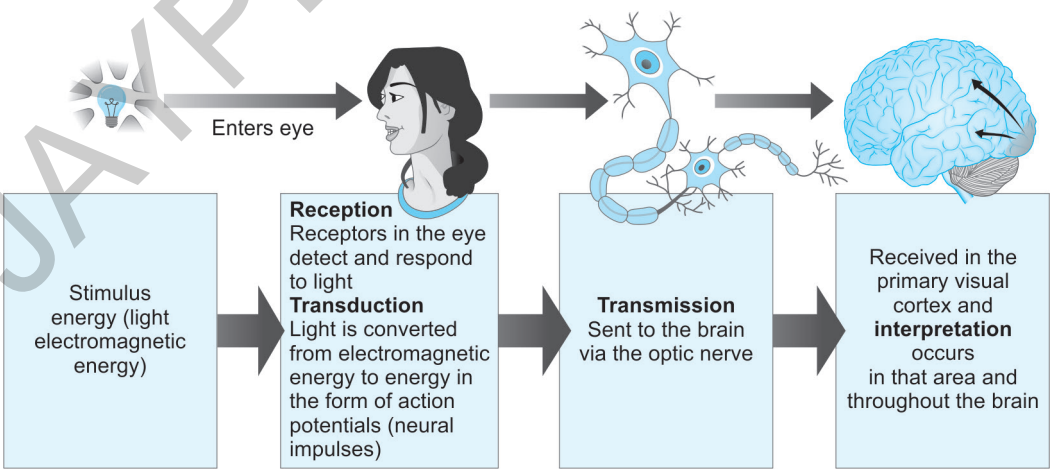


Fig. 2.13: Visual sensation.

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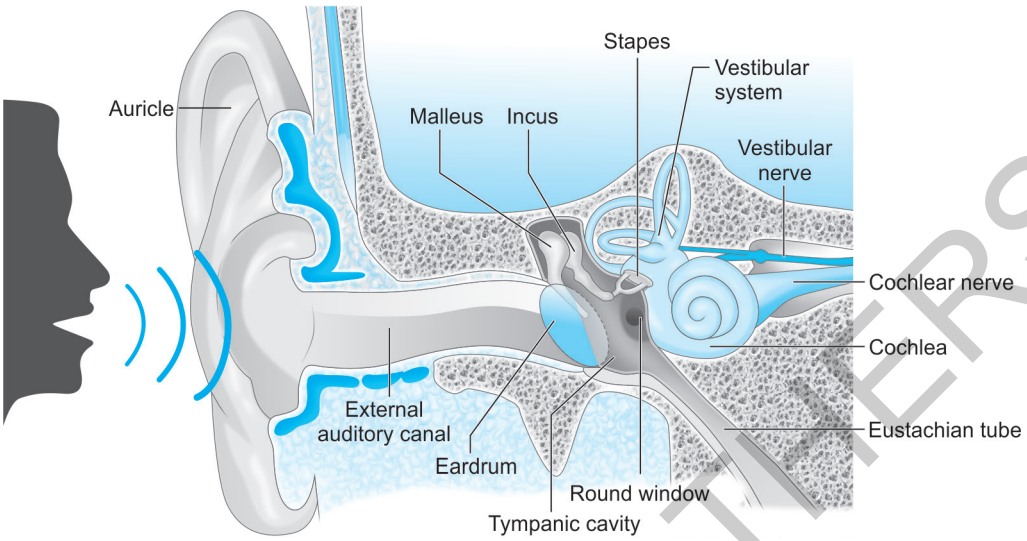


Fig. 2.14: Auditory sensation.

- **Auditory sensation (sense of hearing):** These are received through the ears. The eardrum or "tympanum," vibrates in response to the air vibrations or sound waves reaching it from the outside. These vibrations are intensified, and the auditory nerve ends take up the impression and pass it to the brain. Sound waves are sensed according to their characteristics of pitch, intensity, quality, and harmony (**Fig. 2.14**).
- **Taste or gustatory sensation (sense of taste):** It is the tongue which acquires these sensations. There are many papillae in the tongue. Mostly, there are taste pores in these papillae. There are bag-like structures called taste buds. The taste buds are stimulated chemically by objects brought in contact with them, the impulse being conveyed to the nerves and transmitted to the brain. The sensations of the taste are classified into five classes, i.e., sweet, sour, bitter, salty, and hot. The central portion of the tongue cannot receive sensations of different tastes. The tip of the tongue acquires the sweet taste, the rear the bitter taste, the edges the sour taste, while saline taste is spread uniformly all over the tongue (**Fig. 2.15**).
- **Olfactory sensation (sense of smell):** Receptor cells for the olfactory sensations are located in the nose at its apex. As only a part of the breath reaches them, it is necessary to draw a deeper breath in order to smell the odor. The odor-carrying air, which is drawn in, activates these cells by touching them. We smell the rose only because minute particles of its substance are carried into our nostrils. We smell gas because some of its particles enter our nostrils (**Fig. 2.16**).

