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Biological Basis of Behaviour

Psychology

Body-mind relationship, genetics, inheritance, brain and behaviour, sensation and sensory processes.

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CHAPTER 02: BIOLOGICAL BASIS OF BEHAVIOUR

1. Introduction

The biological basis of behaviour explains how biological structures and processes influence human thoughts, emotions, learning, memory, motivation and actions.

Human behaviour is influenced by the interaction of several factors:

- Brain and nervous system
- Genetic inheritance
- Hormonal activity
- Sensory organs
- Physical health
- Environmental experiences
- Psychological and social conditions

Definition: The biological basis of behaviour refers to the study of how the nervous system, genetics, hormones and other physiological mechanisms influence human behaviour and mental processes.

Importance

Understanding the biological basis of behaviour helps nurses recognise how illness, brain injuries, hormonal changes, hereditary factors and sensory disturbances can affect patients' emotions, cognition and behaviour.

2. Body-Mind Relationship

Meaning

The body-mind relationship refers to the continuous interaction between physical processes and psychological experiences.

Physical conditions can influence thoughts, emotions and behaviour. Similarly, psychological states can affect physiological functions.

Examples

- Anxiety may increase heart rate and respiratory rate.
- Fear can cause sweating and trembling.
- Chronic stress may disturb sleep and appetite.
- Physical pain can affect mood and concentration.
- Depression can influence energy, appetite and sleep.

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- Relaxation may reduce muscle tension and perceived stress.

Major Concepts of the Body-Mind Relationship

1. Mind-Body Dualism

Historically associated with Rene Descartes, dualism considers the mind and body as distinct entities.

This is a philosophical position rather than an established scientific explanation of how psychological processes occur.

2. Biological Perspective

This perspective explains mental processes and behaviour through brain activity, neural signalling, hormones and other biological mechanisms.

3. Biopsychosocial Perspective

The biopsychosocial model explains health and behaviour through the interaction of:

- Biological factors: Genetics, physical health, brain function and hormones.
- Psychological factors: Thoughts, emotions, beliefs and coping.
- Social factors: Family, culture, relationships and socioeconomic conditions.

Nursing example: A patient with chronic pain may experience physical discomfort, anxiety and reduced social participation. Effective nursing care considers all three dimensions.

Effects of Mind on Body

Psychological stress activates physiological stress-response systems.

Possible effects include:

- Increased heart rate
- Increased blood pressure
- Increased respiratory rate
- Muscle tension
- Gastrointestinal discomfort
- Changes in sleep
- Changes in appetite

Effects of Body on Mind

Physical changes and diseases can influence psychological functioning.

Examples:

- Hypoglycaemia may cause confusion, irritability and altered consciousness.
- Hypothyroidism may contribute to fatigue and depressive symptoms.
- Brain injury may affect personality, memory or behaviour.
- Chronic pain can impair sleep and emotional well-being.

- Sleep deprivation can reduce attention and decision-making ability.

Importance in Nursing

Nurses should:

1. 1. Consider both physical and psychological factors during assessment.
2. 2. Recognise the physiological effects of stress.
3. 3. Provide emotional support during illness.
4. 4. Assess changes in mood, sleep and cognition.
5. 5. Use therapeutic communication.
6. 6. Support appropriate relaxation and coping strategies.
7. 7. Refer patients for further evaluation when indicated.

3. Genetics and Behaviour

Meaning of Genetics

Genetics is the branch of biology concerned with genes, heredity and variation among living organisms.

Genes influence human growth, development, physiological characteristics and susceptibility to certain behavioural and mental health conditions.

However, genes do not determine most complex human behaviours on their own.

Behaviour develops through interactions between genetic predispositions and environmental experiences.

Basic Genetic Terms

Term	Meaning
DNA	Deoxyribonucleic acid; molecule that stores genetic information
Gene	Segment of DNA with a functional role, often in producing RNA or proteins
Chromosome	Structure containing DNA and associated proteins
Genome	Complete genetic material of an organism
Genotype	An individual's genetic constitution
Phenotype	Observable characteristics resulting from genes, environment and their interactions
Allele	Alternative form of a gene
Heredity	Transmission of genetic information from parents to offspring
Mutation	Change in a DNA sequence
Epigenetics	Study of changes in gene regulation that do not alter the DNA sequence itself

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Chromosomes in Humans

A typical human somatic cell contains 46 chromosomes arranged in 23 pairs.

- 22 pairs of autosomes.
- 1 pair of sex chromosomes.

