BIOLOGICAL BASIS OF BEHAVIOUR

DPSY535

Edited by:
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LOVELY PROFESSIONAL UNIVERSITY

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DPSY535 BIOLOGICAL BASIS OF BEHAVIOR

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UNIT 1: PHYSIOLOGICAL PSYCHOLOGY

Divya Srivastava, Lovely Professional University

Contents

Objectives:

After accomplished this chapter you will be able to understand,

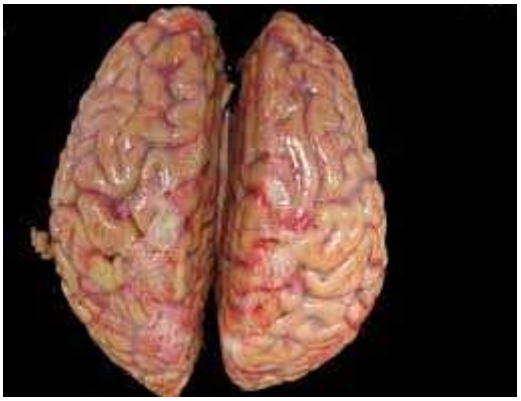
To explain the nature of physiological psychology.

To discuss the nature and relation with other discipline.

Introduction:

1. History of Physiological Psychology:

There are many other names in this field such as psychology psychology, biopsychology, psychobiology, and behavioral neuroscience that are widely used by humans. But Physical Psychology is the first name of this field. We all know about the image of the human brain. It looks like a walnut and has wrinkles (you can see in Figure 1.1). not so attractive. This part of the human body consists of about 1.3 kilograms of tissue and also contains neurons that control the way we behave. This part of the human body is extremely complex and performs all the simple and complex tasks in our body. However, we do not know much about the functions of the human brain.



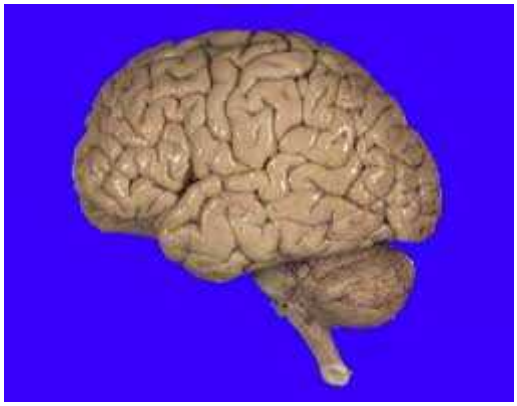


Figure 1.1(a) Dorsal view of human brain (b) Ventral view of human brain.

1.2 NATURE AND SCOPE OF PHYSIOLOGICAL PSYCHOLOGY / BIOPSYCHOLOGY

Neuroscience is called the study of neuroscience, biochemistry and physiology. Biopsychology, which draws on the study of human and animal behavior, is a closely related field of neuroscience. Psychobiology, behavioral biology or behavioral neuroscience is also known. We will talk about this branch of neuroscience related to this unit, which is Physiolohy psychology. There will be descriptions of the key phases of the body / biopsychology and various study methods. In addition, we will discuss behavioral problems involved in physiology / biopsychology. Biopsychology is known as the biological method of studying the behavior of humans and animals. Bio psychiatrists try to scientifically examine how biological processes interact with understanding. A long history of the study of behavioral biology can be followed. But in the 20th century, biopsychology became a separate discipline of neuroscience. Published by seminal D.O. Hebbs (Canadian psychologist) in the field of psychology and neuroscience, The Organization of Behavior in 1949, paved the way for future research on the basis of neural behavior. Hebb's claim in 1949 is now applied to the fields of engines. The Commentary Organization paved the way for future research on the neural foundations of behavior in the field of psychology and neuroscience in 1949. In the field of engineering, robotics, neuroscience, psychologic and neurophyphysiology proposed by Hebb in 1949 is currently being used.Thus, biopsychology draws information from neuroscience and uses data to study the behavior of humans and animals. You can better understand because neuroscience is a collaborative effort and the bio psychologist is part of this integration effort. A bio-psychologist can obtain information and refer it to behavioral studies from other neuroscience disciplines. There are a few neuroscience instructions that are especially important in biopsychology as follows:

Figure 1.2: Donald OldingHebbs (1904-1985)

Image Source: https://can-acn.org

Neuroanatomy: It studies the formation of the nervous system in the field of neurochemistry: a study of the chemical features of the nervous system in the field of neurology in the field of neuropathology: a study of neurological disorders in the field of neurology: a study of nervous and endocrine system communication.

Neuropharmacology: the effects of drugs on neural activity are studied Neurophysiological research: It examines the functions and functions of the nervous system, therefore; it is fair to say

that the biopsychological field is different and that it is one of the fields that contribute to neuroscience. There are also different research ideas in biopsychology. For human or non-human participants, biopsychological research was performed. Mice, mice, cats, dogs and deer are the main contributors to non-human research. Non-human participant research has three benefits. First, non-humans have a much more complex brain and behavior than humans. Basic brain interactions can be demonstrated. Second, the comparative method is adopted when research in such a group leads to a comparison of biological processes of different species. Thirdly, research on laboratory animals was carried out easily on behalf of participants for ethical, ethical reasons during animal studies. However, research in psychology and its industries is all guided by strict ethical standards established by organizations such as the American Psychological Association and the Indian Council for Medical Research (Guidelines ICMR for Biomedical Research in India). Biopsychological research can be pure research or applied research, and research relies on powerful studies and social applications. Research can be done using a test or a non-test method or case studies. It is a matter of understanding the basics of morality. Comfiest changes mainly due to disturbances in various areas of the brain and neural circuits. This may be due to a headache. Second, neural structures change, too. Reading, exercise etc. Therefore, it can be studied using a variety of investigative methods to understand the functioning of psychological processes by examining biological systems of how behavioral functions change. Biopsychology also aims to study aspects such as how the brain came to be, how the nervous system changes over a lifetime, how the senses, perception, memory, movement, brain role in emotional expression and control, and how behavioral changes occur after traumatic brain injury and trauma, which can result in systemic development. nervous system during life. The paper also aims to understand the role played by genes and the endocrine system in maintaining homeostasis and increasing human health and well-being. Research on brain interaction has been invaluable, and it has been awarded the Nobel Prize! In the introduction to the psychology course, you should have read about Ivan Pavlov Russian physical therapist (see Classical Conditioning).

1.3 Relation with anotherfield:

You have just learned about the nature and scope of research in the field of biopsychology in various ways. Few methods have gained prominence and biopsychological divisions have emerged. There are six major categories in biopsychology: physiology, psychopsychology, neuropsychology, psychophysiology, cognitive neuroscience and comparative psychology. These approaches are interdependent and many psychiatrists follow a different approach. These approaches are intertwined.Physiological psychology:

Controlled experimental conditions are used by the physical body to stimulate the brain and to study its behavioral effects. This includes direct manipulation and brain registration especially through surgical or electronic rehabilitation of animal research. They are aimed at developing ideas of how neural pathways regulate function

Psychopharmacology:

Psychopharmacology uses drugs to regenerate and monitor neural systems. The purpose of this study is to study the link between the brain and behavior, but the main purpose of this study is to develop therapeutic drugs and reduce drug use.

Neuropsychology:

Patients with head trauma or traumatic brain injury are treat by neurologists. Neuropsychological examinations help to diagnose deficiencies and improve treatment. This section applies to case studies and quasi-experimental studies of patients related to brain injury from disease, trauma or neurosurgery. The study focuses on the cerebral cortex, which is the most important part of the brain of mammals that contains cell layers other than the hemispheres of the brain.

Psychophysiology:

In psychology the relationship between physical activity and psychological processes is assessed as attention, learning, memory and emotions among the people involved using non-invasive methods (physiology is written on the surface of the body). The measures used include: skin electroencephalogram (EEG), muscle tension, eye movements, galvanic skin reaction, heart rate, blood pressure and pupil connectivity..

Cognitive Neuroscience:

The basics of neural cognition and higher cognitive processes are studied by neuroscientists such as thinking, memory and attention. Therefore, the study was conducted by human participants. Non-invasive techniques are used. The main way to record brain activity is active mental thinking.Comparative Psychology:

Comparative psychologists study the behavior of various species from the theory of evolution, genetics, or adaptation to understand their function. The comportment may be read in the lab or displayed in its natural location. The latter is also called ethology.

CONCULSION

Biopsychology is known as the biological method of studying human and animal behavior. Psychologists are trying to scientifically examine how biological processes interact with understanding.

• Certain fields of neuroscience biopsychology have special significance.

• Neuroanatomy, neurochemistry, neuropathology, neuroendocrinology, neurology, neurophysiology and neurophysiology are among the phases of the study.

• Research is conducted in biopsychology to understand the basis of behavior, when the nervous system is damaged and when behavioral function changes accordingly.

1.6 Self-Assessment

Multiple Choice Questions.

Q1 Which is not the name of Physiological Psychology:

A) biopsychology,
B) psychobiology
C) behavioral neuroscience
D) Psychopharmacology

Answer d

Q2 Which Organization opened the way for the future investigation of neural foundations of behavior in the field of psychology and neuroscience in 1949.

(A) Comportment Organization

(B) Canadian Organization

(C) American Organization

(D) Indian Organization

Answer: (a)

Q3 : It is the study of nervous system structure in the field of neurochemistry:

A) Neuroanatomy

B) Neurochemistry

C) Neuroendocrinology

D) All of the above

Answer a

Q4Neuropharmacology is the study of ?

A) The impact of drugs on neural activity

B) Dopamine increased level

C) disorders of nervous system

D) chemical aspects of nervous activity

Answer a

Q5psychological processes is assessed by

A) using non-invasive methods

B) Invasive methods

C) None of the above are correct

D) By using ECG

Answer a

Q6 Neural cognition and higher cognitive processes are studied by

A) Pharmacologist

B) Physician

C) Neurosurgeon

D) by neuroscientists

Answer d

Q7 . Comparative psychologists study the behavior of various species from which theories

A) evolution

B) genetics

C) adaptation

D) All of the above

Answer d

Q8 The main way to record brain activity is

A) Active mental thinking
B) Comparative psychology
C) Learning
D) A and B are correct
Answer d

Q9 EEGis stand for

A) electroencephalogram
B) electrocardiography
C) electronica
D) None are correct

Answer A

Q10 Donald OldingHebbs was born

A) 1869-1905
B) 1904-1985
C) 1789-1856
D) 1717-1805

Q 1)Writethe name of neurotransmitters and its functions?

Q2 Explain the Dopamine hypothesis?

Q.3 What is the difference between **excitation** or **inhibition?**

Answers							
01	02	03	04	05	06	07	08
d	a	a	a	a	d	d	d
09	10						
a	b						

1.7 .Review Questions

Q 1) Define **physiological psychologist/** biopsychology

Q2) Discuss the main relation with other diciplines

Further Reading 

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BIOLOGY OF BEHAVIOR, PSYCHOLOGY: THE SCIENCE OF BEHAVIOR, Neil R. Carlson, University of Massachusetts, Amherst C. Donald Heth, The University of Alberta Harold Miller, Brigham Young University John W. Donahoe, University of Massachusetts, Amherst William Buskist, Auburn University G. Neil Martin, Middlesex University.

Unit 2 : Methods of study in Physiological psychology

Contents

Objectives

After reading this unit, you will be able to:

- Why methods are important in Physiology
- Learn about the different methods and techniques used in physiological Psychology to understand the relationship between mind, body and behaviour.

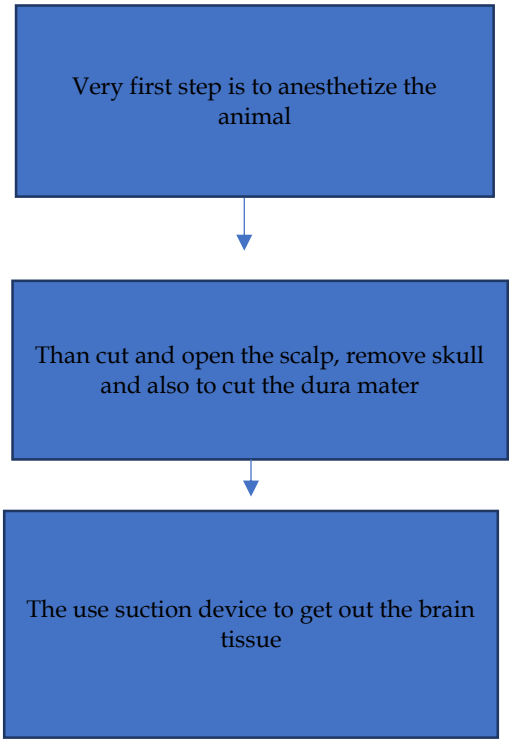
2.1 Introduction

To understand anything there is always methods available for that, so does in physiological psychology. There are numerous methods available to study the physiology of human behaviour. It is important to understand the different techniques available to understand the relation of physiology and behaviour. Through understanding and application of these methods numerous researchers has given us very meaningful findings which helps us in understand the relationship between mind and body well. So, let's begin and understand few of the important methods.

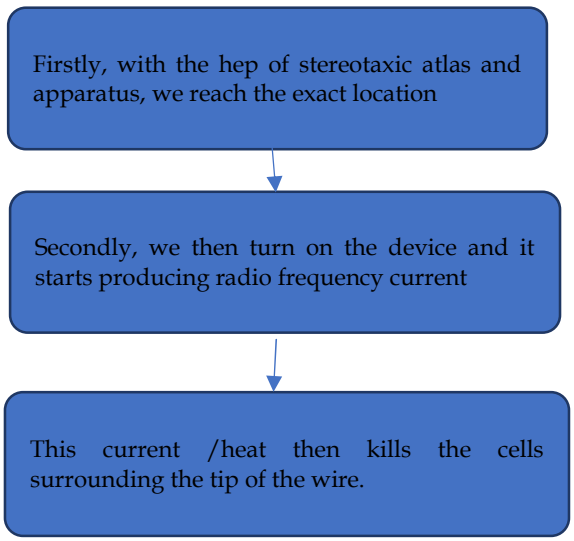
2.2Experimental Ablation- this is the oldest method in the field of research to find out the brain functions by actually destroying the part and then evaluate the behaviour. Suppose, if we destroy the front part of the brain and after the lesion or injury, a person is not able to plan things or his/her planning is not now up to the mark/trouble in planning, then it is very much visible that the front part which the researched had destroyed was responsible for the planning function.

So how to do brain lesion? This is the main question?....See, it is easy to lesion the part of the brain near to skull. Here is the flowchart related to lesion steps.

The very first step is to anesthetize the subject/animal, after this, cut the subject scalp and open it, then is to remove the skull, and also to cut the dura mater (the hard covering) and this makes the cortex observable. After this, researcher they remove the tissue by suction device, which can suck out the target tissue out of the brain. They use glass pipette and get the tissue out with a pump called vacuum pump that is attached to the glass pipette. This is when we want to lesion the area near the surface.



But what if we want to study the area beneath the cortex, i.e., area deep inside. Those areas are in subcortical region of the brain. This lesion is generally done by the producing the electrical current to the area. Things required for this are- stainless steel wire, coated with insulating varnish but not the tip of the wire, stereotaxic apparatus and atlas.



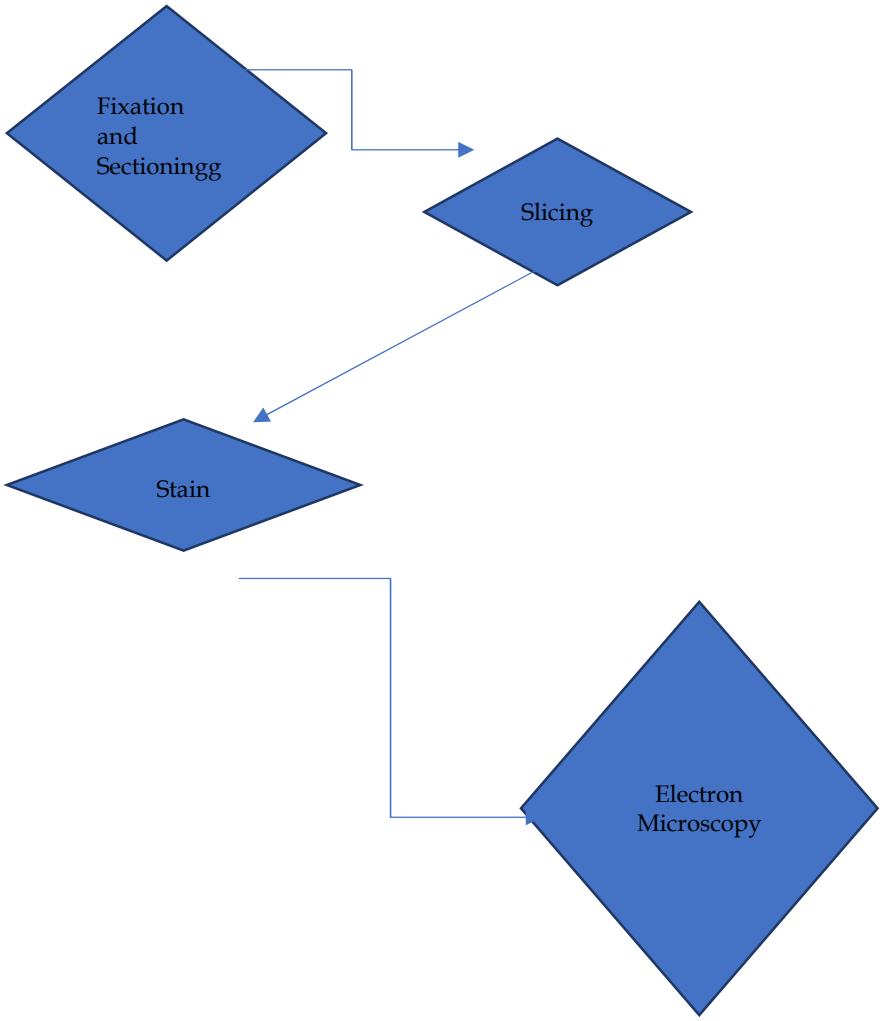
The drawback of this method is that it destroys everything that comes near to the wire tip and this includes the axons, cell bodies etc. So it means here we can't be sure that the missing behaviour is due to the lesion in the particular part as destruction also takes place in other things too.