Tactile sensations (sense of touch): The skin contains the receivers of some aesthetic sensations. There are two types of sensations:

1. Cutaneous sensations include the sensations of pressure, warmth, cold, and pain. There are different areas for these sensations interspersed with insensitive areas. They are different from each other and they have different areas of the body assigned to them.
2. Kinesthetic sensations are felt in muscles, bones, and various nervous joints and their covering membrane. Tension,

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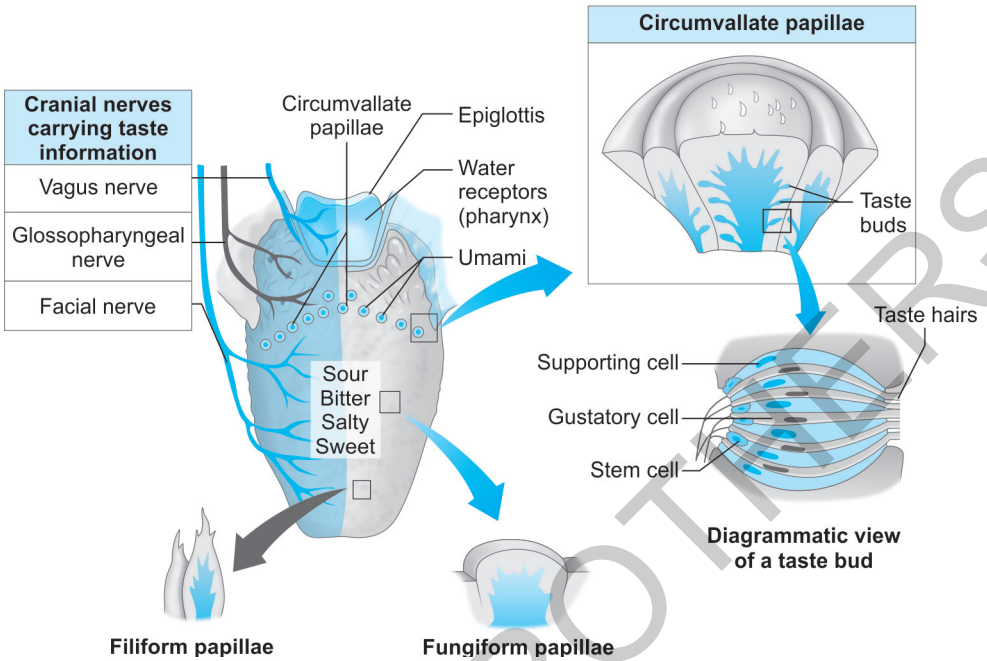


Fig. 2.15: Gustation.

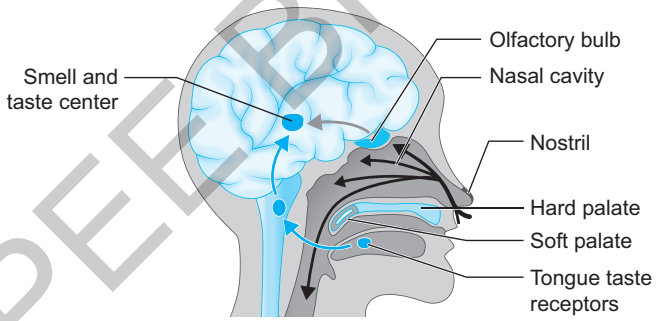


Fig. 2.16: Olfactory sensation.

contraction, pulling, etc., are examples of motor sensations. They are caused by the muscles, tendons, and joints. The nerves embedded in these give the sensations of motion when the muscles contract or the joints move. The brain receives information of these sensations through the sensory nerves whose parts are in muscles, tendons, and joints. The motor sensations put pressure upon the skin. **Figure 2.17** depicted different types of receptors.

Motor Sensations

Motor sensations are a means of the knowledge of the primary qualities of objects, e.g., their position, distance, direction, weight, etc., these sensations take part automatically and generally pass by unnoticed. The kind of motor sensations are as follows:

Sensations of position: Such a sensation is generated when the arms are held motionless in a fully extended position.

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Question Bank

Multiple Choice Questions

1. **A student feels stomach pain before an exam due to stress. This shows the relationship between:**
   a. Digestive and respiratory system
   b. Mind and body
   c. Bones and muscles
   d. Skin and nerves
2. **A patient with anxiety experiences increased heartbeat and sweating. These physical changes are caused by:**
   a. Poor diet
   b. Mental stress affecting the body
   c. Lack of sleep only
   d. Infection
3. **Fear can cause trembling and sweating. This proves that:**
   a. Emotions can affect the body
   b. The body never reacts to emotions
   c. Only medicines affect health
   d. Muscles control emotions
4. **Continuous stress may lead to headache and high blood pressure. This is an example of:**
   a. Healthy lifestyle
   b. Mind affecting body health
   c. Physical fitness only
   d. Good nutrition
5. **A person touches a hot object and quickly pulls back the hand. Which part of the body controls this action?**
   a. Heart
   b. Muscles only
   c. Lungs
   d. Brain and nervous system
6. **Damage to the brain may affect a person's:**
   a. Nail color b. Hair growth only c. Thinking and behavior d. Height
7. **The nervous system mainly helps the body to:**
   a. Digest food
   b. Regulate and coordinate body activities
   c. Produce hormones
   d. Store energy
8. **A patient loses the ability to think and interpret information after a head injury. Which part of the nervous system is most likely affected?**
   a. Peripheral nervous system
   b. Central nervous system
   c. Sympathetic nervous system
   d. Autonomic nervous system
9. **During a clinical examination, the nurse checks reflex actions by tapping the knee. Which structure mainly carries impulses between the body and brain?**
   a. Skin b. Muscles c. Spinal cord d. Tendons
10. **Damage to the nervous system may affect a person's ability to:**
    a. Coordinate body movements
    b. Think and respond
    c. Interpret sensory information
    d. All of the above
11. **A nurse explains that the nervous system helps the body respond quickly to environmental changes. Which example best demonstrates this function?**
    a. Digestion of food
    b. Withdrawal of hand from a hot surface
    c. Formation of urine
    d. Production of insulin
12. **A patient complains of loss of sensation in the fingers after nerve damage. Which system is most likely affected?**
    a. Digestive system
    b. Peripheral nervous system
    c. Endocrine system
    d. Respiratory system

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