Most individuals receive one chromosome from each pair from each biological parent.

Sex chromosomes are commonly XX or XY, although variations occur.

Role of Genes in Behaviour

Genetic differences can influence:

- Temperament
- Cognitive abilities
- Personality traits
- Sensory functioning
- Sleep patterns
- Stress responses
- Vulnerability to certain psychiatric disorders

These characteristics are usually influenced by many genes and environmental factors.

Example

A person may inherit an increased genetic susceptibility to a mental health condition, but environmental experiences, development and other factors influence whether the condition occurs.

Genetic and Environmental Interaction

Human behaviour is shaped by the interaction of heredity and environment.

Heredity-related influences:

- Genetic predispositions
- Inherited neurological conditions
- Differences in physiological regulation

Environmental influences:

- Nutrition
- Family relationships
- Education
- Cultural background
- Childhood experiences
- Exposure to stress
- Social support

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Gene-Environment Interaction

Gene-environment interaction occurs when the effects of genetic variations depend partly on environmental conditions.

Example: Genetic susceptibility to stress-related difficulties may interact with exposure to adversity and availability of social support.

Epigenetics

Epigenetic processes help regulate gene activity without changing the underlying DNA sequence.

They are involved in normal development and may be influenced by environmental conditions.

Important: Epigenetics does not mean that every experience produces a permanent or inherited genetic change.

4. Inheritance and Behaviour

Definition

Inheritance is the transmission of genetic information and associated characteristics from biological parents to offspring.

Types of Genetic Inheritance

1. Autosomal Dominant Inheritance

A pathogenic variant in one copy of a gene may be sufficient to cause a particular inherited condition.

Example: Huntington disease.

2. Autosomal Recessive Inheritance

A person generally needs disease-causing variants in both copies of a gene to develop the condition.

Example: Phenylketonuria.

3. X-Linked Inheritance

A genetic condition associated with a gene located on the X chromosome.

Example: Haemophilia A.

4. Multifactorial Inheritance

A characteristic or condition develops through the combined influence of multiple genes and environmental factors.

Examples include susceptibility to:

- Depression
- Schizophrenia
- Many anxiety disorders
- Differences in cognitive abilities

Most complex behavioural characteristics are multifactorial rather than following simple Mendelian inheritance.

Heredity and Environment

Both heredity and environment contribute to individual development.

Heredity	Environment
Involves transmitted genetic information	Involves external and experiential influences
Contributes to biological predispositions	Influences learning and development
May affect temperament and disease susceptibility	Includes nutrition, education, relationships and culture
Genetic sequence is generally stable	Environmental exposure changes throughout life

Methods Used to Study Heredity and Behaviour

Family Studies

Examine similarities in behavioural characteristics or health conditions among biological relatives.

Twin Studies

Compare similarities between identical and fraternal twins to estimate genetic and environmental contributions to variation.

Adoption Studies

Investigate similarities between adopted individuals and their biological or adoptive families.

Limitation: These methods estimate population-level influences. They do not determine an individual person's future behaviour.

Importance of Genetics in Nursing

- Collect accurate family health histories.
- Identify patients who may benefit from genetic counselling.
- Understand inherited neurological and metabolic disorders.
- Support early identification of developmental problems.
- Educate patients without suggesting genetic inevitability.
- Respect privacy and confidentiality of genetic information.

5. Brain and Behaviour

Introduction

The brain is the main control centre of the nervous system.

It receives sensory information, processes signals, coordinates movement and contributes to emotions, learning, memory, decision-making and behaviour.

The brain operates through interconnected neural networks rather than isolated centres working independently.

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Main Divisions of the Nervous System

A. Central Nervous System (CNS)

Consists of:

1. 1. Brain
2. 2. Spinal cord

Functions:

- Receives and processes information.
- Integrates sensory input.
- Coordinates movement.
- Supports cognition, emotions and behaviour.

B. Peripheral Nervous System (PNS)

Consists of nerves and associated structures outside the CNS.

It connects the CNS to sensory receptors, muscles, glands and organs.

Functional Divisions of the PNS

Somatic nervous system: Involved in voluntary movement and conscious sensation.

Autonomic nervous system: Regulates many involuntary functions, including heart rate, digestion and glandular activity.

Enteric nervous system: Neural network within the gastrointestinal tract that helps control digestive activity.

6. Structure and Function of a Neuron

Definition

A neuron is a specialised nerve cell that receives, processes and transmits information through electrical and chemical signalling.