So, to be sure, instead of applying electric current, it is better to sue amino acid like *Kainic Acid,* which also kills the neurons by strong stimulation. This type of lesion is also known as excitatory lesions. For this kind of lesions, we require a cannula that is a pipe and insert the chemical into it and this acid/chemical kills the cell bodies. Here, the advantage is it does not kill the passing axons.

Next important is to be very sure we can compare these results with the sham lesion results. Sham lesion is just a placebo. In sham lesion, we insert the electrical wire or cannula in the brain but we don not turn the device on or give electrical current or inject amino acid. Rest all we do and later try to compare with actual lesion. If we different results the we can conclude that the missing behaviour is because of the lesion.

Stereotaxic Surgery- this means Solid arrangements. For sub cortical region, it is very important to know the exact area under study. Here stereotaxic surgery provides the Seterotaxic Atlas and Apparatus. With the help of atlas we can react the exact target and Apparatus helps us in to fix the position so that we can insert the wire or cannula properly. This whole is known as Stereotaxic Surgery.

Next is Histological methods- this is after the brain lesion to reach the precise mark of the lesion. There are few steps in this.



The very task after lesion is to stop or destroy all autolytic enzymes otherwise this will destroy the whole tissue under study. To prevent the decomposition we fixate the tissue. The most common is Formalin, a liquid or watery solution of formaldehyde gas. This kills the microorganism and hardens the tissue. After it has been fixed, then we can slice the tissue into sections. The sectioning or slicing is done mainly with the help of microtome. Next step is to attach the slice to glass microscope slides. The next major step is then staining the tissue by putting some colour or dye. This is to reveal the fine details. In 19th century, a person named Franz Nissl, he was a neurologist and he discovered the methylene blue stain. After staining, the next is to use electron microscopy to see the fine details which can't be observable by light microscope. Here, beam of light will be passed on t the tissue under examination. Later the shadow of tissue is cast on photographic film.

So, above are the steps to see the fine details of a target tissue after lesion.

Tracing Neural Connections- no one area of the brain is working in isolation, there are numerous connections responsible for a one particular behaviour. Like from which area a target area is receiving messages and to whom the target area sending the messages, this is discovered by method of tracing neural connections. There are two tracing axons- Efferent axons and Afferent axons.

Tracing Efferent Axons- also known as anterograde labelling method. This means moving forward. Like to whom the target area is sending message. To find the pathway, neuroscientists have discovered several methods and one of them is using proteins called lectins. To discover the neural pathway to trace efferent axon, we inject PHA-L (kind of protein). This PHA-L the taken up by dendrites------then to soma and to axon and then to terminal buttons. After few days the cell will be filled with PHA-L molecule. The next step is to kill the subject, then slice and mount the sections on the slides of microscope. Then with chemical procedure that stains the particular tissue which containing the PHA-L with brown colour. Form this stained colour it is possible to know the efferent pathway.

Tracing Afferent Axons- also known as retrograde labelling method. This means moving backward. Like from where the target area is receiving messages. To find this pathway, neuroscientists insert a chemical that can be taken up by terminal buttons and then transported back to cell bodies. This method is almost similar to the efferent axon tracing, in afferent we inject s small amount of chemical known as fluorogold. After few days, we kill animal, and study the tissue in microscope where we can see the fluorogold colour and trace the afferent axon and get the area from where the target area was receiving the input or message.

2.3 Recording and Stimulating Neural Activity-

There are two methods- recording with microelectrodes and recording with macro electrodes.

First, we will understand the recording with microelectrodes. This method has microelectrodes with a very fine tip and very small enough to record the individual neural activity. This is also known as single-unit recording method. These fine wires are very special varnished wires with bare tip and the wires are flexible enough to bend according to the movement, this is so to minimized the chance of additional danger. Here we implant these microelectrode wires in brain with the help of stereotaxic surgery and we attach those wires to miniaturized electrical sockets and fix these sockets to skull. After recovery from surgery, then we plugged in the recording system to record the activities.

Second is recording by macroelectrodes. This is used when we are interested to study the region not the single neural activity. We insert unsharpened wires in brain, attach screw or metal disc on the scalp by applying some special paste. This is the other way to record the activity.

Magnetoencephalography is the third way to record the activity. We neural message passing down to axon or postsynaptic membrane, it produces the magnetic field. This field is so small to detect that engineers have developed a sophisticated device called SQUIDS to detect the magnetic field. The full form is Superconducting quantum interference devices. This device helps in finding the source of seizures.

Recording the Brain's Metabolic and Synaptic activity-

Another thing is if neural activity of any region increases the metabolic rate also increases. To detect the increased metabolic rate, experimenter inject 2-deoxyglucose (2-DG) into the bloodstream and then it is taken up by the cell because it resembles the glucose. Other important thing is this 2-DG cannot metabolize, so it stays in side and with the help of autoradiography. The region of brain containing more radioactivity means this was more active before this process.

Another way to find the active regions of the brain is when neuron is active, it produces a gene in neuron called immediate early genes automatically turned on and it produced a particular protein. The presence of these genes conclude that the neurons has just been activated. And Fos is the one neural protein produced during neural activation. Presence of Fos indicates that this area was active recently.

Metabolic activity in humans can be measure through- CT scan, PET and fMRI.

Measuring Brain Secretion- To measure the brain secretion the method is called Microdialysis. Dialysis is a process which separates the substance through artificial membrane which is permeable to some substances and not to others.

2.4 Genetic Methods- there are majorly two method to find the role of genes.

Firstly, twin studies, by twin studies rared together and rared apart with adopted parents will give the picture of a role played by genes in any particular disorder or disease.

Next method is targeted mutations. Here a mutated gene is produced and insert into the chromosome and see the effect.

2.5 Summary

1. Methods rea important to understand the physiological basis if psychological factors.
2. The old method is experimental ablation, where we damage the part intentionally and see the effect. Here we use electrical or chemical method for lesion.
3. The stereotaxic surgery is very important in physiology, this contains atlas and apparatus which helps us in reaching the particular target accurately.
4. After ablation is histological method to see the fine sections. It consists of fixation, sectioning, staining and electron microscopy.
5. To trace neural connections we have tracing efferent axons and tracing efferent neurons.
6. 2-DG is used to measure the brain's metabolic activity. Others are immediate early genes, microdialysis
7. Genetic factors can be study by adoption studies and targeted mutations.

2.5 Self-Assessment Questions

1. Experiments in which part of the brain is damaged and the animal's behavior is subsequently observed are called

(A) lesion

(B) lesion studies

(c) damage studies

(D) brain lesion

2 . Sham lesion is like

(A) real effect

(B) experimental effect

(c) placebo effect

(D) placement effect

3. Stereotaxis literally means

(A) Solid arrangements

(B) Liquid arrangements

(c) medium arrangements

(D) no arrangements

4.To perform stereotaxic surgery one must first study

(A) Brain

(B) Spinal cord

(c) Blood pressure

(D) Stereotaxic atlas

5. Fixing, sectioning, staining and examine the brain. Together, these procedures are referred to as

(A) Historical method

(B) Histological method

(c) History method

(D) Human method

6. Retrograde means

(A) moving forward

(B) moving straight

(c) moving between

(D) Moving backward

7. Full form of MRI is

(a) Magnetic resonance imaging

(b) Magnetic repeated imaging

(c) Magnetic reason imaging

(d) Magnetic resting imaging

8. Microelectrode technique usually called as

(a) single-unit recording

(b) double unit recording

(c) triple unit recording

(d) middle unit recording

9. For recording the brain's metabolic and synaptic activity we use

(a) 2-DE

(b) 2- DG

(c) 2-DC

(d) 2-DR

10. FOS is a

(a) protein

(b) vitamin

(c) liquid

(d) mineral

11. Immediate early genes are produced by

(a) Dendrites

(b) Axon

(c) Nucleus

(d) Terminal buttons

12. Kainic is

(a) amino acid

(b) vitamin

(c) Mineral

(d) Jell

13. Microdialysis is used for ___ ?

a) substance separation

b) electrical current

c) Stimulation

d) all the above

14.Mutated target is to study the

a) Environmental factor
b) Social factor
c) Genetic factor
d) Adoption studies

15. Physiological psychology is a branch of

a) Psychology
b) Neurology
c) Sociology
d) science

Answer Key

1B. 2D. 3A. 4D. 5B. 6D. 7A. 8A. 9B. 10A. 11C. 12A. 13A. 14C. 15A.

2.6 Review Questions

Discuss the ablation of subcortical region of brain.

How we can study a living human brain?

Explain the tracing efferent and afferent axons.

Discuss the twin study method.

2.7 Further Readings

Carlson, N. R. (2005). *Foundations of physiological psychology*. Pearson Education New Zealand.

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UNIT 3: Cells Of The Nervous Systems

Objectives

- After finishing this unit, you would be able to: Identify the nature and structure of neurons; Understand different classification of neurons based on structure and functions.
- Comprehend the way neurons transmit signals from one cell to another;
- Understand the basic structure of central nervous system.

Introduction

- There are about 300 billion cells in the human nervous system, which can be divided into thousands of different types. The two main classes are neurons (neurons) and glial cells (or glial cells), which are distinct from each other. Neurons are the main communication units in the nervous system. Neurons send information to each other in the central nervous system (CNS) and other cells in the peripheral nervous system (PRF). This network of interconnected cells forms a complex loop supported by glial cells, which play an important but distinct role in maintaining glia. This article describes the structure of these cells, the different types of cells in the nervous system, and the communication mechanisms.

- **Neuron Definition**

"Neurons are the fundamental unit of the nervous system specialized to transmit information to different parts of the body."

The neural network is an integrated communication network (nervous system) made up of neurons and glia and distributed throughout the body. They vary in shape and size, but all neurons have the same basic structure. They are all surrounded by an excitatory membrane that can change the potential. This potential change could be limited to a specific area or spread to all locations. These cells have receptor surfaces, somatic and dendritic membranes, as well as transmission regions, axons and axons. This gives the neuron structural and functional polarity (Fig. 1). The role of glial cells is to support neurons by isolating part of the nervous processes, providing nutritional factors, regulating the extracellular environment within strict limits and protecting against harmful substances. Grouped by location, size, shape, activation response and function.

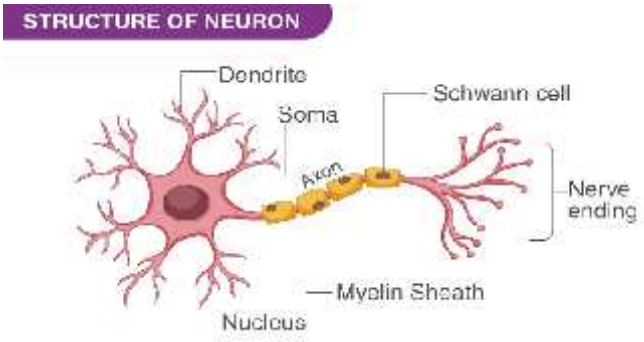


Figure 1.1: Structure of Neuron

Table 1 Classification of the cells of the nervous system

Structural	identity Neurons	Glia
Morphology (size and shape)	Depending on the number of processes emanating from somatic cells, polyploid neurons have three or more cellular processes, axons and dendrites. Bip olar neuronshave dendrites and axons. The pseudo-unipolar neuron has a single outgrowth near the pelican and splits into two branches, forming.	Microglia Phagocytic and Ependymal cells obtain from macrophages *Macroglia *Astrocytes *Oligodendrocyte s
Cells are activated and trigger reactions in oth ers.	When a neuron is stimulated or suppressed, the cell membrane in co ntact with the neuron is depolarized (stimulated) or hyperpolarized (suppressed	
Role	Motor neurons control effector organs (muscles, sweat glands) or muscle fibers. Sensory neurons are involved in the perception and development of stimuli. Neurons form connections between other neurons.	
Place	Central: within the brain and the spinal cord Peripheral:	

3.1 Structure of Neurons

Neurons vary in shape and size depending on their function and location. Each neuron has three parts: dendrites, cell bodies, and axons.

Parts of the neuron

(**cell body, dendrite, axon, synapse**)
In a typical neuron, there are 4 regions with different structures. Cell bodies (also called somatic cells or pelical ions), axons, presynaptic ends, and dendrites.

Cell body (perikaryon) :Neural cell bodies vary in shape and size. It can be spherical, oval or square. Sizes range from 4 to (Figure 2). Optical images of pyramidal neurons (left)

and interneurons (right), stained by the Gorgisilver method. Interneurons are photographed at higher magnification (with small black arrows) to show the large number of spines along the dendrites. Axons emerging from the cell body are also shown (large black arrow). The scale bar on the left is 50 mm and the scale on the right is 20 mm. Nervous system cells with a diameter of 35 mm to 150 mm. The cell body is the metabolic center of neurons and usually contains most of the cellular machinery such as enzymes, structural proteins, neurotransmitters, and organelles.

The nucleusappears pale under the microscope due
to large, easily transcribed diffuse chromatin. Multiple corescan often be seen. The appearance of th e nucleus shows more evidence that cells are involved inhigh
protein synthesis. It contains a coarse endoplasmic reticulum, free ribosomes and a cytoplasm rich in mitochondria, as well as a well-developed Golgi apparatus. The characteristic large set of ribosomes that are associated with the endoplasmic reticulum and ribosomes that are not associated with the endoplasmic
reticulum make the thistle bodies highly pigmented basophilic spots used in histological studies un der light microscopy. Thus, various properties of
neurons were used to study neurons. In addition to the tubulin proteins that make up the microtubules of the cytoskeleton, various other internal fibers form a scaffold within these cells. Neurofilaments are neurons that resemble the intermediate fibers in most other cells.
These structures, added to histological specimens such as the silver staining by Camillio Golgi (1843-1926), are represented as nerve fibers (see Fig. Modern histological classification of the nervous system

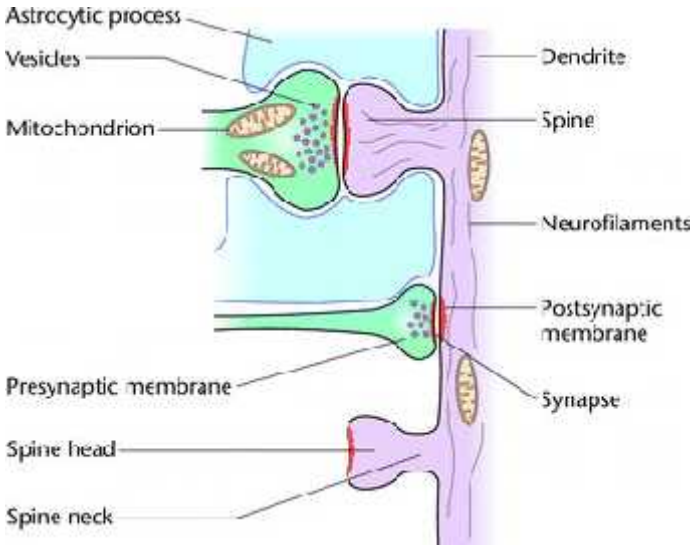


IMAGE 1.2 Schematic representation of two forms of synapse, one formed between an axon's bouton and a dendritic spine, the other between a bouton and the dendrite's shaft. Note the vesicles within the presynaptic terminal close to the synapse.

Dendrites

The cell body can have one or more branched protrusions, called dendrites, and together with the cell body form the main entrance surface. Many neurons in the CNS
have several major dendrites that can bind to the cell
body and diverge several times. These dendritic dendrites can form large and complex structures with which many other cells can contact and influence. Thus, the receptive field of a neuron is determined by the volume that this structure occupies, and varies widely for different classes of cells. As they move away from the stem cell, with
the exception of mitochondria, cytoskeleton microtubules, and
nerve fibers, dendrites have fewer and fewer synapse-like organelles (Figure 3). Many of them are shaped like small bumps or nails (Figures 3 and 5). Dendrite heat is not typical of all

dendrites and appears to be closely related to the level of signaling in certain neurons. The spine is the main target for stimulation.)It is believed that a change in their structure changes the physiological properties of the synapses arising in them. The cell body also has a single axon, a tubular structure that can expand over long distances. Axons differ from dendrites in that they do not have rough ends.

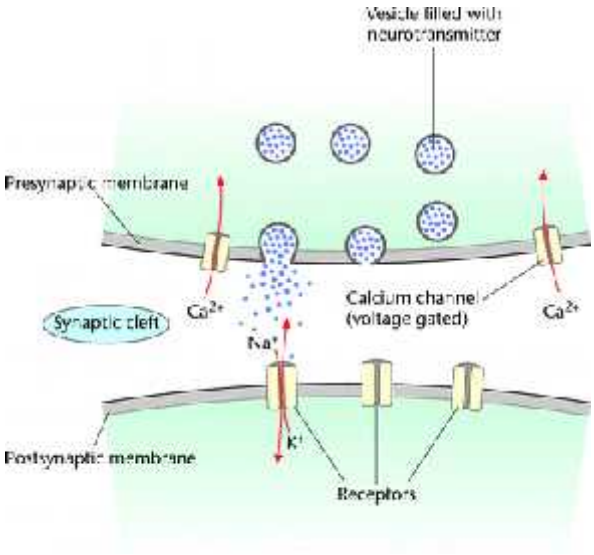
Axon

Free network of plasmin and ribosome. Thus, axons cannot synthesize protein and depend on the supply of the axonal transport system to the microtubule bundle.
Axons can carry different molecules (such as neurotransmitters or precursors) along their length to the ends of the axons. The axonal membrane is called the axon, and its contents are called the axonal protoplasm. The diameter of an axon determines the speed at which an electrical signal travels along its length. The larger the diameter, the higher the speed of movement. The separation also speeds up driving. This is done by SNPs and
CNS glial cells, which rotate the proliferation of myelin-rich lipid cell bodies around axons.
At the distal end, the myelinated axons divide into narrower ends,
each end having a specific edema called the presynaptic process. It is a neurotransmitter containing all the devices needed to release neurotransmitters at synapses

The synapse

Neurotransmission is transmitted from one neuron to another via synapses These are points on the surface of the cell membrane that can receive signals from other neurons or the presynaptic end of the same neuron. Each neuron in the central nervous system has an average of 105 synapses. In PRF, the postsynaptic membrane may belong to target cells such as muscle fibers. There are two types of synapses: electrical and chemical.

IMAGE 1.3



May utilizes some conventional existential terms somewhat uniquely in contrast to other people, and imagines new words for a portion of existentialism's old thoughts.

3.2 Neuron Classifying and its types:

There are many types of neurons. Different types must perform different functions. Neurons vary in size and shape. Neurons are classified according to their function and structure. There are three types of neurons: unipolar neurons, bipolar neurons, and multipolar neurons, and they are classified by structure. The classification is based on the number of protrusions emanating from the cellular organism. The type of neuron is indicated in Figure 2.3.

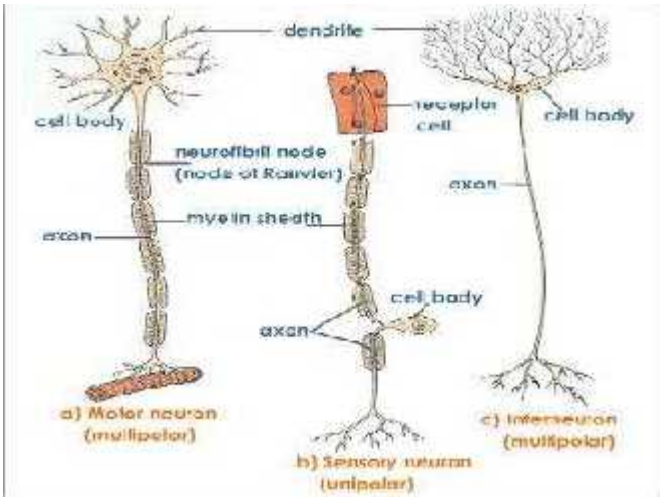


Figure 1.4: classifying of Neurons

Pseudo-unipolar or unipolar neurons have axons that are split in two by cells and somatic branches. These neurons have sensory functions. Impulses are sent from the environment to the central nervous system. Bipolar neurons are sensory organs. They have axons and dendrites sticking out like trees. Dendrites are on the opposite side of the catfish. They are very rare and occur in the retina, inner ear, and olfactory region of the eye. There are very few of them. Only one axon, several dendrites, have multipolar neurons. The most common are the brain and spinal cord. Depending on the width of the axons and the number of branches present, they are further classified into type I Golgi neurons and Type II Golgi neurons. I have very long axons and several branches, and I have a lot more information about motor neurons. Type II Golgi neurons branch many times into short axons. These neurons mostly function locally around them. Neurons are also divided into several types: afferent neurons, efferent neurons, and interneurons, which function accordingly. Afferent neurons are neurons that stimulate sensory nerves that are connected to the central nervous system (CNS). They are affected by changes in the environment. Inexpensive neurons send impulses to muscles or glands in the brain or spinal cord. Also called motor neurons. Neurons are located in the central nervous system. It contains information ranging from afferent neurons to efferent neurons (mainly the spinal cord and brain). Neurons are placed in a reflex arc to stimulate the brain and spinal cord. The most common are afferent neurons, interneurons, and efferent neurons.

Neuron functions

Pseudo-unipolar or unipolar neurons have axons that are split in two by cells and somatic branches. These neurons have sensory functions. Impulses are sent from the environment to the central nervous system. Bipolar neurons are sensory organs. They have axons and dendrites that branch out like trees. Dendrites are on the opposite side of the catfish. Several types of neurons are involved in all reflexes, from solving simple and complex problems to the transmission of sensory and motor neurons. Hence, you cannot perform any activity without proper neurological function. For example, if you see an object, the receptors in your eye tell your brain about it, and you can see things clearly. If there are blood vessels in the arm, sensory neurons can only be controlled by motoneurons, which send and hold the muscles. There is a complex network of connections between these neurons in the brain and spinal cord. Genetic and environmental factors influence the development of the nervous system. For example, if you see an object, the receptors in your eye tell the brain about it, and you can see clearly.

The synapse

Neurotransmission is transmitted from one neuron to another via synapses. These are areas within the cell membrane subfactor that can receive signals from other neurons or from the ends of presynaptic neurons. Interestingly, each neuron in the CNS has anaverage of 105 synapses. The postsynaptic membrane can become part of the PRF target cell. B. Muscle fibers. There are two types of synapses: electrical and chemical.

3.3 Glial cells and its functions:

Absolutely countless Cells in the Nervous System

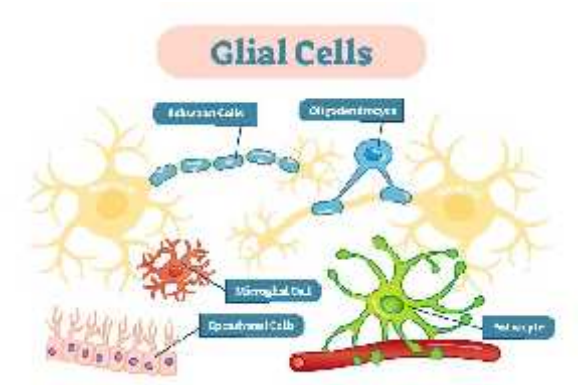
Glial cells are usually small and do not directly participate in neural communication. In humans, there are 10-50 times more glial cells in the
central nervous system than neurons. However, since glial cells are small, they only take up half the volume of all nerve tissue. They are small. The structures in which neurons can grow are structured and lined up to accelerate conduction, providing a functional environment for
neurons through structural and chemical support.

Different kind of glia in the central and peripheral nervous system

Glial cells are classified into two major classes:

(1**Microglia** (an assortment of phagocytic cells that are mobilized after injury, infection or disease). These cells are thought to derive from bloodborne macrophages

(2)**Macroglia**(e.g., astrocytes, oligodendrocytes and ependymal cells) and ependymal cells



Macroglia

Astrocytes are divided into two groups according to their star shape: protoplasm, which is found in the gray matter of the brain and spinal cord, and fibrous matter, which is found mainly in white matter. A third radial glial type is under development. It is a structural framework on which multiple neurons can navigate. Subsequent research showed that he had developed into adult astrocytes. In areas rich in axons, especially in the white matter, fibrous astrocytes contain many intermediate filaments, microtubules, and actin. It is a long, subtle, subtle and poorly connected process. These cells provide the main structural support for neurons in areas of CNS damage and form a network of processes known as gliotic scars. Protoplasmic astrocytes have abundant granular cytoplasm, shorter and stronger processes, and few filaments. These cells are associated with gray matter and often show clear cytoplasm with few organelles on electron microscopy. It is especially suitable for dendrites, synapses, neurons and endothelial processes. This suggests that the ionic balance of the extracellular space is important for metabolism.

Oligodendrocytes

There are very few processes in the cell. Its main function is
to increase conduction through the myelin sheath around axons. They are much smaller than astrocytes. Their analogs are myelin axons of peripheral nerves, but goose cells are found only in the gray and white matter of the central nervous system. The terms gray and white matter come from the intact neural networks that display these colors. In areas rich in myelinated axons, the lack of white matter is mainly due to the high density of myelin sheaths. Thus, this white matter can be easily distinguished from areas with more cells and less
myelin (gray matter). Myelinated oligodendrocytes near many central axons and Schwann cells bind to a single axon. By trimming the axon to the optimum length, the
conduction speed is increased. The small space between two myelinated glial cells is called the Ranvier node and is the open area of the axon where depolarization occurs. Thus, the action potential spreads from one node to another. This type of conduction is called salt action in Latin saltir, when the action potential jumps from one node to another. The surface of
the ventricular system and the central duct of the spinal cord are divided into the upper half of

the cells. This light surface is structurally polarized into the cilia. It exits into the cerebrospinal fluid (CSF), which extends to the surface of the pia mater and may contain the basal surface. Side chains, which are closely associated with brain endothelial cells, can also develop from these cells into astrocytes. It also forms the structure of the ventricles associated with the production of cerebrospinal fluid, the outer layer of cells in the choroid plexus. Penetration between the capillary cells and the brush provides a barrier to blood fluids through special bonds between the epithelial cells of the choroid plexus.

Microglia

White and gray matter contains microglial cells. They have small, dense, elongated cell bodies, a very short
process,and in the nucleus there is very thick chromatin throughout the serum. The lines of mononuclear phagocytes of the neural network are considered equivalent. These cells are thought to come from macrophages, which are inherited from blood and their movements after injury, illness, or infection. Unlike the nervous system, they
remain mitotic throughout life and make up about 10% of all cells in the central nervous system.

Differences between glia and neurons

Glial cells do not have to generate action potentials or create synapses with other cells. There is no evidence that glial cells are directly involved in neuronal signaling. However, glial cells respond by converting external levels of potassium into nerve impulses. Glia is said to be able to keep neurons alive.

3.4. Keywords

dendrite, axon, oligodendrocytes, microglia, macroglia, peripheral nervous system, electrical and chemical, motor neurons, sensory neuron, , unipolar neurons, bipolar neurons and multipolar neurons, perikaryon(cell body)

3.5 Summary:

The neurons and glia are the building blocks of the nerve tissue. The neurons are anatomically and functionally independent units with different morphologies and functions. Neuronal activity, neuronal nutrition and the defense processes of CNS are supported and protected by glia. With highly specialized interactions between these components, the living organisms perform fundamental and unique functions within and outside of the narrative tissue.

3.6 Self-Assessment 

Q1 Normally, the impulses move from a neuron to the ……

A) dendrite, dendrite
B) dendrite, axon
C) axon, axon
D) axon, dendrite

Answer b

Q2 What is the significant event in the neuron that leads to a potential for action?

A) calcium is released
B) enzymes are activated
C) ATP is formed
D) ion channels are opened

Answer d

Q3 Why does the nervous momentum move quicker when myelin is on the nerve?

A) the action potential moves faster along the myelin
B) the action potential "skips" over the myelin
C) the action potential doesn't have to cross a synapse
D) the action potential is stronger

Answer B

Q4 The neurons which interpret, receive and stimulate motor neurons are

A) sensory neurons
B) motor neurons
C) interneurons
D) rotator neurons

Answer c

Q5 The axons are classified as all sensory neurons..

A) motor nerves
B) rotator nerves
C) mixed nerves
D) sensory nerves

Answer A

Q6 The supporting cells in the human nervous system are classified as neurons…

A) dendrite cells
B) malign cells
C) benign cells
D) neuroglial cells

Answer D

Q7 Which of the following statements is false?

A) The soma is the nerve cell's cell body.

B) Myelin sheath provides the dendrites with an isolating layer.

C) The signal from the soma to the target is carried by axons.

D) The signal to the soma is transported by Dendrites.

Answer B

Q8 Neurons contain that can have other neuronal signals.

A) Axon
B) Mitochondria
C) Dendrites
D) Golgi bodies

Answer C

Q9 A(n)_____ has an axon and dendrite stretching from the cell body.

A) Unipolar
B) Bipolar

C) Multipolar

D) Psudounipolar

Answer B

Q10 Glia that provide myelin for neurons in the brain are called

A Schwann cells

B) Oligodendrocytes

(C**) Microglia**

D) Astrocyte

Answer **B**

Answers							
01	02	03	04	05	06	07	08
b	d	b	c	a	d	b	c
09	10	11	12	13	14	15	
b	b						

3.7 Review Questions

3 **Q1 Define neuron and it's functions with diagram.**

4 **Q2 Discuss the types of neuron and its parts.**

5 **Q3 What are glial cells and its types with diagram.**

Further Reading

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UNIT 4: NEURAL CONDUCTION AND YTRNSMISSION

Contents

Objectives:

- Will you able to understand the procedure of neural conduction.
- Explain to procedure of synaptic transmission.
- To understand Action potential process.

Introduction:

4.0 NEURAL CONDUCTION

In our very complex system of billions of nerves, electrical currents enable us to sense the world, control parts of our body and think. These represent the three main **nerve functions**. First, the nerves carry messages to the central nervous system, consisting of the brain and spinal cord of our sensory organs and others. Secondly, the nerves contain central nerve messages. Thirdly, in the central nervous system nerves transmit and process signals. This system is the subtle surprise of the sheer number of nerve cells and the incredibly larger number of connections between them. The conduction of nerves is a general term in nerve cell transmitted electrical signals. This is one aspect of bioelectricity or electricity in biological systems and creates it. Nerves, properly known as **neurons**, look different from other cells, some of which have long tendrils, connecting with other cells (See Figure 1.) Signs are sent through synapses or by dendrites to the cell body and stimulate the neuron to generate its own signal, which is sent to other nerve or muscle cells along its long axon. Signals can be transmitted from many other locations, by using the synapses to make the system complex and able to learn.

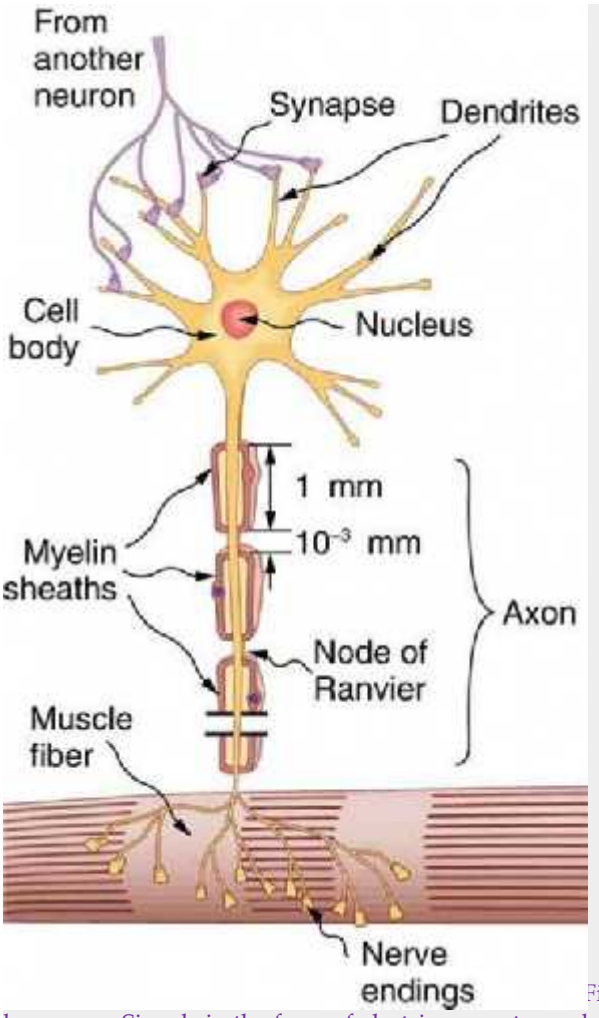


Figure 1. A neuron with its dendrites and long axon. Signals in the form of electric currents reach the cell body through dendrites and across synapses, stimulating the neuron to generate its own signal sent down the axon. The number of interconnections can be far greater than shown here.

The method of generating and transmitting these electric currents is more complex than simply moving freight charges within a driver; however, the principles that have already been discussed in this text can be understood. **The coulomb force** and diffusion are the most important.

4.1 The Resting Membrane Potential

The cell's resting membrane potential varies depending on the cell type. For neurons, it is typically between -50 and -75mV. The value is based on the type of open ion channels in intracellular and extracellular fluid and the concentration of the ion in its remaining state. Neurons usually occur at cell concentrations higher than outside the cell with K+ and organic ions. At higher concentrations outside the cell, Na+ and Cl on the other side are usually foundThis concentration difference gives an ion flow gradient when its channels are open. Thus K+ ions were moving from the cells, while Na+ and Cl ions were moving into the cells. If the cell is resting it is mainly permeable to K+ which is the reason why three ions are most influenced by the resting membrane potential. Further information about the restaurant potential can be found here.

The activity of the Na+/K+ ATPases via active transport keeps these concentration gradients alive, which in turn permits the preservation of membrane potential.

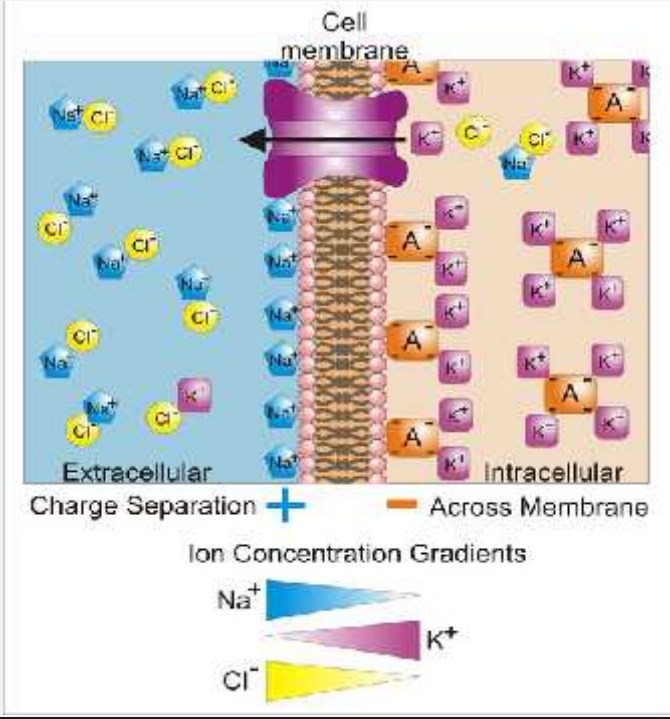


Fig 1 – Diagram demonstrating the ions involved in setting the resting membrane potential, as well as the direction of the ion concentration gradients.

4.2 Generation of Action Potential

Due to the predominantly K+ permeability of the membrane, the membrane potential arises during the rest. Depolarization begins on the axon hill with an action potential. **During depolarization,** sodium ion channels open due to electrical stimulus. The cell's potential is moved from negative to more positive when sodium ions return to the cell.When a **potential threshold** is reached, a potential action is generated. There will only be action opportunities if a threshold is reached. Thus, they **are "all-or-nothing**" described. In addition, the maximum response will be requested when the threshold is reached.The voltage-driven sodium ion channels start to close once the cell has been depolarized. The increasing positive charging within the cell leads to the opening of potassium channels, with the electromagnetic gradients of K + ions now moving down from the cell. As the K+ leaves the cell, membrane potential is negatively affected and the rest potential begins to approach.

Repolarization normally exceeds the renewable membrane potential, which makes membrane capacity worse. The term "**hyperpolarization**" is used. It is important to note that the Na+/K+ ATPase does not participate after the action potential in repolarization process.