Parts of a Neuron

1. Cell Body (Soma)

- Contains the nucleus and cellular organelles.
- Maintains the cell's metabolic functions.
- Integrates incoming signals.

2. Dendrites

- Receive signals from other neurons.
- Carry information toward the cell body.

3. Axon

- Conducts electrical impulses away from the cell body.
- May extend over long distances.

4. Myelin Sheath

- Insulating covering surrounding many axons.
- Increases the speed and efficiency of nerve impulse conduction.

5. Nodes of Ranvier

- Gaps between myelin segments.
- Allow saltatory conduction in myelinated axons.

6. Axon Terminals

- Form connections with other neurons or target cells.
- Release neurotransmitters at chemical synapses.

Types of Neurons

Type	Function
Sensory neurons	Carry sensory information toward the CNS
Motor neurons	Carry signals from the CNS to muscles or glands
Interneurons	Connect and process signals between neurons within the CNS

Nerve Impulse

A nerve impulse, or action potential, is a rapid electrical change across the neuronal membrane.

It occurs through changes in ion permeability, especially sodium and potassium movement.

Important Features

- Resting membrane potential.
- Depolarisation.
- Repolarisation.
- Refractory period.
- Propagation along the axon.

Synapse

A synapse is a junction through which a neuron communicates with another neuron, muscle cell or gland cell.

Types

- Chemical synapse
- Electrical synapse

Most neuronal communication occurs through chemical synapses using neurotransmitters.

7. Neurotransmitters and Behaviour

Definition

Neurotransmitters are chemical messengers released by neurons to communicate with other cells.

They influence movement, mood, attention, learning, sleep and many other physiological functions.

Neurotransmitter	Major functions
Acetylcholine	Muscle contraction, autonomic functions, attention and memory
Dopamine	Movement, motivation, reward-related learning and cognition
Serotonin	Mood-related signalling, sleep, appetite and gastrointestinal function
Norepinephrine	Alertness, attention and stress responses
GABA	Major inhibitory neurotransmitter in the adult brain

Glutamate	Major excitatory neurotransmitter; important in learning and memory
Glycine	Inhibitory signalling, particularly in the spinal cord and brainstem
Endogenous opioids	Modulation of pain, stress and reward

Clinical note: Conditions such as depression and schizophrenia involve complex biological and psychosocial processes. They cannot be explained accurately as a simple deficiency or excess of one neurotransmitter.

Importance in Nursing

Neurotransmitter knowledge helps nurses understand:

- The action of certain neurological and psychiatric medications.
- Changes in consciousness and cognition.
- Neuromuscular transmission.
- Movement disorders.
- Responses to stress.
- Pain modulation.

8. Major Parts of the Brain and Their Functions

A. Cerebrum

The cerebrum is the largest part of the brain and contains the cerebral cortex and important deeper structures.

Functions:

- Conscious perception

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- Thinking
- Memory
- Language
- Learning
- Voluntary movement
- Decision-making
- Emotional regulation

Lobes of the Cerebral Cortex

1. Frontal Lobe

Functions:

- Planning and decision-making
- Voluntary motor control
- Behaviour regulation
- Working memory
- Speech production in language-dominant regions

Damage may lead to changes in planning, personality, behaviour or voluntary movement.

2. Parietal Lobe

Functions:

- Processing touch, pressure, pain and temperature information
- Body awareness
- Spatial perception
- Integration of sensory information

Damage may cause sensory disturbances or spatial neglect.

3. Temporal Lobe

Functions:

- Auditory processing
- Memory
- Language comprehension in relevant regions
- Recognition of objects and faces through distributed networks

Damage may affect memory, hearing-related processing or language comprehension.

4. Occipital Lobe

Functions:

- Primary visual processing
- Interpretation of visual features through connected cortical areas

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Damage may cause visual impairment despite structurally normal eyes.

5. Insula

Functions include:

- Awareness of internal body sensations
- Taste processing
- Pain-related processing
- Emotional and autonomic integration

B. Diencephalon

1. Thalamus

The thalamus acts as a major relay and processing centre for sensory and motor information.

Functions:

- Relays most sensory information to the cerebral cortex.
- Participates in attention and consciousness.
- Contributes to motor and cognitive circuits.

Important: Olfaction initially reaches cortical areas without the same obligatory thalamic relay used by most other senses.

2. Hypothalamus

The hypothalamus helps regulate homeostasis.