Every action potential is followed by a refractory period. This period can be further divided into

The absolute refractory period

After an AP closes sodium channels, that happens. Sodium channels enter an inactive state in which they cannot be reopened irrespective of their membrane potential. The relative refractory periods

This happens when inactivation slowly emerges from sodium channels. The neuron may be excited with stimuli that are stronger than one normally required to initiate an AP during this period. The strength of the stimulus needed is very high early on in the relative refractory period. The amount of sodium canals recover from inactivation gradually becomes smaller during the relatively refractory period.

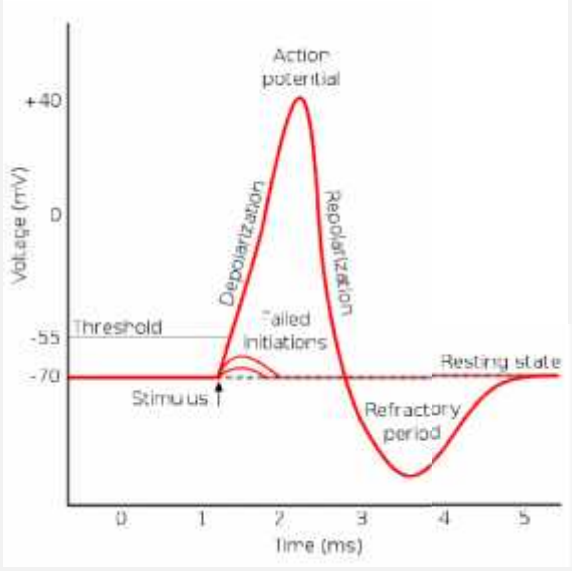


Fig 2 Diagram which shows over time phases of the potential for action with respect to membrane voltage.

Action potentials development

The potential for action is spread through local currents along the axons of the neurons. The local current causes the adjacent axonal membrane to be depolarized and additional action potentials are generated where this reaches a threshold. Due to the period of **refractive activity**, the membrane areas that have depolarized recently will not depolarize again – which means that the action potential only goes one way.

Eventually, these local currents will decrease until a threshold has been reached. The distance it takes depends on the capacity and strength of the membrane:

Membrane capacitance

Store charging ability. The lower capacity means that the threshold can't be reached any longer

Membrane resistance

Depending on the number of open ion channels. The lower the number of the channel, the greater the membrane resistance. Higher diaphragm resistance leads to a longer threshold distance

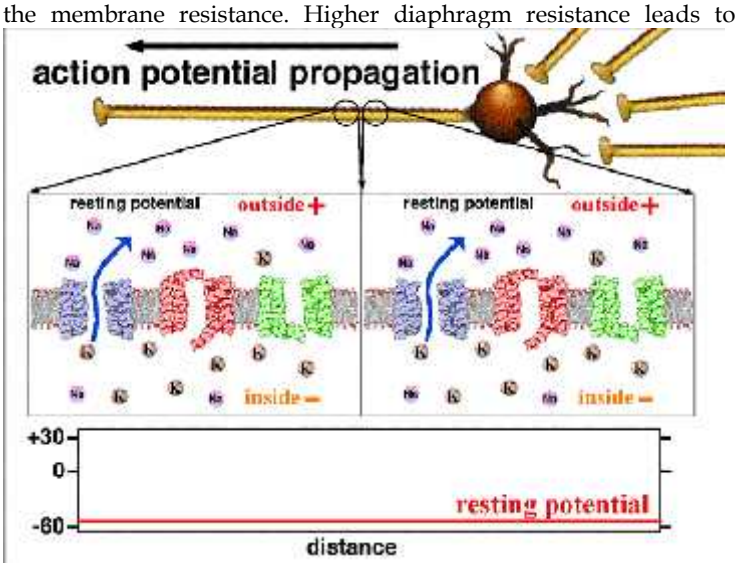
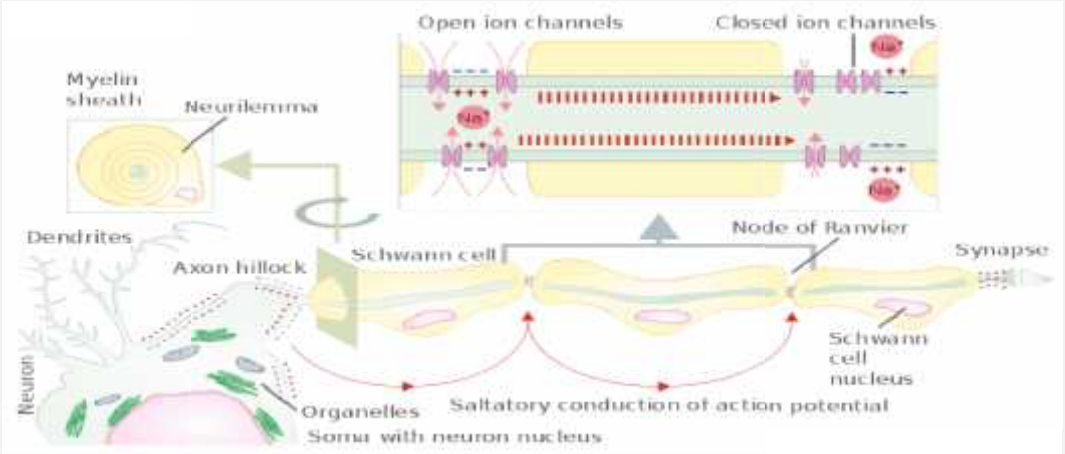


Figure Animation to show how the potential for action was propagated with Axon.

Some neuronal axons are covered by a **myelin sheath** to enable the electric signals to be rapidly transmitted through a neuron and make it more energising. The myelin sheath encircles the axon in an isolating layer. More information can be found on the myelin sheath.

A myelinized axon does not have a myelinized myelin and an axonally exposed membrane, periodic lacunes are found along a melanized axon in which there is no Myelin and the axonal membrane is exposed. These gaps are the Nodes of Ranvier. Unlike myelinated parts of the axon that have no voltage gate ion channels, the Nodes from Ranvier have a high density of ion channels. Only nodes can therefore have a potential for action.

By increasing membrane resistance and reducing membrane capacities, the Myelin sheath speeds the conduction. The potential action is, therefore, more likely than possible in unmi-lined neurons to spread over the neuron at a higher speed. Electrical signals are conducted quickly from one node to the next, causing the membrane to be depolarized. If depolarization is higher than the threshold, another action potential is initiated which is carried on to the next node. A neuron is thus quickly driven down by an action potential. This is known as **saltatory conduction.**

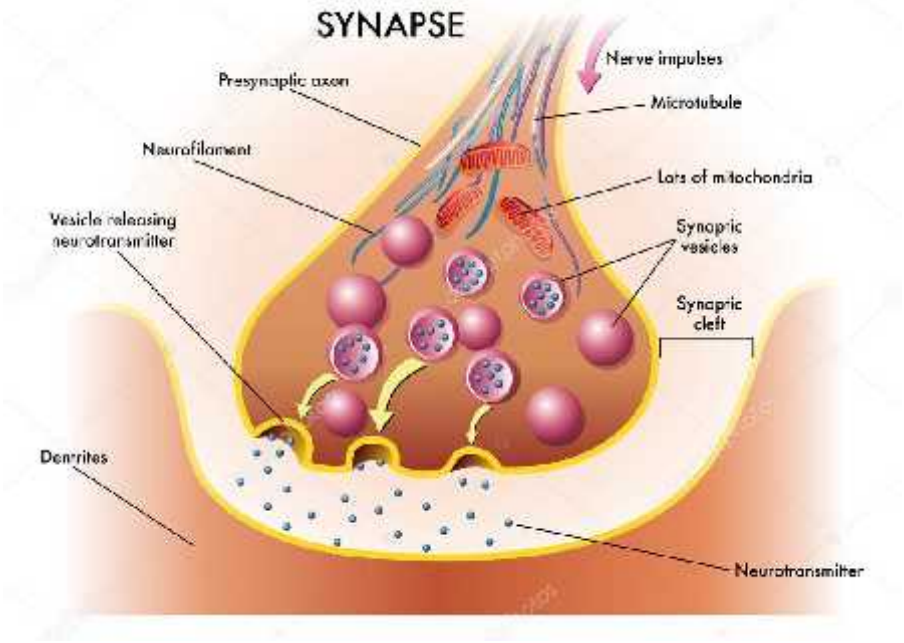


4.3 SYNAPTIC TRANSMISSION

The facts goes from one neuron to another through the synapse. Therefore the action potential extends to the end of the axon and to the final buttons. A synapse is known as the point at which the terminal button of a neuron is connected with the dendrite of another neuron. Through information these junctions formed by the following neuron. Synapses in 3 places, mostly dendrites, somas or axons, can be found on the following neurons. Thus, synapses are called axon dendritic, axosomal and axoaxonic. Together, electrical synapses and 40 neuron and nerve pulse synapses are present for two types of synapses. Electrical synapses are rare. In this case, neuron information is transmitted through certain nearby canals to the next neuron. When close to each other, the ions pass through the neurons easily and effectively. They send data directly and faster in either direction. Chemical synapses include neurotransmitters from the neuron to the neurotransmitter A small distance called a cleft synaptic exists when the cell membrane transmitter is in contact with the cell membrane (postsynaptic membranes). (The membrane synaptic) This data is transmitted by the cell membrane. The vesicles in the presynaptic neuron's terminal button release and enter the division. It reaches receptors on the postsynaptic neuron membrane. This is a chemical synapse that occurs more often. There are certain synaptic steps in transmission. Synaptic transmission involves certain steps, but let us first know the structure of a synapse..

Structure of a Synapse

The synapse consists of three structures we must comprehend. They are the synaptic button, the synaptic spindle and post-synaptic neuron plasma membrane.



The synaptic button is a small bulge when the terminal buttons finish. In the bulge there are many vesicles or bags containing numerous. The transmitters of neurotransmitters. The synaptic split is the interspace between the neurons (between the pre-synaptic neuron's axon terminal and the neural dendrite).Info cannot transfer from one neuron to another directly. The information will be passed through the conversion of the first neuron's electrical signal to a chemical signal passing across the rift in the next neuron. Presynaptic terminals comprise of vesicles synaptic n. ("fluid-filled sac").

The chemical molecules, referred to as neurotransmitters, are released into the split from the synaptic vesicles, and move around using the extra cells in the split. The post-synaptic neuron's plasma membrane is the neuron membrane in which the data are collected. Some receptors on this membrane come in and attach neurotransmitters molecules.

Steps of Synaptic Transmission

The calcium ions move very quickly inside the membrane although the nerve impulses reach the **terminal buttons** of the **presynaptic neuron**. This causes the vesicles to circulate and blend to the partition of the presynaptic neuron membrane in the synaptic button. When this happens, the vesicles release the neurotransmitters. The neurotransmitters make over through the synaptic split and attempt to reach the **postsynaptic neuron plasma membrane**. They are attached to the receptors on the **postsynaptic neuron membrane**. This creates a local post-synaptic potential. In the membrane, **sodium ions** are much faster than potassium from the membrane because of the exciting neurotransmitters. **This is called an exciting possibility after synaptic (EPSP**). Once the EPSP threshold point is reached, the action potential is initiated within the post-synaptic membrane. The inhibiting neurotransmitters that cause potassium ions to move inside are used to open the potassium canals. This is much more adverse than restful to the membrane. This temporary state of hyperpolarization is called the postsynaptic inhibitor (IPSP).The synaptic button is returned to neurotransmitters not attached to the receptors. Either they are returned to the synaptical vesicles, or the synaptic enzymes are degraded in a process known as the recovery. This removes the synapse of the next release of the neurotransmitter. (For example, highly addictive stimulant drugs such as cocaine blocking recovery process when consumed affect the nervous system).

Importance of Synapse

- Synapse is important in the nervous system's functioning

- It assist link neurons in sync through synapses and therefore transmits information that arbitratebehavioural answers. If synaptic dysfunction occurs, it can result in behavioural change and lead to depression, schizophrenia etc.
- Synapse ensures that impulses that pass through neurons should only go one way. But how do neurons ensure that pulses are one-directional? Denn only the pre-synaptic membrane contains transmitters, and only the post-synaptic membrane can be found with the receptor molecules. Therefore, impulses only go one way.

Synapse helps to integrate impulses from various neurons

• Helps to filter out undesirable and unrequired stimuli. An incentive should reach +40mV of action to span a synaptic divide. If the pulses are weak, i.e. less than 40mV, sufficient neurotransmitters cannot be generated. As a result, our body does not react to these stimuli so that unnecessary stimuli are filtered.Keywords:

bioelectricity , electricity, neurons, axon, synopses , Resting Membrane Potential, Dendrites, depolarization, All- and Non Law, terminal buttons, sodium ions, Potassium ions, postsynaptic exciting possibility (EPSP), postsynaptic inhibitor (IPSP), the synaptic enzymes.

Summary:

5 The neural system coordinates and integrates functions as well as functions of all organ metabolism and homeostatic. Neurons, functional units of the neural system, due to a differential ion gradient concentration across the membrane, are excitable cells. The electrical difference between the rest of the neural membrane is known as the 'restorative potential.' A wave of depolarization and repolarization is carried out along the axon membrane. A synapse consists of pre-synaptic neuron membranes and the post-synaptic neuron which can be separated, or cannot, by the gap known as the synaptic cleft. Chemicals involved in chemical pulse transmission.

4.6 Self-Assessment

Q1 In order to initiate an action potential, electrical impulses collect and accumulate which part of a neuron?

A) 'Dendrites'
B) Hillock of axon
C) Branches of the Axon terminal
D) Ranvier Node

Q2 What is the main cause of the negative neuronal membrane rest potential (about -70 mV)?

A) Schwann cells axonal isolation.
B) the opening of sodium voltage-gated channels
C) The potential for action..
D) Current leaks of potassium

Q3 Typically, Aα fibers carry action potentials to signal which?

A) The CNS in contact with painful stimuli.
B) the CNS in terms of change in the surface temperature of the body
C) The viscera to increase intestinal motility.
D) Contract skeleton muscles.

Q4 The following mechanisms apply to local anesthesia drugs:

A) Internal blocking of axon-voltage-gated sodium channels

B)locking release of the neurotransmitters of neuronal terminals

C) Blocking synapse nicotinic receptors of the acetylcholine

D) Inhibit the synapse effect of acetylcholinesterase

Q5 What is Schwann cells' role in neurotransmission?

A) neuronal axon thermal insulation
B) Limit the rate of the potential for action
C) Improve the speed of the potential
D) Protect from trauma the neuronal soma

Q 6 Which portion of the action potential is responsible for opening the axon membrane voltage-gated potassium channels?

A) Depolarization membrane

B) Repolarization membrane

C)Post synaptic muscle fiber contraction

D)Signal of neurotransmitter vesicular release.

Q7 What medicine is used as a neuromuscular blocker that impedes neurotransmission?

A) "Lidocaine"
B) Tetrodotoxin
C) 'Suxamethonium'
D) Tubocurarine

Q8 What would you expect from the following neurotransmitters when the synapse is inhibitory? In your synapse?

A) Glutamate
B) Noradrenaline
C) 'Acetylcholine'
D) 'GABA'

Q 9 What is the name of the mechanism by which the possible action promotes a skeletal muscle contract?

A) Endplate-contraction generation

B) Excitation-contraction coupling

C) Inhibition-contraction coupling

D)Endplate potential generation

Q10 What is the term between a neuron and its target cell?

A) Post synaptic membrane
B) Synaptic cleft
C) Dendritic spine
D) Axon Terminal

Answers							
01	02	03	04	05	06	07	08
b	d	d	a	c	b	c	a
09	10	11	12	13	14	15	

c	b						

4.7 .Review Questions

Q1Discuss the Action Potential ?

Q2 Explain absolute refractory period and the relative refractory periods.

Q3 Draw structure of synapses and explain it **?**

Q4 Discuss the synaptic transmission and its steps with diagram.

Further Reading

Book : BIOLOGY OF BEHAVIOR, PSYCHOLOGY: THE SCIENCE OF BEHAVIOR, Neil R. Carlson, University of Massachusetts, Amherst C. Donald Heth, The University of Alberta Harold Miller, Brigham Young University John W. Donahoe, University of Massachusetts, Amherst William Buskist, Auburn University G. Neil Martin, Middlesex University.

General Psychology: An Introduction Tori Kearns East Georgia State College, tkearns@ega.edu Deborah Lee East Georgia State College, dlee@ega.edu

Visit www.ablongman.com/replocator to contact your local Allyn & Bacon/Longman representative

http://www.egyankosh.ac.in/bitstream/123456789/61406/1/Unit2.pdf

UNIT 5: NEURTRANSMITTERS

Divya Srivastava, Lovely Professional University

Contents

Objectives:

Explain neurotransmitters .

discuss types of neurotransmitters.

Will be able to understand Functions of neurotransmitters

Introduction:

5.O Neurotransmitters

'Neurotransmitters are a synthesis found in the synaptic vesicles and, when delivered, effect the following cell. It is in a neuron, as the name suggests, and something specific is communicated. The terminal catches discharge synapses at the point when neurons fire. More than 100 distinct synapses have been produced. In three groups of small atomic neurotransmitters,'

'Amino acids, monoamines, acetylcholine and neurotransmitters will be arranged. A fourth collection of unconventional neurotransmitters is taking place in this class. The collection of huge neuropeptides is one. The neuropeptides are specific. Neurons and nerve impulses are often excited or restrained by 42 synapses. However, a few synapses create excitement and restraint under one circumstance in the other'

5.1 Types of Neurotransmitters

Catecholamines, Glutamate, Histamine, Serotonin and some neuropeptides are different kinds as acetylcholine (ACh). Nerve transmitters also exist. The main synapse was ACh distinguished. ACh plays an important role in neuro-strength, rest control, training and memory. It also stimulates the

skeletal muscle constriction in the heart muscles but facilitates their recovery. Inhibitory synapses include Gama-Aminobutyric Acid (GABA), Glycine, and a few peptides. The synapses of amines are responsible for sentiments, engine control, etc. Monoamines include dopamine, norepinephrine, and epinephrine. It looks like monoamines. Motor capacity with epin is used."