Functions:

- Body temperature
- Hunger and thirst
- Sleep-wake regulation
- Autonomic activity
- Endocrine regulation through the pituitary gland
- Stress responses
- Reproductive and motivational functions

C. Cerebellum

The cerebellum coordinates movement and helps maintain balance and posture.

Functions:

- Coordination of voluntary movement
- Balance
- Posture
- Motor learning

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- Timing and correction of movements

Damage: May cause ataxia, impaired coordination and abnormal balance.

D. Brainstem

The brainstem consists of:

1. 1. Midbrain
2. 2. Pons
3. 3. Medulla oblongata

Major Functions

- Regulation of breathing
- Cardiovascular control
- Sleep and arousal
- Cranial nerve functions
- Important reflexes, including swallowing and coughing

Damage to the brainstem may be life-threatening.

E. Limbic System

The limbic system refers to interconnected structures involved in memory, motivation and emotional processing.

Important Structures

Amygdala

- Important in emotional learning.
- Processes threat-related and emotionally significant information.

Hippocampus

- Important for forming new episodic memories.
- Contributes to spatial learning.

Cingulate cortex

- Participates in attention, emotion, motivation and pain processing.

Hypothalamus

- Connects emotional and motivational processes with physiological responses.

Important: Emotions are generated and regulated by interconnected brain networks, not by one isolated emotional centre.

F. Basal Ganglia

The basal ganglia are groups of deep brain nuclei involved in:

- Movement control
- Habit learning

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- Action selection
- Reward-related learning

Dysfunction of basal ganglia circuits is important in disorders such as Parkinson disease.

9. Spinal Cord, Reflexes and Behaviour

Spinal Cord

The spinal cord is a major part of the CNS that connects the brain with the peripheral nervous system.

Functions

- Transmits sensory signals toward the brain.
- Carries motor signals toward the body.
- Coordinates many reflex actions.
- Participates in autonomic functions.

Reflex Action

A reflex is a rapid, relatively automatic response to a stimulus.

Reflex Arc

The basic reflex arc consists of:

1. 1. Receptor
2. 2. Sensory neuron
3. 3. Central integration
4. 4. Motor neuron
5. 5. Effector

Example: Withdrawal Reflex

When a person touches a painful object, sensory signals activate spinal neural circuits that produce a rapid withdrawal response.

Nursing Importance

Reflex testing helps assess the integrity of selected nervous system pathways.

Examples:

- Patellar reflex
- Achilles reflex
- Plantar response
- Pupillary light reflex

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10. Autonomic Nervous System and Behaviour

The autonomic nervous system regulates many involuntary physiological functions.

It includes sympathetic and parasympathetic divisions.

Sympathetic Nervous System

Associated with mobilisation of the body during stress or physical activity.

Often described as the fight-or-flight response.

Effects may include:

- Increased heart rate
- Pupil dilation
- Increased blood flow to skeletal muscles
- Reduced gastrointestinal motility
- Increased sweating
- Bronchodilation

Parasympathetic Nervous System

Generally supports restorative and digestive functions.

Often described as the rest-and-digest response.

Effects may include:

- Slower heart rate
- Increased gastrointestinal activity
- Stimulation of salivation
- Promotion of bladder emptying
- Pupillary constriction

Comparison

Sympathetic	Parasympathetic
Supports physiological mobilisation	Supports many restorative functions
Generally increases heart rate	Generally decreases heart rate
Dilates pupils	Constricts pupils
Generally reduces gastrointestinal activity	Generally increases gastrointestinal activity
Promotes sweating	No equivalent widespread sweat-gland effect
Supports urine storage	Promotes bladder emptying

Both divisions work together to maintain physiological regulation.

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11. Endocrine System and Behaviour

The endocrine system influences behaviour by releasing hormones into the bloodstream.

Hormones act on specific receptors and can affect brain function, metabolism, growth and stress responses.

Important Hormones

Hormone	Main physiological or behavioural relevance
Cortisol	Stress response, metabolism and energy regulation
Adrenaline	Rapid physiological responses to stress
Thyroid hormones	Metabolism, development and normal neurological function
Insulin	Blood glucose regulation; affects brain energy availability
Melatonin	Circadian rhythm and sleep timing
Oxytocin	Reproductive functions and aspects of social behaviour
Oestrogens	Reproduction, brain function and other physiological processes
Testosterone	Reproductive functions and influences on development and behaviour

Stress Response

Two major biological systems contribute to stress responses.

1. Sympathetic-Adrenomedullary System

- Stress-related neural activity increases sympathetic output.
- The adrenal medulla releases adrenaline and noradrenaline.
- Heart rate, alertness and other physiological functions may increase.