'The most well-known neurotransmitters engaged with protein amalgamation are amino acids. Any unevenness within the sight of the GABA synapse may likewise incline stroke conditions when glutamates annihilate certain neurons. GABA is a significant inhibitory neurotransmitters. It adds to the decrease of dread. Glutamate, then again, is the fundamental excitatory synapse. Overactivation and neuronal harm may result from overabundance glutamate. Neuropeptides are known as endorphins and affect the body.'

Table 2.1: Important Neurotransmitters and their functions

Neurotransmitters	Functions
Acetylcholine (ACh)	Affects movement, learning, memory, REM sleep
Gaba-Aminobutyric Acid(GABA)	Acid Facilitates neural inhibition in the central nervous system (too much action potential)
Endorphins	Provide relief from pain and feelings of pleasure and well-being
Dopamine (DA)	Controls voluntary movements of the body and affects movement, attention, learning, reinforcement, pleasure
Norepihephrine (NE)	Affects eating, alertness, wakefulness
Epinephrine	Affects metabolism of glucose, energy release during exercise.
Serotonin (5HT)	Affects mood, sleep, appetite, impulsivity, aggression

- 'The above record of neurotransmitters shows that the synthetic substance can have an exhilarating or inhaling effect. This helps us understand why experts endorse a few medicines for the treatment of a problem or dangerous medications And it's supposed to be forested. A medication can be performed as an agonist that means the synthetic can copy or increase the impact of the cell's subsequent expansion or decrease of cell movement on receptor destinations. For instance, GABA is an agonist for stress drugs like diazepam. As you found that GABA is an inhibitor synapse, medication and medication expands the inhibitor activity directly through/"
- Excitatory neurotransmitters urge the target cell to move.

- • Inhibitory neurotransmitters decreases the probability of objective cell movements. These synapses sometimes have a relaxing effect.
- • Neurotransmitters can send messages to many neurons at the same time . They speak with various synapses in addition.
- Acetylcholine : 'Acetylcholine generate muscle tightening, incitement and heartbeat control of certain chemicals. It also takes on a significant part in the brain capacity and memory. It's stimulation of synapse. Low levels of acetylcholine, like people with Alzheimer's disease, are related with memory and thought issues. Some Alzheimer medicines help prevent acetylcholine in the body and help control some side effects such as cognitive declines. With significant acetylcholine levels, muscle withdrawal can be excessive. This can lead to convulsions, adaptation and other medical issues. A structure square of acetylcholine is additional choline available in many foods.'
- **Dopamine :'**Dopamine is important for memory, learning, behaviour and coordination of developments. Many know that dopamine is a joy or prize synapse. The mind releases dopamine in pleasurable exercises. Dopamine is also responsible for the development of muscles. A lack of dopamine may lead to infection with Parkinson. The grade of dopamine may be modified by a decent eating routine. The body has to supply dopamine with selected amino acids, and rich protein contains amino acids. The use of high measures of soaked fat can lead to less dopamine action, as indicated by the research led in2015. Furthermore, insufficient nutrient D could lead to low dopamine movement by some supposed sources. Where do we go?'
- **Endorphin : '**Paint signals, energy and euphoric inclination by endorphins are limited. Paint signals They are also the common experts in torment calming the body. Among other practises that have been implemented to improve endorphins are high-impact practises. For example, the arrival of endorphins is "high runner." In addition, Trusted Source research shows that chuckling releases endorphins. In the fight against torment, endorphines can be added. In certain migraine problems, the National Headache Foundation says that low endorphine correlations can be significant. Fibromyalgia can also be increased by the absence of Endorphin. The Arthritis Foundation suggests that it be able to support endorphins'.
- **Epinephrine**: Epinephrine, also referred to as adrenaline, is involved in a "fighter or flight" reaction of the body. It's a chemical synapse. Epinephrine could be delivered if an

individual is focused or fearful. Epinephrine expands your pulse and breath and increases energy in your muscles. It also helps the mind to choose the danger quickly. Whilst epinephrine may be helpful if a person is undermined, a lot of the chemical can be delivered at a constant pressure. Long-term pressure, like reduced resilience, high blood pressure, diabetes and cardiovascular diseases, can lead to medical problems over some time. People who face high pressure can reach:

- **"Asthma attacks'**
- **'heart capture'**
- **'Severe diseases',**

'a genuine unfavorably susceptible response Asthma'.

The capacity of epinephrine to vein limitation can diminish aggravation because of hypersensitive responses and asthma assaults. Additionally, epinephrine serves to re-commitment the heart on the off chance that it quits during heart capture**.**

GABA:'A gamma-aminobutyric corrosive temperament controller (GABA). It has a blocking effect that prevents over-energizing of neurons. Low levels of GABA can therefore lead to tension, turmoil and disturbance. Drugs for the treatment of tension are benzodiazepines or "benzos." They work through the expansion of the GABA business. This has a soothing effect, which can handle mental disorders. GABA is available for an additional structure, but it is not clear whether these improvements improve the degree of GABA in the body, as demonstrated by certain examinations. Serotonin: Serotonin: Serotonin is a restraining synapse. It contributes to the control of temperament, craving, blood clotting, rest and circadian beat.'

Sessional emotional issue **(SAD**), "In pre-winter and winter, when the light is less abundant, it causes side effects in melancholy. SAD is linked to lower levels of serotonin, shows exploration. The serotonin-norepinephrine reuptake inhibitors (SNRIs, for example) increase serotonin and norepinephrine measurement. Dismissive, restless, persistent agony and side-effects of fibromyalgia are taken by SNRIs. A few checks Confidence Source Confidence Source PubMed Central In-depth insight of the National Institutes of Health Go to source shows that people normally can build serotonin through: light, particularly ardent daylight exercise."

Dopamine Hypothesis and the function of Glutamate in Schizophrenia

"Irregularities in dopamine transmission, such as schizophrenia, are a major cause of confusion. The theory of schizophrenia in dopamine shows that in some areas of the brain overabundance in dopamine neural connections is the cause of schizophrenia. Exploration has found that people with initial symptoms of schizophrenia have an increased dopamine arrival (pipedreams and hallucinations). Schizophrenia is the best medicines to treat dopamine receptors. Explorations have shown that the use of drugs such as amphetamines, cocaine and others has also shown manic indications and caused the introduction of substances."

Dopamine restrains glutamate cells and animates neurons which repress dopamine in an enormous number of cerebrum areas. In this manner, the impacts of dopamine development are like those of glutamate decline. Subsequently, the impact of against insane medications obstructing dopamine is either identified with a theory of overabundance dopamine or insufficient glutamate

5.4 Keywords:

'Terminal buttons, Amino Acids, Monoamines , Acetylcholine, Neuropeptides, Excitation or Inhibition, Acetylcholine (ACh), catecholamines, glutamate, histamine, serotonin and certain neuropeptides, Gama-Aminobutyric Acid (GABA), glycine, dopamine (DA) Diazepam, agonist, Excitatory neurotransmitters , Inhibitory neurotransmitters, Modulatory neurotransmitters'

5.5 Summary:

In virtually every capacity of the human body, synapses assume a part neurotransmitter should be adjusted to stay away from specific states of wellbeing like discouragement, anxiety, Alzheimer's and Parkinson's sickness. No demonstrated method of guaranteeing adjusting and working of synapses is accessible. In any case, standard exercise and stress the board can now and again help with a sound way of life. Ask a medical services supplier prior to attempting an enhancement. Meds may connect with enhancements and in any case might be risky, specifically for people with specific states of wellbeing. Ailments which are regularly brought about by a synapse unevenness.

5.6 Self-Assessment

Multiple Choice Questions.

Q1 dopamine, serotonin, and noradrenaline combine name are

A)Amines.

B) Hallucinogens.

C) Anxiolytics.

D) Neurotransmitters

Q2 presynaptic neurons of neurotransmitters releases some excess quantity of neurotransmitters called

(A) Taken up by postsynaptic neurons

(B) Recycled once again into the presynaptic neuro

(C) Removed and taken around the remainder of the body

(D) Eliminated by substances contained inside the cell body

Q3 In which disorder dopamine dies

A) Seizure disorder

B) Multiple sclerosis

C) Parkinson's disease

D) Alzheimer disease

Q4 Well -known neurotransmitters is:

A) Acetylcholine

B) Dopamine

C) Serotonin

D) All of the above

Q5 which one are Neurotransmitters?

A) Exogenous chemical

B) Endogenous chemical

C) A and B are correct

D) None of the above are correct

Q6 Neurotransmitters categories are not below given categories:

A) Monoamines

B) Amino Acids

C) Peptides

D) Adenosines

Answer d

Q7 pleasure Neurotransmitters are:

ADopamine

B) Serotonin

C) GABA

D) Peptides

Q8 Seasonal affective disorder (SAD) is linked with neurotransmitter :

A) GABA

B) Serotonin

C) Amino Acids
D) Endorphin

Q9 Anti-anxiety medication is

A) Diazepam
B) SSRIs
C) SNRIs
D) None of the above

Q10 Pain releasing agent in brain are

A) Endorphin
B) Excitatory neurotransmitters
C) Acetylcholine
D) All are right

Answers							
01	02	03	04	05	06	07	08
a	b	c	d	B	d	a	b
09	10	11	12	13	14	15	
a	a						

5.7 .Review Questions

Q 1)Writethe name of neurotransmitters and its functions?

Q2 Explain the Dopamine hypothesis?

Q.3 What is the difference between **excitation** or **inhibition?**

Q4 what is the synapse and what is the role of neurotransmitters in the gap between two neurons?

Further Reading 

General Psychology: An Introduction Tori Kearns East Georgia State College, tkearns@ega.edu Deborah Lee East Georgia State College, dlee@ega.edu

http://www.egyankosh.ac.in/bitstream/123456789/61406/1/Unit2.pdf

https://www.medicalnewstoday.com/articles/326649#dopamine

Unit 6: Basic Features of the Nervous System

CONTENTS

Objectives

After reading this unit you will be able to:

- Understand the basic units of the nervous system.
- Classify the nervous system and understand the various other systems.
- Understand the basic terminologies used in the study of anatomy.

Introduction

Nervous system is one of the major systems of our body and in psychology we always say that mind and body can never be separated. Nervous system is one thing which controls a lot of functions in the body (well, its brain after all) which we can directly relate with our psyche. In this unit we will be reading about the nervous system from the very beginning starting with the classification and components of each subsystem of it. In addition to it, we will be understanding the basic terminologies that are used in the study of biology so that we won't be having any difficulty floating through the coming units which will be a little in detail about the beauty that our human body is.

6.1 Basic terminologies

Before beginning the description of the nervous system, we will start with learning about the terminologies. In the study of anatomy, everything is named and we use specific words for directions inside the body. To study organs like brain we often cut them through various planes and to maintain uniformity and to universality we name the planes as well. For the ease of it, we will be focusing only on the nervous system for now.

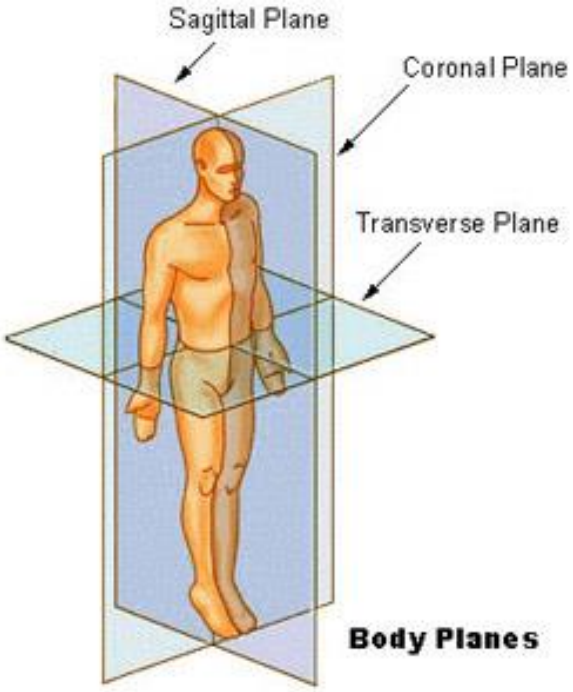
So, lets begin with the directions. The directions in the nervous system are described or we can say named relative to the **neuraxis**. Neuraxis is the imaginary linedrawn trough the centre of the length of the central nervous system, from the front of the forebrain to the bottom of the spinal cord.

If the body is placed face down it is the prone position and when the body is placed on a flat surface face up just like we lie down on our beds it is a supine position. I think everyone who works ot or does yoga will be familiar of these two terms. Next, we will make a little table for a few other important directional terms.

Anterior	At or near the front of the body (front view)
Posterior	At or near the back of the body (back view)
Midline	An imaginary vertical line that divides the body equally (right down the middle)
Lateral	Farther from midline (side view)
Medial	Nearer to midline (side view)
Superior	Toward the head/upper part of a structure (bird's-eye view, looking down)
Inferior	Away from the head/lower part of a structure (bottom view, looking up)
Superficial	Close to the surface of the body
Deep	Away from the surface of the body
Proximal	Nearer to the origination of a structure
Distal	Farther from the origination of a structure

In many cases the terms can be combined as well. For example, posterosuperior which will mean that we are talking about the posterior side of the body (back) from a superior angle. Just like looking down at someone's back.

So, these were the directional terms and now let us move on towards the planes of the body.



Coronal Plane (Frontal Plane) - A vertical plane running from side to side; divides the body or any of its parts into anterior and posterior portions.

Sagittal Plane (Lateral Plane) - A vertical plane running from front to back; divides the body or any of its parts into right and left sides.

Axial Plane (Transverse Plane) - A horizontal plane; divides the body or any of its parts into upper and lower parts.

Median plane - Sagittal plane through the midline of the body; divides the body or any of its parts into right and left halves.

There are definitely a few more important terms we will overview before moving to the classification of nervous system.

lateral Toward the side of the body, away from the middle.

medial Toward the middle of the body, away from the side.

ipsilateral Located on the same side of the body.

contralateral Located on the opposite side of the body.

cross section With respect to the central nervous system, a slice taken at right angles to the neuraxis.

frontal section A slice through the brain parallel to the forehead.

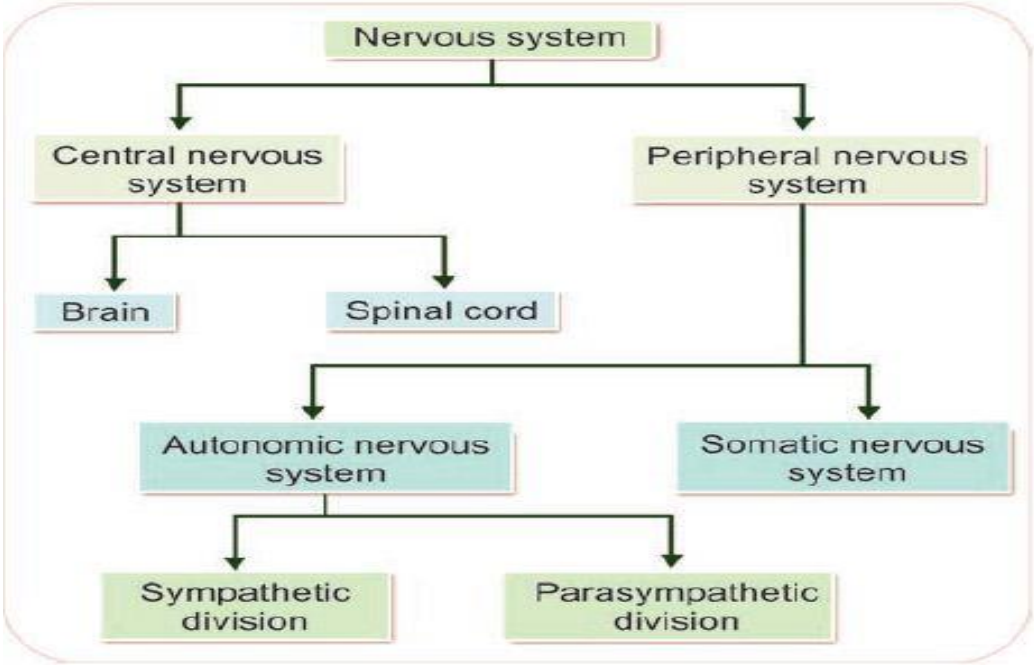
horizontal section A slice through the brain parallel to the ground.

sagittal section A slice through the brain parallel to the neuraxis and perpendicular to the ground.

midsagittal plane The plane through the neuraxis perpendicular to the ground; divides the brain into two symmetrical halves.

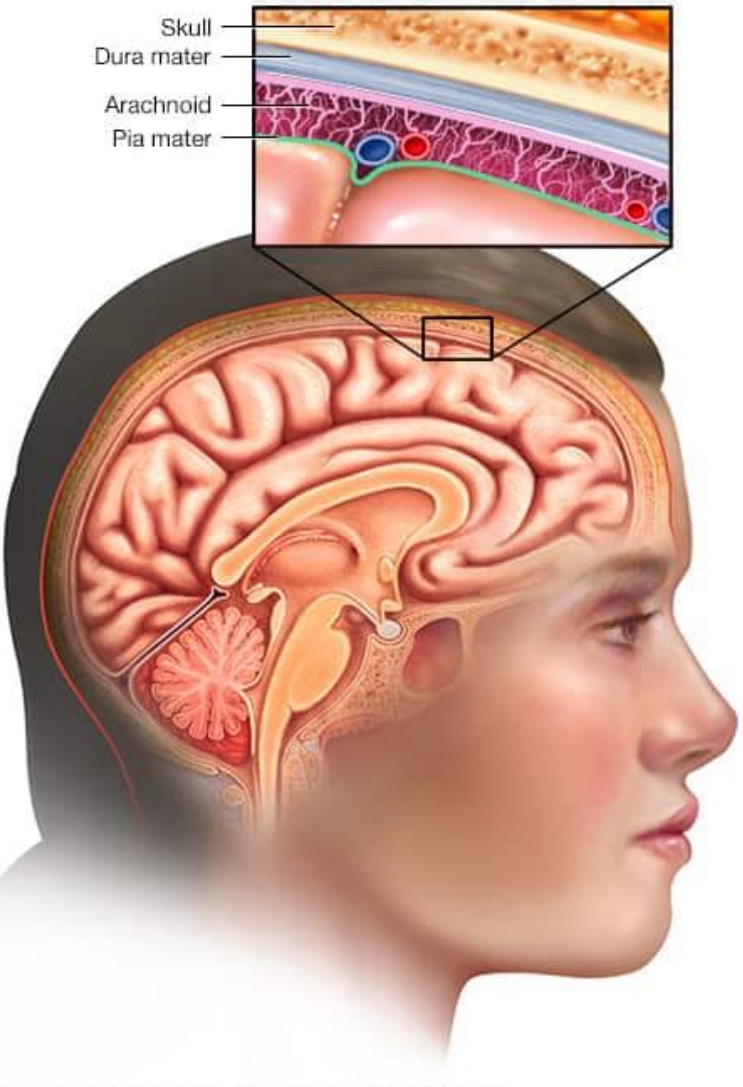
6.2 Classification of the Nervous system

The nervous system consists of two main parts, the central nervous system (CNS) and the peripheral nervous system (PNS). The CNS consists of the brain and the spinal cord. The PNS consists mainly of nerves which can connect the CNS to every other part of the body. The PNS is further divided into separate subsystems. The somatic and the Autonomic. The Somatic nervous system controls voluntary movements while the Autonomic nervous system again has subdivisions namely, sympathetic and parasympathetic nervous systems. The sympathetic nervous system is activated in case of emergencies when our bodies need to utilize all the energy available to it whereas, the parasympathetic nervous system is activated to keep the body in the relaxed state.