2. Hypothalamic-Pituitary-Adrenal (HPA) Axis

The hormonal pathway is:

Hypothalamus (CRH) -> Anterior pituitary (ACTH) -> Adrenal cortex (Cortisol)

Cortisol contributes to energy regulation and adaptation during stress.

Prolonged disturbances in stress-response systems may affect sleep, mood, metabolism and physical health.

12. Sensation

Definition

Sensation is the process by which specialised sensory receptors detect physical or chemical stimuli and convert them into neural signals.

It is the initial stage of receiving sensory information.

Examples include:

- Detecting light

- Hearing a sound
- Feeling pressure
- Detecting heat
- Tasting sweetness
- Smelling an odour

Difference Between Sensation and Perception

Sensation	Perception
Detection and neural encoding of stimuli	Organization and interpretation of sensory information
Begins at sensory receptors	Involves processing across brain networks
Provides sensory signals	Produces meaningful interpretation
Example: Detecting a sound	Example: Recognising the sound as a ringing telephone

Remember: Sensation detects stimuli; perception interprets their meaning.

13. Sensory Processes

Sensory processing involves several stages through which information is detected, transmitted and interpreted.

Stages of Sensory Processing

1. Stimulation

A physical or chemical stimulus activates a sensory receptor.

Example: Light enters the eye.

2. Reception

The sensory receptor responds to the stimulus.

Example: Photoreceptor cells in the retina respond to light.

3. Transduction

The receptor converts stimulus energy into an electrical change that can contribute to neural signalling.

4. Transmission

Sensory information travels through neural pathways toward the CNS.

5. Central Processing

The brain and spinal cord process and integrate sensory information.

6. Perception

Conscious awareness and interpretation may occur, depending on the sensory system and processing conditions.

Example: Recognising a visual stimulus as a familiar face.

14. Types of Sensory Receptors

Sensory receptors are classified according to the stimuli they detect.

Receptor type	Stimulus detected	Example
Photoreceptors	Light	Rods and cones of retina
Mechanoreceptors	Mechanical deformation	Touch receptors, inner ear hair cells
Thermoreceptors	Temperature changes	Warm and cold receptors
Chemoreceptors	Chemical substances	Taste and smell receptors
Nociceptors	Potentially tissue-damaging stimuli	Pain-related sensory endings
Proprioceptors	Position, movement and muscle stretch	Muscle spindles and joint-related receptors
Osmoreceptors	Changes in fluid osmolarity	Hypothalamic osmosensitive structures

15. Major Sensory Systems

1. Visual Sensation

Organ: Eye

Receptors: Rods and cones in the retina.

Functions

- Detection of light
- Colour vision
- Recognition of shapes
- Visual acuity
- Motion perception

Basic Visual Pathway

Retina -> Optic nerve -> Optic chiasm -> Optic tract -> Lateral geniculate nucleus -> Optic radiations -> Visual cortex.

Clinical importance: Lesions along the visual pathway may cause characteristic visual field defects.

2. Auditory Sensation

Organ: Ear

Receptors: Hair cells of the cochlea.

Basic Hearing Process

1. 1. Sound waves enter the external ear.
2. 2. The tympanic membrane vibrates.
3. 3. Auditory ossicles transmit mechanical vibrations.

4. 4. Cochlear fluid movement stimulates hair cells.
5. 5. Electrical signals travel through the cochlear division of cranial nerve VIII.
6. 6. Brain pathways process sound.

Functions: Hearing and recognition of sound characteristics.

3. Olfactory Sensation

Organ: Nose

Receptors: Olfactory receptor neurons in the olfactory epithelium.

Process

Odour molecules -> Olfactory receptors -> Olfactory nerve fibres -> Olfactory bulb -> Olfactory pathways and cortical regions.

Function: Detection and identification of odours.

Smell has important connections with emotional and memory systems.

4. Gustatory Sensation

Organ: Tongue and other regions containing taste buds.

Receptors: Taste receptor cells.

Five Commonly Recognised Basic Tastes

1. 1. Sweet
2. 2. Sour
3. 3. Salty
4. 4. Bitter
5. 5. Umami

Taste information is transmitted primarily through cranial nerves VII, IX and X.

Clinical importance: Changes in taste may affect appetite, nutrition and quality of life.

5. Tactile Sensation

Organ: Skin

Includes:

- Touch
- Pressure
- Vibration
- Texture discrimination

Specialised cutaneous receptors transmit information through sensory nerves to the CNS.

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6. Temperature Sensation

Thermoreceptors detect changes in skin temperature.

This information contributes to protective responses and thermal awareness.

7. Pain Sensation (Nociception)

Nociceptors detect potentially harmful mechanical, thermal or chemical stimuli.

Pain is a personal sensory and emotional experience influenced by biological, psychological and social factors.

Important: Nociception and conscious pain are related but not identical processes.

8. Proprioception

Proprioception is the awareness of body position and movement.

Receptors in muscles, tendons and joints provide relevant sensory information.

Example: A person can identify the position of their arm with their eyes closed.

9. Vestibular Sensation

The vestibular apparatus of the inner ear detects head movement and orientation relative to gravity.

Functions:

- Balance
- Postural control
- Stabilisation of gaze during head movement

16. Important Concepts in Sensory Psychology

A. Absolute Threshold

The minimum intensity of a stimulus that can be detected under specified conditions, often defined as detection on 50% of trials.

Example: The faintest sound a person can detect under particular testing conditions.

B. Difference Threshold

The smallest detectable difference between two stimuli under specified conditions.

Also called the just noticeable difference (JND).

Example: Detecting a small difference between two weights.

C. Weber's Law

Weber's law describes how, for many sensory tasks within certain ranges, the detectable change in stimulus intensity is approximately proportional to the original intensity.

Formula:

I / I = k

Where:

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- I = Just noticeable difference
- I = Original stimulus intensity
- k = Weber fraction

D. Sensory Adaptation

A reduction in sensory receptor response or perceived intensity during continued exposure to a constant stimulus.

Example: Becoming less aware of a persistent odour.

E. Habituation

A reduction in a behavioural or neural response following repeated exposure to a stimulus that has no significant consequences.

Example: Gradually ignoring a harmless, repeated background noise.

Difference: Sensory adaptation often involves changes in receptor or sensory pathway responsiveness, whereas habituation is a form of learning or central response reduction.

F. Sensory Deprivation

A condition involving reduced sensory input.

Prolonged or severe deprivation may affect attention, mood, perception and orientation.

G. Sensory Overload

Occurs when incoming sensory stimulation exceeds an individual's ability to process it comfortably.

Example: A patient in an ICU may experience distress from continuous alarms, bright lights, pain and frequent interruptions.

17. Factors Affecting Sensation and Sensory Processing

Important factors include:

1. 1. Age: Sensory functioning may change during development and ageing.
2. 2. Physical health: Neurological or sensory disorders may impair function.
3. 3. Attention: Influences which sensory information receives further processing.
4. 4. Previous experience: Can affect interpretation of sensory information.
5. 5. Medication: Some medicines may influence hearing, vision, alertness or sensory responses.
6. 6. Fatigue: May reduce attention and sensory performance.
7. 7. Emotional state: Anxiety and stress may influence sensory experiences.
8. 8. Environmental conditions: Lighting, noise and other conditions affect sensory input.
9. 9. Nutritional status: Certain deficiencies may impair neurological or sensory function.

18. Biological Basis of Learning, Memory and Emotions

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Learning

Learning involves relatively lasting changes in knowledge or behaviour resulting from experience.

Biological processes supporting learning include:

- Synaptic plasticity
- Changes in neural connections
- Neurotransmitter signalling
- Repeated activation of neural circuits

Memory

Memory involves encoding, storage and retrieval of information.

Important brain regions and networks include:

- Hippocampus and related medial temporal structures
- Prefrontal cortex
- Distributed cortical networks
- Amygdala for some forms of emotional learning

Emotions

Emotions involve coordinated activity across brain, autonomic and endocrine systems.

Important structures include:

- Amygdala
- Prefrontal cortex
- Insula
- Hypothalamus
- Other interconnected regions

Neuroplasticity

Definition: Neuroplasticity is the nervous system's capacity to change its structure, function or connections in response to experience, learning, development or injury.

Nursing Importance

Neuroplasticity contributes to learning and some forms of functional recovery during rehabilitation after neurological injuries.

Recovery depends on multiple factors, including injury severity, timing, treatment and patient-specific circumstances.

19. Clinical Applications in Nursing

Understanding biological influences on behaviour is important in medical, surgical, psychiatric, paediatric and community nursing.