6.3 Meninges

The entire nervous system—brain, spinal cord, cranial and spinal nerves, and peripheral ganglia—is covered by tough connective tissue. The protective sheaths around the brain and spinal cord are referred to as the meninges (singular: meninx, the Greek word for "membrane"). The meninges consist of three layers. The outer layer is thick, tough, and flexible but unstretchable; its name, **dura mater**, means "hard mother." The middle layer of the meninges, **the arachnoid membrane**, gets its name from the weblike appearance of the arachnoid trabeculae that protrude from it (from the Greek arachne, meaning "spider"; trabecula means "track"). The arachnoid membrane, soft and spongy, lies beneath the dura mater. Closely attached to the brain and spinal cord, and following every surface convolution, is the **pia mater** ("pious mother"). The smaller surface blood vessels of the brain and spinal cord are contained within this layer. Between the pia mater and arachnoid membrane is a gap called the subarachnoid space. This space is filled with a liquid called **cerebrospinal fluid (CSF)**. The peripheral nervous system (PNS) is covered with two layers of meninges. The middle layer (arachnoid membrane), with its associated pool of CSF, covers only the brain and spinal cord. Outside the central nervous system, the outer and inner layers (dura mater and pia mater) fuse and form a sheath that covers the spinal and cranial nerves and the peripheral ganglia.



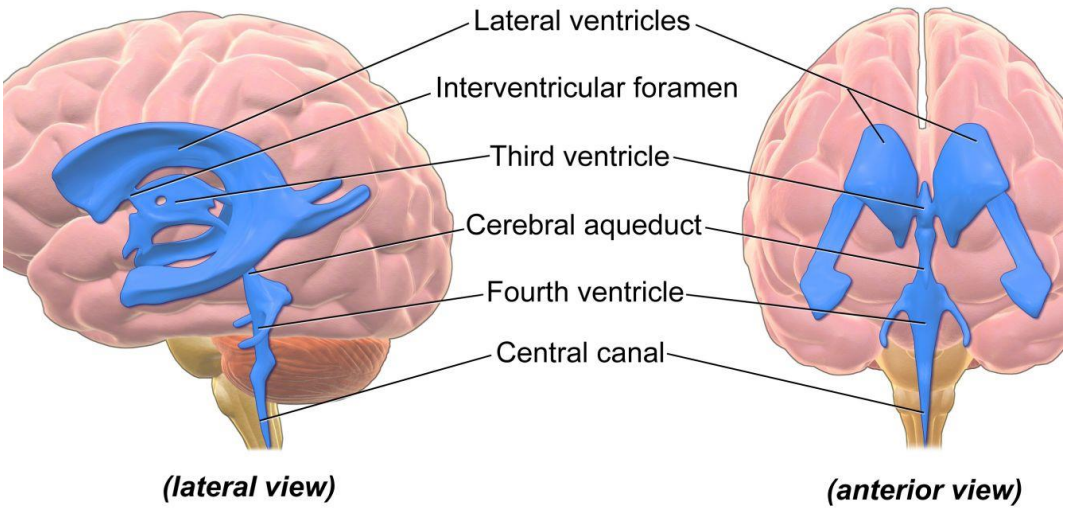
6.4 The Ventricular System

The brain is very soft and jellylike. The considerable weight of a human brain (approximately 1400 g), along with its delicate construction, necessitates that it be protected from shock. A human brain cannot even support its own weight well; it is difficult to remove and handle a fresh brain from a recently deceased human without damaging it. Fortunately, the intact brain within a living human

is well protected. It floats in a bath of CSF contained within the subarachnoid space. Because the brain is completely immersed in liquid, its net weight is reduced to approximately 80 g; thus, pressure on the base of the brain is considerably diminished.

The CSF surrounding the brain and spinal cord also reduces the shock to the central nervous system that would be caused by sudden head movement. The brain contains a series of hollow, interconnected chambers called ventricles ("little bellies"), which are filled with CSF.

The largest chambers are the **lateral ventricles**, which are connected to the third ventricle. The **third ventricle** is located at the midline of the brain; its walls divide the surrounding part of the brain into symmetrical halves. A bridge of neural tissue called the massa intermedia crosses through the middle of the third ventricle and serves as a convenient reference point. **The cerebral aqueduct**, a long tube, connects the third ventricle to the **fourth ventricle**. The lateral ventricles constitute the first and second ventricles, but they are never referred to as such. Cerebrospinal fluid is extracted from the blood and resembles blood plasma in its composition. CSF is manufactured by special tissue with an especially rich blood supply called **the choroid plexus**, which protrudes into all four of the ventricles. CSF is produced continuously; the total volume of CSF is approximately 125 ml, and the half-life (the time it takes for half of the CSF present in the ventricular system to be replaced by fresh fluid) is about 3 hours. Therefore, several times this amount is produced by the choroid plexus each day.



6.5 Summary

So, in this unit we covered basic terms that are used to study the anatomy of the human nervous system. Also, we talked about the classification of the nervous system. Central nervous system is called so because it is located centrally in our body and consists of brain and spinal cord. The peripheral Nervous system connects the central nervous system with the rest of the body with the help of its subsystems. Also, we learnt about the protective covering in which our central nervous system is, which is called the Meninges and they are 3 in number, dura, arachnoid and pia mater. Also, to keep the brain light and protected there is a fluid known as Cerebrospinal fluid which is produced by the ventricular system in our body.

6.6 Keywords

CNS, PNS, anterior, posterior, meninges, ventricles

6.7 Review questions

1. Explain the origins of the names of brain structures and the terms used to indicate directions and planes of section.
2. Describe the blood supply to the brain, the meninges, the ventricular system, and flow of cerebrospinal fluid through the brain and its production.
3. Outline the development of the central nervous system.

6.8 Self-assessment questions

1. The meninges cover the _____.
   a. Brain
   b. Spinal cord
   c. Brain and spinal cord
2. Which of the following is the correct sequence of the layers of meningeal membranes beginning with the brain and going to the skull?
   a. Pia mater, arachnoid mater, dura mater
   b. Pia meter, dura mater, arachnoid mater
   c. Dura mater, arachnoid mater, pia mater
3. The front side of the body is referred to as
   a. Dorsal
   b. Anterior
   c. Posterior
   d. None of the above
4. The sides away from the neuraxis are known as
   a. Midline
   b. Saggital
   c. Lateral
   d. Cross section
5. The basic function of meninges is
   a. Protection of the CNS
   b. Beautification of the CNS
6. The fluid that the CNS is immersed in is known as
   a. Cerebral fluid
   b. Cerebrospinal fluid
   c. Caudal-spinal fluid
7. The CSF is produced the
   a. Meninges
   b. Ventricles
   c. Spinal cord
   d. Brain
8. There are how many ventricles in the ventricular system?
   a. 4
   b. 5
   c. 3
   d. 10
9. The third and fourth ventricle are connected by
   a. Duct

b. Cerebral aqueduct
c. Central canal
d. They are not connected

10. The immersion of brain in the CSF
    a. Lightens the brain
    b. Protects from shock
    c. Protects from mechanical injury
    d. All of the above

Answer Key:

1	2	3	4	5	6	7	8	9	10
c	a	b	c	a	b	b	a	b	d

6.9 Suggested Readings

1. Kalat, J.W.. (2008), Biological Psychology, 10th. Wadsworth.
2. Alexio, P & Baillon, M. (2008), Biological Psychology: An illustrative Survival Guide, Wiley.
3. John P.J. Pinel. Biopsychology, Prentice Hall, p.608, [ISBN: 0205832563].
4. Barnes, J. (2013), Essential Biological Psychology, Sage Publications Ltd., London, [ISBN: 1847875408].

Unit 7: Central Nervous System

Objectives

After reading this unit you will be able to

- Understand the parts of Central Nervous system
- Enumerate the various structures of the brain along with their functions.
- Understand the structure of the spinal cord and origin of the nerves.
- Apply the understanding of brain functions to the human behavior.

Introduction

In this unit we will be reading about the Central Nervous System (CNS). The CNS consists of the brain and the spinal cord, so understandably this unit will dive deep inside the brain as well as the spinal cord to give you a better view and understanding on how these two works and also will help you in understanding why these organs are vital organs and how they are connected with the behavior of human being and the mental processes. By learning about the terms used in the study of anatomy, it will be much easier for you to navigate inside the brain and remember the location of the various structures of the brain.

7.1 Development of the CNS

The development of CNS begins almost by the 18th day of the conception when a tube-like structure starts developing which is known as **the neural tube**. This neural tube then develops into the brain and the spinal cord. By the twenty-eighth day of development the neural tube is closed, and its rostral end has developed three interconnected chambers. These chambers become ventricles, and the tissue that surrounds them becomes the three major parts of the brain: **the forebrain, the midbrain, and the hindbrain.**

As development progresses, the rostral chamber (the forebrain) divides into three separate parts, which become the two lateral ventricles and the third ventricle. The region around the lateral ventricles becomes the telencephalon ("end brain"), and the region around the third ventricle becomes the diencephalon ("interbrain"). In its final form, the chamber inside the midbrain (mesencephalon) becomes narrow, forming the cerebral aqueduct, and two structures develop in the hindbrain: the metencephalon ("afterbrain") and the myelencephalon ("marrowbrain")

ANATOMICAL SUBDIVISIONS OF THE BRAIN			
Major division	**Ventricle**	**Subdivision**	**Principal structures**
Forebrain	Lateral	Telencephalon	Cerebral cortex
			Basal ganglia
			Limbic System
	Third	Diencephalon	Thalamus
			Hypothalamus
Midbrain	Cerebral aqueduct	Mesencephalon	Tectum Tegmentum
Hindbrain	Fourth	Metencephalon	Cerebellum
			Pons
		Myencephalon	Medulla oblangata

7.2 The Forebrain

Forebrain is considered to be the largest part of the human brain with respect to the area covered. The two symmetrical hemispheres which we all are so familiar with are known as **cerebral hemispheres** and are a part of the forebrain. The outer part of the cerebral hemispheres is known as **the cerebral cortex** and the **subcortical regions** (The region located within the brain, beneath the cortical surface) include the limbic system and the basal ganglia.

Cerebral Cortex.

In humans the cerebral cortex is greatly convoluted; these convolutions, consisting of **sulci** (small grooves), fissures (large grooves), and **gyri** (bulges between adjacent sulci or fissures), greatly enlarge the surface area of the cortex, compared with a smooth brain of the same size. In fact, two-thirds of the surface of the cortex is hidden in the grooves; thus, the presence of these convolutions triples the area of the cerebral cortex. The total surface area is approximately 2360 cm2 (2.5 ft2), and the thickness is approximately 3 mm. The cerebral cortex consists mostly of glia and the cell bodies, dendrites, and interconnecting axons of neurons. Because cell bodies predominate, giving the cerebral cortex a grayish tan appearance, it is referred to as **gray matter**.

Beneath the cerebral cortex run millions of axons that connect the neurons of the cerebral cortex with those located elsewhere in the brain. The large concentration of myelin gives this tissue an opaque white appearance—hence the term **white matter.**

Three areas of the cerebral cortex receive information from the sensory organs. The **primary visual cortex**, which receives visual information, is located at the back of the brain, on the inner surfaces of the cerebral hemispheres.

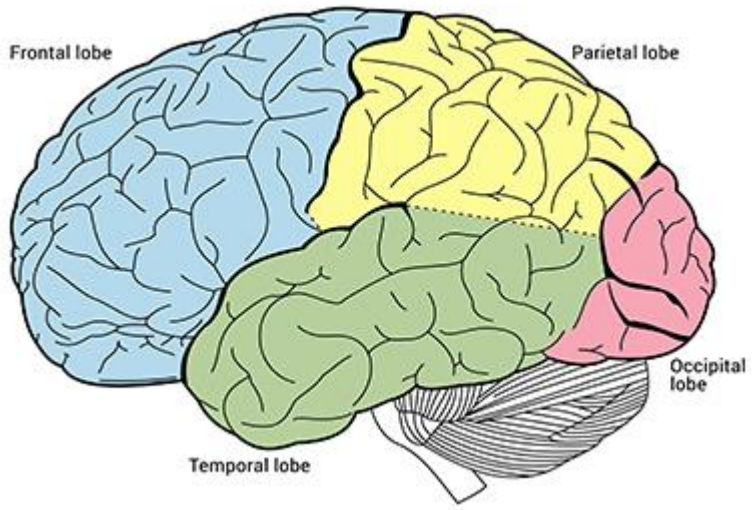
The **primary auditory cortex**, which receives auditory information, is located on the lower surface of a deep fissure in the side of the brain—the lateral fissure. The **primary somatosensory cortex**, a vertical strip of cortex just caudal to the central sulcus, receives information from the body senses.

With the exception of olfaction and gustation (taste), sensory information from the body or the environment is sent to primary sensory cortex of the contralateral hemisphere. Thus, the primary somatosensory cortex of the left hemisphere learns what the right hand is holding, the left primary visual cortex learns what is happening toward the person's right, and so on.

The region of the cerebral cortex that is most directly involved in the control of movement is the **primary motor cortex**, located just in front of the primary somatosensory cortex. The regions of

primary sensory and motor cortex occupy only a small part of the cerebral cortex. The rest of the cerebral cortex accomplishes what is done between sensation and action: perceiving, learning and remembering, planning, and acting.

The cerebral cortex is divided into four areas, or lobes, named for the bones of the skull that cover them: **the frontal lobe, parietal lobe, temporal lobe, and occipital lobe**. Of course, the brain contains two of each lobe, one in each hemisphere. The frontal lobe (the "front") includes everything in front of the central sulcus. The parietal lobe (the "wall") is located on the side of the cerebral hemisphere, just behind the central sulcus, caudal to the frontal lobe. The temporal lobe (the "temple") juts forward from the base of the brain, ventral to the frontal and parietal lobes. The occipital lobe (from the Latin ob, "in back of," and caput, "head") lies at the very back of the brain, caudal to the parietal and temporal lobes.



The Frontal Lobe

The frontal lobe is located in the front of the brain. They are very large and have many functions. The frontal lobes are considered to be our cognitive centre. They play a central role in our personality and how we act. They are also involved in attention skills and controlling movements.

The frontal lobes manage skills known as executive functions. These are very important skills we use for things such as problem solving, planning, making decisions and controlling our behavior. The frontal lobes work like the conductor of an orchestra who keeps all the musicians playing together harmoniously.

The Temporal lobes

The temporal lobe is located on the side of the head (temporal means "near the temples"), and is associated with hearing, memory, emotion, and some aspects of language. The auditory cortex, the main area responsible for processing auditory information, is located within the temporal lobe. Wernicke's area, important for speech comprehension, is also located here. Whereas individuals with damage to Broca's area have difficulty producing language, those with damage to Wernicke's area can produce sensible language, but they are unable to understand it.

The Parietal lobes

The brain's parietal lobe is located immediately behind the frontal lobe, and is involved in processing information from the body's senses. It contains the somatosensory cortex, which is essential for processing sensory information from across the body, such as touch, temperature, and pain. The somatosensory cortex is organized topographically, which means that spatial relationships that exist in the body are generally maintained on the surface of the somatosensory cortex. For example, the portion of the cortex that processes sensory information from the hand is adjacent to the portion that processes information from the wrist.

The occipital lobes

The **occipital lobe** is located at the very back of the brain, and contains the primary visual cortex, which is responsible for interpreting incoming visual information. The occipital cortex is organized

retinotopically, which means there is a close relationship between the position of an object in a person's visual field and the position of that object's representation on the cortex. You will learn much more about how visual information is processed in the occipital lobe when you study sensation and perception.

The brain consists of two types of tissues: Grey matter and White matter**.**

Grey matter mainly consists of various types of cells, which make up the bulk of the brain.

White matter is primarily composed of axons, which connect various grey matter areas of the brain with each other.

The exterior portion of the cerebrum is called the cortex or the cerebral mantle. The cortex is extremely convoluted, due to which, it has a large surface area. The cerebrum also includes:

Sensory areas: To receive the messages.

Association areas: These areas integrate the incoming sensory information. It also forms a connection between sensory and motor areas.

Motor areas: This area is responsible for the action of the voluntary muscles.

With the exception of olfaction and gustation (taste), sensory information from the body or the environment is sent to primary sensory cortex of the contralateral hemisphere. Thus, the primary somatosensory cortex of the left hemisphere learns what the right hand is holding, the left primary visual cortex learns what is happening toward the person's right, and so on. The region of the cerebral cortex that is most directly involved in the control of movement is the primary motor cortex, located just in front of the primary somatosensory cortex.

The motor association cortex (also known as the premotor cortex) is located just rostral to the primary motor cortex. This region controls the primary motor cortex; thus, it directly controls behavior. If the primary motor cortex is the keyboard of the piano, then the motor association cortex is the piano player. The rest of the frontal lobe, rostral to the motor association cortex, is known as the prefrontal cortex. This region of the brain is less involved with the control of movement and more involved in formulating plans and strategies.

We are not aware of the fact that each hemisphere perceives the world differently. Although the two cerebral hemispheres perform somewhat different functions, our perceptions and our memories are unified. This unity is accomplished by the corpus callosum, a large band of axons that connects corresponding parts of the cerebral cortex of the left and right hemispheres.