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Clinical condition	Possible biological effect on behaviour or cognition
Stroke	Changes in movement, language, cognition or emotional regulation
Hypoglycaemia	Confusion, irritability, behavioural change or reduced consciousness
Hypothyroidism	Fatigue, slowed cognition and depressive symptoms

Hyperthyroidism	Nervousness, restlessness and sleep disturbance
Dementia	Progressive cognitive and functional impairment
Traumatic brain injury	Changes in attention, memory, emotion and behaviour
Sleep deprivation	Reduced concentration, emotional regulation and judgment
Sensory impairment	Communication difficulties and reduced environmental awareness
Delirium	Acute, fluctuating disturbances in attention and awareness

Nursing Responsibilities

1. Neurological Assessment
   - Assess level of consciousness.
   - Observe orientation, memory and attention.
   - Check pupil responses where indicated.
   - Assess motor strength and sensation.
   - Monitor for sudden neurological changes.
2. Psychological Assessment
   - Observe mood and behaviour.
   - Identify emotional distress.
   - Assess coping and support systems.
   - Report significant changes in cognition or behaviour.
3. Sensory Assessment
   - Assess vision and hearing difficulties.
   - Identify sensory loss or abnormal sensations.
   - Support the use of prescribed glasses and hearing aids.
   - Maintain a safe environment.
4. Patient Communication
   - Use simple, clear language.
   - Allow adequate response time.

- Reduce distracting noise.
- Adapt communication for sensory or cognitive impairment.

5. Patient Safety
   - Implement appropriate fall-prevention measures.
   - Monitor patients with altered consciousness.
   - Recognise and report acute confusion.
   - Prevent avoidable sensory deprivation or overload.

6. Health Education
   - Explain the relationship between physical and psychological health.
   - Encourage healthy sleep and appropriate nutrition.
   - Support stress-management strategies.
   - Educate patients and families regarding neurological or sensory limitations.

Clinical priority: Sudden confusion, new weakness, speech disturbance, seizure activity or reduced consciousness requires prompt medical assessment.

20. Important Differences for Examinations

Heredity vs Environment

Heredity	Environment
Transmission of genetic information	External and experiential influences
Involves genes and chromosomes	Includes family, nutrition, education and culture
Contributes to biological predispositions	Contributes to learning and adaptation
Interacts with environmental influences	Interacts with inherited characteristics

Sensory Neuron vs Motor Neuron

Sensory neuron	Motor neuron
Carries information toward CNS	Carries signals away from CNS
Also called afferent neuron	Also called efferent neuron
Associated with sensory input	Associated with motor output

Sensation vs Perception

Sensation	Perception
Detects and encodes stimuli	Organizes and interprets sensory information
Starts at sensory receptors	Involves central nervous system processing

Example: Detecting light	Example: Recognising a face

CNS vs PNS

CNS	PNS
Brain and spinal cord	Nerves and structures outside the CNS
Integrates and processes information	Connects the CNS with the rest of the body
Coordinates many responses	Transmits sensory, motor and autonomic signals

21. Important University Examination Questions

Long Answer Questions (10-15 Marks)

1. 1. Define the biological basis of behaviour. Explain the role of the nervous system in human behaviour.
2. 2. Describe the relationship between body and mind with suitable examples.
3. 3. Explain the influence of heredity and environment on human behaviour.
4. 4. Describe the structure and major functions of the brain in relation to behaviour.
5. 5. Define sensation. Explain the stages and types of sensory processes.
6. 6. Discuss the role of hormones and neurotransmitters in human behaviour.

Short Answer Questions (5 Marks)

1. 1. Explain the biopsychosocial model.
2. 2. Describe the influence of genetics on behaviour.
3. 3. Define genotype and phenotype.
4. 4. Explain the role of the hypothalamus in behaviour.
5. 5. Write the functions of the frontal lobe.
6. 6. Describe the structure of a neuron.
7. 7. Differentiate between sympathetic and parasympathetic nervous systems.
8. 8. Explain the functions of major neurotransmitters.
1. 9. Differentiate between sensation and perception.
2. 10. Explain sensory adaptation and habituation.
3. 11. Describe the role of the limbic system.
4. 12. Write the nursing importance of understanding brain and behaviour.

Very Short Answer Questions (2 Marks)

1. 1. Define the biological basis of behaviour.
2. 2. What is heredity?
3. 3. Define gene.

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4. 4. What is genotype?
5. 5. Name the major divisions of the nervous system.
6. 6. What is a neuron?
7. 7. Define synapse.
8. 8. Name the largest part of the brain.
9. 9. Which brain structure is important for coordination and balance?
10. 10. What is the function of the hippocampus?
11. 11. Define sensation.
12. 12. What is sensory adaptation?
13. 13. Define absolute threshold.
14. 14. What is a reflex arc?
15. 15. Define neuroplasticity.

22. Multiple-Choice Questions (MCQs)

1. The structural and functional unit of the nervous system is:

A. Nephron B. Neuron C. Osteon D. Alveolus

Answer: B. Neuron

2. Which brain structure is especially important in forming new episodic memories?

A. Medulla B. Hippocampus C. Cerebellum D. Pons

Answer: B. Hippocampus

3. Which lobe is most closely associated with primary visual processing?

A. Frontal B. Parietal C. Occipital D. Temporal

Answer: C. Occipital

4. The primary inhibitory neurotransmitter in the adult brain is:

A. GABA B. Glutamate C. Dopamine D. Acetylcholine

Answer: A. GABA

5. The autonomic nervous system is divided mainly into:

A. Sensory and motor divisions B. Sympathetic and parasympathetic divisions C. Central and peripheral divisions D. Right and left divisions

Answer: B. Sympathetic and parasympathetic divisions

6. The biological process of converting sensory stimulus energy into neural signals is called:

A. Perception B. Transduction C. Habituation D. Reinforcement

Answer: B. Transduction

7. Which structure is especially important for movement coordination?

A. Cerebellum B. Hippocampus C. Thalamus D. Pineal gland

Answer: A. Cerebellum

8. The hormone released from the adrenal cortex during activation of the HPA axis is:

A. Insulin B. Melatonin C. Cortisol D. Oxytocin

Answer: C. Cortisol

9. The smallest detectable difference between two stimuli is called:

A. Absolute threshold B. Difference threshold C. Sensory deprivation D. Sensory overload

Answer: B. Difference threshold

10. Human behaviour is best understood as the result of:

A. Heredity alone B. Environment alone C. Brain activity alone D. Interaction of biological, psychological and environmental factors

Answer: D. Interaction of biological, psychological and environmental factors

23. Quick Revision Notes

- The biological basis of behaviour explains how biological processes influence thoughts, emotions and actions.
- Mind and body influence each other continuously.
- The biopsychosocial model includes biological, psychological and social factors.
- Genes influence behaviour but do not determine most complex behaviours independently.
- Typical human somatic cells contain 46 chromosomes.
- The nervous system is divided into CNS and PNS.
- The neuron is the basic functional unit of the nervous system.
- Neurotransmitters transmit chemical signals between neurons.
- GABA is a major inhibitory neurotransmitter in the adult brain.
- Glutamate is a major excitatory neurotransmitter.
- The frontal lobe contributes to planning, behaviour regulation and voluntary movement.
- The occipital lobe is important for vision.
- The cerebellum coordinates movement and balance.
- The hippocampus is important in forming new episodic memories.
- The hypothalamus regulates many homeostatic functions.
- The sympathetic nervous system supports physiological mobilisation.
- The parasympathetic nervous system supports many restorative functions.
- Sensation involves detection of stimuli.
- Perception involves interpretation of sensory information.
- Transduction converts stimulus energy into electrical changes.
- Sensory adaptation occurs during sustained stimulation.

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- Neuroplasticity allows the nervous system to change with learning and experience.

24. Conclusion

Human behaviour develops through the interaction of the nervous system, genetics, hormonal activity, sensory processes and environmental experiences.

The brain plays a central role in learning, memory, emotions, movement and cognition, while genetic and endocrine factors contribute to individual differences in behaviour.

Understanding the biological basis of behaviour helps nurses recognise neurological, psychological and sensory changes, communicate effectively, provide holistic care and support patient safety.

This knowledge forms the foundation for further study of mental health, developmental psychology, cognition, personality, motivation and emotional processes.

Practice questions

Choose one best answer. The answer key and explanations follow the questions.

1. Which cell receives and transmits information through electrical and chemical signalling?

A. Neuron
B. Erythrocyte
C. Platelet
D. Hepatocyte

2. Which structure is closely associated with coordination, balance and posture?

A. Occipital lobe
B. Cerebellum
C. Pituitary gland
D. Thyroid gland

3. Primary visual processing is associated with which cerebral lobe?

A. Frontal
B. Parietal
C. Temporal
D. Occipital

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Answer key and explanations

1. A - Neuron

A neuron is the specialised nerve cell described in your notes.

2. B - Cerebellum

The cerebellum coordinates movement and helps maintain balance and posture.

3. D - Occipital

Your notes list primary visual processing under the occipital lobe.

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