Limbic System

A set of interconnected brain structures formed a circuit whose primary function was motivation and emotion is known as the Limbic System. MacLean (1949) coined the term limbic system. The most important parts of the limbic system are the hippocampus ("sea horse") and the amygdala ("almond"), located next to the lateral ventricle in the temporal lobe. The fornix ("arch") is a bundle of axons that connects the hippocampus with other regions of the brain, including the mammillary ("breast-shaped") bodies, protrusions on the base of the brain that contain parts of the hypothalamus.

Hippocampus:

A forebrain structure of the temporal lobe, constituting an important part of the limbic system; includes the hippocampus proper (Ammon's horn), dentate gyrus, and subiculum

Amygdala:

A structure in the interior of the rostral temporal lobe, containing a set of nuclei; part of the limbic system.

Fornix:

A fiber bundle that connects the hippocampus with other parts of the brain, including the mammillary bodies of the hypothalamus; part of the limbic system

Mammillary bodies:

A protrusion of the bottom of the brain at the posterior end of the hypothalamus, containing some hypothalamic nuclei; part of the limbic system.

Basal Ganglia

The basal ganglia are a collection of subcortical nuclei in the forebrain, which lie beneath the anterior portion of the lateral ventricles. Nuclei are groups of neurons of similar shape. The major parts of the basal ganglia are the caudate nucleus, the putamen, and the globus pallidus (the "nucleus with a tail," the "shell," and the "pale globe"). Basal ganglia are involved in the control of movement.

Thalamus

The thalamus is situated near the middle of the cerebral hemispheres, immediately medial and caudal to the basal ganglia. The thalamus has two lobes, connected by a bridge of gray matter called the massa intermedia, which pierces the middle of the third ventricle. Most neural input to the cerebral cortex is received from the thalamus; indeed, much of the cortical surface can be divided into regions that receive projections from specific parts of the thalamus. The thalamus is divided into several nuclei. Some thalamic nuclei receive sensory information from the sensory systems. The neurons in these nuclei then relay the sensory information to specific sensory projection areas of the cerebral cortex. Other thalamic nuclei project to specific regions of the cerebral cortex, but they do not relay sensory information.

Hypothalamus

the hypothalamus lies at the base of the brain, under the thalamus. It controls the autonomic nervous system and the endocrine system and organizes behaviors related to survival of the species—the so-called four F's: fighting, feeding, fleeing, and mating. the pituitary gland is attached to the base of the hypothalamus via the pituitary stalk. Just in front of the pituitary stalk is the optic chiasm, where half of the axons in the optic nerves (from the eyes) cross from one side of the brain to the other. Much of the endocrine system is controlled by hormones produced by cells in the hypothalamus. A special system of blood vessels directly connects the hypothalamus with the anterior pituitary gland. The hypothalamic hormones are secreted by specialized neurons called neurosecretory cells, located near the base of the pituitary stalk. These hormones stimulate the anterior pituitary gland to secrete its hormones.

7.3 The Midbrain

The midbrain (also called the mesencephalon) surrounds the cerebral aqueduct and consists of two major parts: the tectum and the tegmentum.

Tectum

The tectum ("roof") is located in the dorsal portion of the mesencephalon. Its principal structures are the superior colliculi and the inferior colliculi, which appear as four bumps on the dorsal surface of the brain stem. The brain stem includes the midbrain and the hindbrain. The inferior colliculi are a part of the auditory system. The superior colliculi are part of the visual system. In mammals they are primarily involved in visual reflexes and reactions to moving stimuli.

Tegmentum

The tegmentum ("covering") consists of the portion of the mesencephalon beneath the tectum. It includes the rostral end of the reticular formation, several nuclei controlling eye movements, the periaqueductal gray matter, the red nucleus, the substantia nigra, and the ventral tegmental area.

The Reticular Formation

The reticular formation is a large structure consisting of many nuclei (over ninety in all). It is also characterized by a diffuse, interconnected network of neurons with complex dendritic and axonal processes. (Indeed, reticulum means "little net"; early anatomists were struck by the netlike appearance of the reticular formation.) The reticular formation occupies the core of the brain stem, from the lower border of the medulla to the upper border of the midbrain. The reticular formation receives sensory information by means of various pathways and projects axons to the cerebral cortex, thalamus, and spinal cord. It plays a role in sleep and arousal, attention, muscle tonus, movement, and various vital reflexes.

Red Nucleus

A large nucleus of the midbrain that receives inputs from the cerebellum and motor cortex and sends axons to motor neurons in the spinal cord. A bundle of axons that arises from the red nucleus constitutes one of the two major fiber systems that bring motor information from the cerebral cortex and cerebellum to the spinal cord.

Substantia nigra

A darkly stained region of the tegmentum that contains neurons that communicate with the caudate nucleus and putamen in the basal ganglia. Degeneration of these neurons causes Parkinson's disease.

7.4 The Hindbrain

The hindbrain consists of cerebellum, medulla oblangata and pons varolli

Cerebellum

The cerebellum ("little brain"), with its two hemispheres, resembles a miniature version of the cerebrum. It is covered by the cerebellar cortex and has a set of deep cerebellar nuclei. These nuclei receive projections from the cerebellar cortex and themselves send projections out of the cerebellum to other parts of the brain. Each hemisphere of the cerebellum is attached to the dorsal surface of the pons by bundles of axons: the superior, middle, and inferior cerebellar peduncles ("little feet"). Damage to the cerebellum impairs standing, walking, or performance of coordinated movements. The cerebellum receives visual, auditory, vestibular, and somatosensory information, and it also receives information about individual muscle movements being directed by the brain. The cerebellum integrates this information and modifies the motor outflow, exerting a coordinating and smoothing effect on the movements.

Pons

The pons, a large bulge in the brain stem, lies between the mesencephalon and medulla oblongata, immediately ventral to the cerebellum. Pons means "bridge" The pons contains a portion of the reticular formation, including some nuclei that appear to be important in sleep and arousal. It also contains a large nucleus that relays information from the cerebral cortex to the cerebellum.

Medulla oblangata

This structure is the most caudal portion of the brain stem; its lower border is the rostral end of the spinal cord. The medulla contains part of the reticular formation, including nuclei that control vital functions such as regulation of the cardiovascular system, respiration, and skeletal muscle tonus.

7.5 Spinal Cord

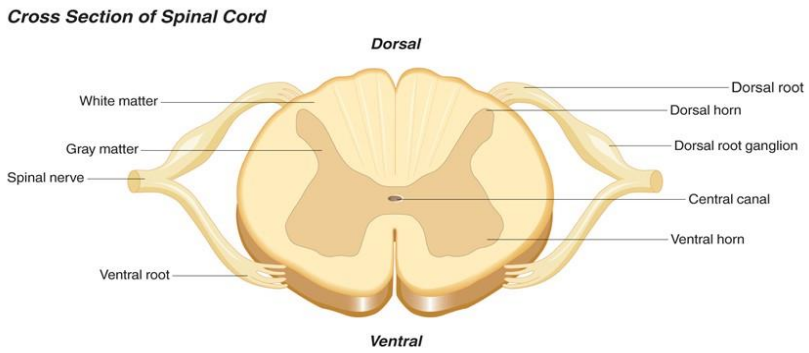
The spinal cord is a long, conical structure, approximately as thick as our little finger. The principal function of the spinal cord is to distribute motor fibers to the effector organs of the body (glands and muscles) and to collect somatosensory information to be passed on to the brain. The spinal cord also has a certain degree of autonomy from the brain; various reflexive control circuits are located there.

The spinal cord is protected by the vertebral column, which is composed of twenty-four individual vertebrae of the cervical (neck), thoracic (chest), and lumbar (lower back) regions and the fused vertebrae that make up the sacral and coccygeal portions of the column (located in the pelvic region). The spinal cord passes through a hole in each of the vertebrae (the spinal foramens).

The spinal cord is only about two-thirds as long as the vertebral column; the rest of the space is filled by a mass of spinal roots composing the cauda equina ("horse's tail")

Spinal roots: A bundle of axons surrounded by connective tissue that occurs in pairs, which fuse and form a spinal nerve.

Cauda equina: A bundle of spinal roots located caudal to the end of the spinal cord.



Like the brain, the spinal cord consists of white matter and gray matter. Unlike the brain's, the spinal cord's white matter (consisting of ascending and descending bundles of myelinated axons) is on the outside; the gray matter (mostly neural cell bodies and short, unmyelinated axons) is on the inside.

Small bundles of fibers emerge from each side of the spinal cord in two straight lines along its dorsolateral and ventrolateral surfaces. Groups of these bundles fuse together and become the thirty-one paired sets of dorsal roots and ventral roots. The dorsal and ventral roots join together as they pass through the intervertebral foramens and become **spinal nerves**.

7.6 Summary

In this unit, we covered the structure of brain and spinal cord. The brain is divided into three major divisions, namely, the forebrain, the midbrain and the hindbrain. The structures of the forebrain, the mid brain and the hindbrain control various motor and cognitive functions of the human body and as described in the unit, the damage to any of the brain area can lead to physical or mental impairment. With the help of this unit, you will be able to correlate various bodily functions with various parts of the brain. The spinal cord is also the part of the central nervous system covered with meninges and cerebrospinal fluid. The spinal cord consists of gray matter and white matter and its major function is to communicate between the periphery and the brain and also to control reflex actions. The spinal cord also gives rise to a network of nerves known as spinal nerves.

7.7 Keywords

Brain, encephalon, forebrain, midbrain, hindbrain, limbic system, corpus callosum, thalamus, hypothalamus, primary cortex, motor cortex, spinal cord, cauda equina, spinal nerves

7.8 Review Questions

1. Outline the development of the central nervous system.
2. Describe two major structures of the forebrain
3. Describe the two major structures of the diencephalon.
4. Describe the two major structures of the midbrain.
5. Explain the structure of the spinal cord.

7.9 Self-assessment Questions

1. The supporting and nutritive cells found in brains are _____
   a. Oligodendrocytes
   b. Astrocytes
   c. Microglia
   d. Ependymal cells
2. The cerebellum is located between cerebrum and the brain stem in the back of the head. It helps in _____.
   a. Breathing and control of blood pressure
   b. Balance and coordination
   c. Speech and hearing
   d. Voluntary movements
3. The brain stem is composed of _____.
   a. Brain buds and flowers
   b. Spinal cord
   c. Axon and vertebra
   d. Medulla, pons and middle brain tissue
4. What connects the two hemispheres of the brain?
   a. Pons
   b. Pia mater
   c. Corpus callosum

d. Diencephalon

5. Which part of the brain controls higher mental activities like reasoning?
   a. Temporal lobe
   b. Frontal lobe
   c. Medulla oblongata
   d. Cerebellum
6. Which part of the brain controls emotional experiences?
   a. Pia mater
   b. Hypothalamus
   c. Limbic system
   d. Medulla oblongata
7. An injury sustained by the hypothalamus is most likely to interrupt
   a. Coordination during locomotion
   b. Short term memory
   c. Regulation of body temperature
   d. Executive functioning
8. Which of these functions will be affected if the medulla is damaged?
   a. Vision
   b. Thermoregulation
   c. Memory
   d. Tactile sensation- response when prickled with a needle
9. What is the function of associated areas?
   a. Connects each other
   b. Connects to the areas of the cortex
   c. Movements of muscles
   d. Both a and b
10. What is the function of cerebral cortex?
    a. Sense of responsibility
    b. Hearing
    c. Movements of skeletal muscles
    d. All of the above

Answer Key:

1	2	3	4	5	6	7	8	9	10
b	b	d	c	b	c	c	d	d	d

7.10 Suggested Readings

1. Kalat, J.W.. (2008), Biological Psychology, 10th. Wadsworth.
2. Alexio, P & Baillon, M. (2008), Biological Psychology: An illustrative Survival Guide, Wiley.
3. John P.J. Pinel. Biopsychology, Prentice Hall, p.608, [ISBN: 0205832563].
4. Barnes, J. (2013), Essential Biological Psychology, Sage Publications Ltd., London, [ISBN: 1847875408].

Unit 8: Peripheral Nervous System

Objectives

After reading this unit, you will be able to:

- Learn about the peripheral nervous system and its components.
- Understand the origin of the Spinal nerves and cranial nerves
- Understand the mechanism of communication between brain and the rest of the body.

Introduction

In the previous unit, we studied about the central nervous system and the two major organs of the body which is the brain and the spinal cord. We also studied on how these two organs controls various bodily functions. But to do the same they need to communicate with the rest of the body. The communication system that helps the brain and spinal cord to do its function is the peripheral nervous system. In this short unit, we will be looking at the origin of the spinal nerves, the nerves that originate from the brain called as cranial nerves and also about another system of the body known as the Autonomic Nervous System. So, first we will have a look at the Peripheral Nervous System.

8.1 Peripheral Nervous System

Peripheral Nervous System (PNS) is one of the two components of the nervous system, the other one being the central nervous system. The PNS consists of many nerves and ganglia which are outside the brain and the spinal cord so that it can connect the CNS with the other parts of the body. Thus, the PNS acts as a relay between CNS and the body. The PNS conveys sensory information to the central nervous system and conveys messages from the central nervous system to the body's muscles and glands.

Spinal Nerves

The spinal nerves begin at the junction of the dorsal and ventral roots of the spinal cord. The nerves leave the vertebral column and travel to the muscles or sensory receptors they innervate, branching repeatedly as they go. Branches of spinal nerves often follow blood vessels, especially those branches that innervate skeletal muscles.

There are a total of 31 pair of spinal nerves at different levels, namely, cervical, thoracic, lumbar, sacral and coccygeal. The major function of the spinal nerves is to transmit information between the spinal cord and the rest of the body like limbs, skin and other internal organs. Each of the spinal nerve is dedicated to a different region of the body. When the spinal nerves originate from the spinal cord, they may be 31 in number only but they branch and divide all the way and are spread throughout the body.

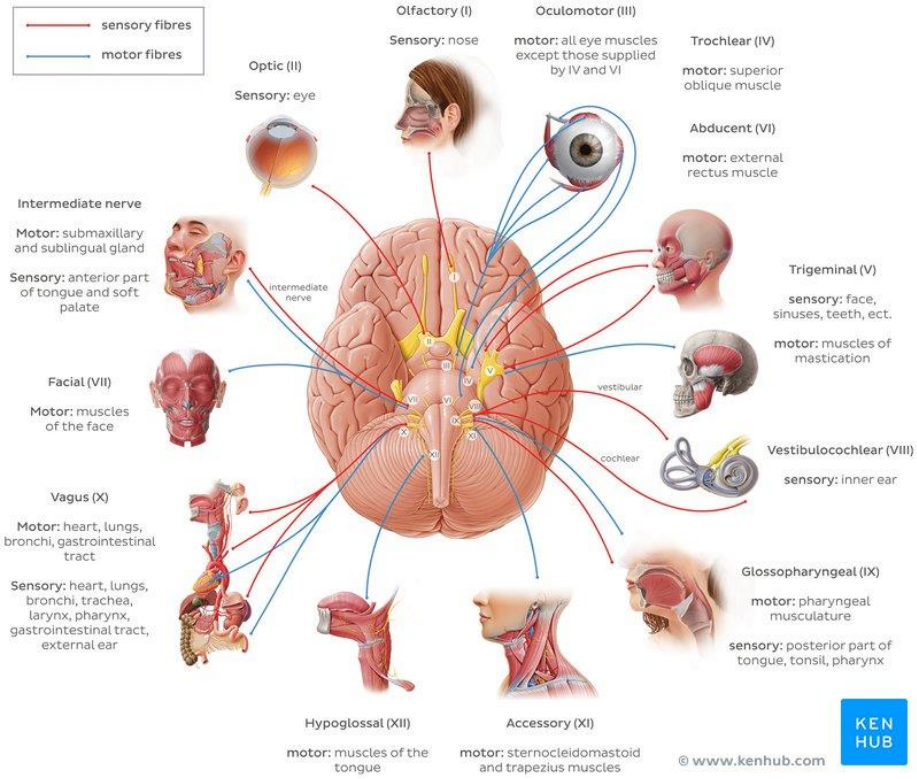
Spinal nerves are evenly spread alongside our spine and each spinal nerve emerges through the foramen of the vertebrae. The foramen are the openings that are there on the left and right side of the vertebral bone.

The cell bodies of all axons that bring sensory information into the brain and spinal cord are located outside the CNS. These incoming axons are referred to as afferent axons because they "bear toward" the CNS. The cell bodies that give rise to the axons that bring somatosensory information to the spinal cord reside in the dorsal root ganglia, rounded swellings of the dorsal root. These neurons are of the unipolar type. The axonal stalk divides close to the cell body, sending one limb into the spinal cord and the other limb out to the sensory organ.

Cell bodies that give rise to the ventral root are located within the gray matter of the spinal cord. The axons of these multipolar neurons leave the spinal cord via a ventral root, which joins a dorsal root to make a spinal nerve. The axons that leave the spinal cord through the ventral roots control muscles and glands. They are referred to as efferent axons because they "bear away from" the CNS.

Cranial Nerves

Cranial nerves are the nerves that originate from the brain. As the brain is in the cranial cavity hence the name, cranial nerves. Twelve pairs of cranial nerves are attached to the ventral surface of the brain. Most of these nerves serve sensory and motor functions of the head and neck region.



Below is the table that lists all the 12 cranial nerves along with their functions:

Cranial Nerves List	Location	Type	Function
Olfactory (I)	Cribriform plate	Sensory	Smell
Optic (II)	Optic foramen	Sensory	Vision
Oculomotor (III)	Superior orbital fissure	Motor	Eye movement
Trochlear (IV)	Superior orbital fissure	Motor	Eye movement
Trigeminal (V)	Superior orbital fissure	Mixed	Facial sensation
Abducens (VI)	Superior orbital fissure	Motor	Eye movement
Facial (VII)	Internal auditory canal	Mixed	Facial expression

Vestibulocochlear nerve (VIII) (auditory vestibular nerve)	Internal auditory canal	Sensory	Hearing and balance
Glossopharyngeal (XI)	Jugular foramen	Mixed	Oral sensation and taste
Vagus (X)	Jugular foramen	Mixed	Vagus nerve
Accessory (XI)	Jugular foramen	Motor	Shoulder elevation and head-turning
Hypoglossal (XII)	Hypoglossal	Motor	Tongue movement

8.2 The Autonomic Nervous System

Till now we have discussed the part of the nervous system that controls the voluntary sensory and motor movements. There is this another part of the PNS which controls the movements of smooth muscles and cardiac muscles and this part of the PNS is known as the Autonomic Nervous System.

Smooth muscle is found in the skin (associated with hair follicles), in blood vessels, in the eyes (controlling pupil size and accommodation of the lens), and in the walls and sphincters of the gut, gallbladder, and urinary bladder. Merely describing the organs innervated by the autonomic nervous system suggests the function of this system: regulation of "vegetative processes" in the body. The ANS consists of two anatomically separate systems: the sympathetic division and the parasympathetic division. With few exceptions, organs of the body are innervated by both of these subdivisions, and each has a different effect. For example, the sympathetic division speeds the heart rate, whereas the parasympathetic division slows it.

Sympathetic Nervous System

The sympathetic division is most involved in activities associated with expenditure of energy from reserves that are stored in the body. For example, when an organism is excited, the sympathetic nervous system increases blood flow to skeletal muscles, stimulates the secretion of epinephrine (resulting in increased heart rate and a rise in blood sugar level), and causes piloerection (erection of fur in mammals that have it and production of "goose bumps" in humans).

The Sympathetic Nervous System send axons to the target organs, such as the intestines, stomach, kidneys, or sweat glands. The sympathetic nervous system controls the adrenal medulla, a set of cells located in the center of the adrenal gland. These cells secrete epinephrine and norepinephrine when they are stimulated. These hormones function chiefly as an adjunct to the direct neural effects of sympathetic activity; for example, they increase blood flow to the muscles and cause stored nutrients to be broken down into glucose within skeletal muscle cells, thus increasing the energy available to these cells.

Parasympathetic Nervous System

The parasympathetic division of the autonomic nervous system supports activities that are involved with increases in the body's supply of stored energy. These activities include salivation, gastric and intestinal motility, secretion of digestive juices, and increased blood flow to the gastrointestinal system. When the body is relaxed, resting, or feeding, the parasympathetic nervous system is in charge of rest and digestion. After a stressful situation, it basically undoes the work of sympathetic division. The parasympathetic nervous system slows respiration and heart rate while speeding up digestion. Stimulation of the parasympathetic nervous system results in the following given below:

- Contraction of pupils

- Lower heart rate and blood pressure
- Improved digestion
- Increased saliva and mucus production
- Urine secretion increases

8.3 Summary

The spinal nerves and the cranial nerves convey sensory axons into the central nervous system and motor axons out from it. Spinal nerves are formed by the junctions of the dorsal roots, which contain incoming (afferent) axons, and the ventral roots, which contain outgoing (efferent) axons. The autonomic nervous system consists of two divisions: the sympathetic division, which controls activities that occur during excitement or exertion, such as increased heart rate, and the parasympathetic division, which controls activities that occur during relaxation, such as decreased heart rate and increased activity of the digestive system. The pathways of the autonomic nervous system contain preganglionic axons, from the brain or spinal cord to the sympathetic or parasympathetic ganglia, and postganglionic axons, from the ganglia to the target organ. The adrenal medulla, which secretes epinephrine and norepinephrine, is controlled by axons of the sympathetic nervous system.

8.4 Keywords

Peripheral Nervous System, afferent, efferent, spinal nerves, cranial nerves, Sympathetic Nervous system, parasympathetic nervous system

8.5 Review Questions

1. Describe the peripheral nervous system.
2. Explain the two divisions of the autonomic nervous system.
3. What are the major functions of the spinal nerves?
4. How many cranial nerves are present? Describe each with their functions.

8.6 Self-assessment Questions

1. Which of the followings is the function of the parasympathetic nervous system?
   a. Stimulates oil and sweat glands in the skin
   b. Pupil constriction
   c. Acceleration of heartbeat
   d. Contraction of hair muscles
2. Functions of smooth muscles, cardiac muscles, organs and glands are regulated by _____ system.
   a. Parasympathetic
   b. Sympathetic
   c. Central
   d. Autonomic
3. The basic cyclic pattern of inspiration and expiration are established by a respiratory center within the_____.
   a. Cerebellum
   b. Medulla oblangata
   c. Cerebral cortex
   d. Thalamus
4. Which portion of the brain is responsible for various emotions such as pleasure, fear and happiness?
   a. Thalamus
   b. Reticular formation

c. Hypothalamus
d. Limbic system

5. Autonomic nervous system affects:
   a. Reflex actions
   b. Visceral organs
   c. Sensory organs
   d. None of the mentioned
6. Which of the following is an example of the autonomic nervous system?
   a. Peristalsis of intestine
   b. Swallowing
   c. Movement of eyes
   d. Knee jerk
7. The brain area that most directly controls the activity of the autonomic nervous system is the _____-
   a. Pituitary gland
   b. Medulla
   c. Cerebellum
   d. Hypothalamus
8. How many pairs of spinal nerves are present in the body?
   a. 31
   b. 12
   c. 15
   d. 30
9. Spinal nerves come under which part of nervous system?
   a. Central nervous system
   b. Peripheral nervous system
   c. Somatic nervous system
   d. Autonomic nervous system
10. Through which structure, the spinal nerves leave the spinal cord?
    a. Intervertebral foramen
    b. Intervertebral ligaments
    c. Grey matter of spinal cord
    d. White matter of spinal cord

Answer Key:

1	2	3	4	5	6	7	8	9	10
b	d	b	d	b	a	b	a	b	a

8.7 Suggested Readings

1. Kalat, J.W.. (2008), Biological Psychology, 10th. Wadsworth.
2. Alexio, P & Baillon, M. (2008), Biological Psychology: An illustrative Survival Guide, Wiley.
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Unit 9: Sensory Systems

CONTENTS

Objectives

After reading this unit, you will be able to:

- Understand the structure of eye
- Understand the structure of ear
- Learn about the theories of vision
- Learn about the theories of hearing

Introduction

Sensation is the input about physical world around us which is provided by our sensory receptors which are the special receptors in our sense organs. Sensation activates our sense organs by source of any physical energy. The study of sensation includes the initial connection between organisms and their physical surroundings. Also, we study how the physical information that is received is translated in the form of electrical signals, a process known as transduction.

The sensory receptors are nothing but specialized form of neurons. Neurons are the building block of our nervous system. The senses provide us with very accurate information of whatever is happening inside and outside of the body. We generally think of five sensations like vision, hearing, taste, touch and smell, but there are more senses like somosthesis which is actually a combination of senses including touch, pressure and pain. Kinaesthetic and vestibular sensations are other extra senses which are important but very less talked about.

9.1 Sensory thresholds

Ernst Weber gave us Weber's law of just noticeable difference (jnd) also known as the difference threshold. A jnd is the smallest difference between two stimuli which we are able to detect 50% of the time. So Weber's law simply states that the jnd for different sensations is constant. The work of Ernst Weber was expanded by Gustav Fechner (1801-1887) by studying absolute threshold (Fechner, 1860). An absolute threshold is the lowest point or the minimal level of stimulation that a person can detect 50% of the time. People normally get confused between jnd and absolute threshold. Jnd is detecting difference between 2 stimuli whereas absolute threshold is detecting the minimal level of stimulation.

Examples of absolute thresholds

Sense	Threshold
Sight	A candle flame at 30 miles on a clear, dark night
Hearing	The tick of a watch 20 feet away in a quiet room
Smell	One drop of perfume diffused throughout a 3-room apartment
Taste	1 teaspoon sugar in 2 gallons of water
Touch	A bee's wing falling on your cheek from 1 cm above

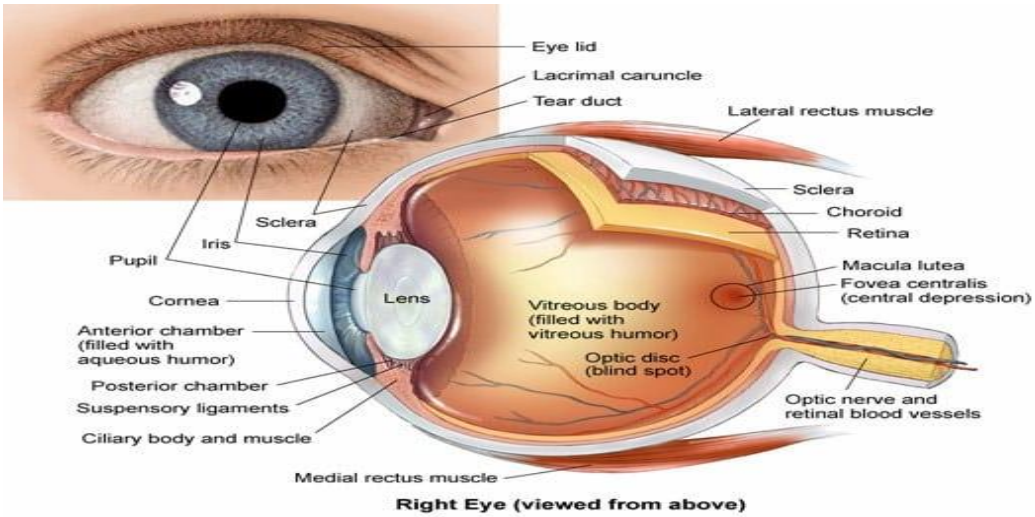
There are many a time we get influenced by stuff that is on the television or in the movies which we did not even pay a lot of attention to. How does this happen? This happens by subliminal stimuli. 'limin' means threshold so sublimin means below the threshold. The stimuli which are strong enough to activate our sensory receptors but not strong enough to get our conscious attention are known as subliminal stimuli. These subliminal stimuli affect the way we think and behave by a process known as subliminal perception.

Habituation and Sensory Adaptation

We all know that the information present around is infinite and we cannot be aware of each and everything that is going on around us. Just like we never seem to notice the sound of the fan until it is suddenly turned off. The process by which our brain deals with the information that is relatively unchanging in our environment is known as habituation. There is another process known as sensory adaptation. Sensory adaption is a process by which receptor cells become less responsive to an unchanging stimulus and no longer send signals to the brain. Just like when you first come home you can smell the odour of the garbage but after a while you no longer notice.

9.2 Visual Sensation

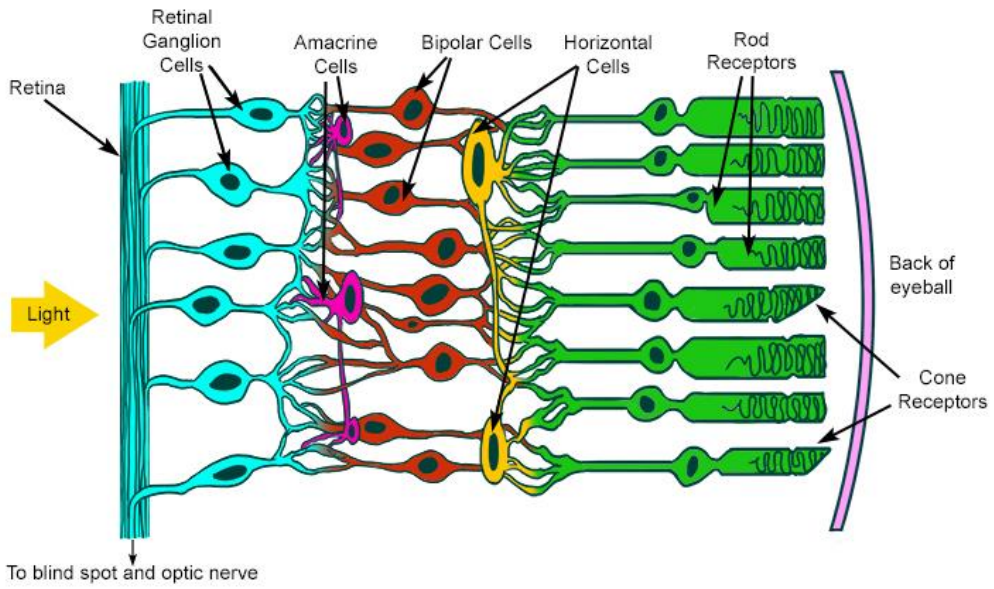
Visual sensation is the process where we take in information about the outside world through eyes. Our eyes receive the stimulus from the environment through eyes. Our eyes detect the presence of light which is a small part of the electromagnetic radiation. Our eyes can detect radiations between wavelength of 380 and 760nm. The colour of the light perceived by us is determined by us in three dimensions, namely, hue, saturation and brightness. The hue depends on the wavelength of the light wave. The colour corresponds to the wavelength of the light from the electromagnetic spectrum. If the light received by the eyes is of only one wavelength is received more pure or saturated the colour perception is. Brightness of light depends on the amplitude of the light wavelarger the amplitude brighter the colour.



Right Eye (viewed from above)

The front surface of the eye is covered by a transparent membrane known as **cornea**. The cornea protects the eye from foreign substances and also focuses the light inside the eye. The black coloured hole we can see in the centre is known as **pupil**. Light enters the inside of the eye through this hole. The pupil is formed by a round muscle known as **iris**. Iris is responsible for the colour of our eye and also is very flexible as it can change the size of the pupil and let more or less light inside the eye. Behind the pupil is the **lens** or the **eye lens**. The lens is flexible, so that it can focus the light directly onto the back of the eye which acts as a screen known as retina. So, the light enters the eye and falls on the **retina**. Retina is the light sensitive area consisting of photoreceptors cells, bipolar cells and ganglion cells. The photoreceptor cells receive the light and turn them into neuronal signals. There are two types of photoreceptor cells present in the eye, namely, **rods** and **cones**. Cones are responsible for colour vision and our ability to see very fine details. There are around 6 million cones in the retina concentrated on a point known as **fovea centralis**. Cones function at their best in brightly lit conditions. Rods function best in dim-lit conditions and are responsible for vision at night. Rods can see in black and white and are responsible for peripheral vision. There are about 100 million rods in each eye which are found all over the retina except the fovea. There is a spot in the eye where all the neurons leave the eye in the form of optic nerve which carries information from the eye to the brain. This particular spot in the eye is known as the "blind spot" as there are no rods and cones at this spot. We are not usually aware of the blind spot because of the presence of two eyes because of which there is no blind area.

The arrangement of rods and cones in the retina of the eye is shown in the image below. Alongwith the rods and cones there are several other supporting cells including glia and neurons which help in the transformation of light energy into the electrochemical energy and then that information is taken to the brain via the **optic nerve**.

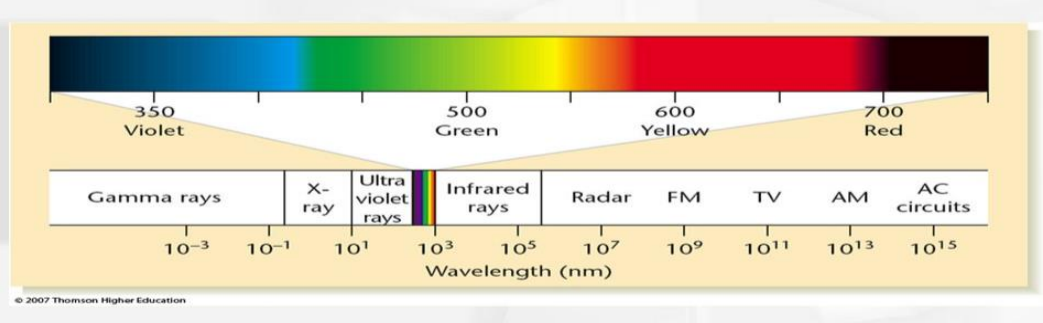


There are ganglion cells the axons of whom make up the optic nerve. The bipolar cells connect the rods and cones to the ganglion cells, whereas, the horizontal cells and the amacrine cells provide the major connection of rods and cones with the layer of bipolar cells.

9.3 Theories of Vision

Colour Vision

In the human visual system, the shortest visible wavelengths, about 350 nm (1 nm _ nanometer, or 10^{-9} m), are perceived as violet; progressively longer wavelengths are perceived as blue, green, yellow, orange, and red, near 700 nm.



The Trichromatic (Young-Helmholtz) Theory

- People distinguish red, green, yellow, blue, orange, pink, purple, greenish-blue, and so forth. But we possibly can not have a receptor specific for each colour and their shades.
- Thomas Young proposed that we perceive colour by comparing the responses across a few types of receptors, each of which was sensitive to a different range of wavelengths.
- Hermann von Helmholtz modified this theory. According to this theory, we perceive colour through the relative rates of response by three kinds of cones, each kind maximally sensitive to a different set of wavelengths. (*Trichromatic* means "three colours.")
- He concluded that three kinds of receptors—we now call them cones—are sufficient to account for human colour vision. According to the trichromatic theory, we discriminate among wavelengths by the ratio of activity across the three types of cones.
- For example, light at 550 nm excites the medium-wavelength and long-wavelength receptors about equally and the short-wavelength receptor almost not at all. This ratio of responses among the three cones determines a perception of yellow-green. More intense light increases the activity of all three cones without much change in their ratio of responses. As a result, the light appears brighter but still the same colour. When all three types of cones are equally active, we see white or grey.
- The nervous system determines the colour and brightness of the light by comparing the responses of different types of cones. (Consequently, animals such as mice, with only one kind of cone, are colour-blind.) Long and medium-wavelength cones are far more abundant than short-wavelength (blue) cones, and consequently, it is easier to see tiny red, yellow, or green dots than blue dots

The Opponent-Process Theory

Ewald Hering proposed the **opponent-process theory:** We perceive colour in terms of opposites. That is, the brain has a mechanism that perceives colour on a continuum from red to green, another from yellow to blue, and another from white to black.

The opponent process theory of colour vision suggests that our ability to perceive colour is controlled by three receptor complexes with opposing actions. These three receptor complexes are the red-green complex, the blue-yellow complex, and the black-white complex.

According to the opponent process theory, these cells can only detect the presence of one colour at a time because the two colours oppose one another. You do not see greenish-red because the opponent cells can only detect one of these colours at a time.

The opponent colour process works through a process of excitatory and inhibitory responses. For example, red creates a positive (or excitatory) response, while green creates a negative (or inhibitory) response.

After staring at an image for an extended period of time, you may see a brief afterimage in complementary colours after looking away.

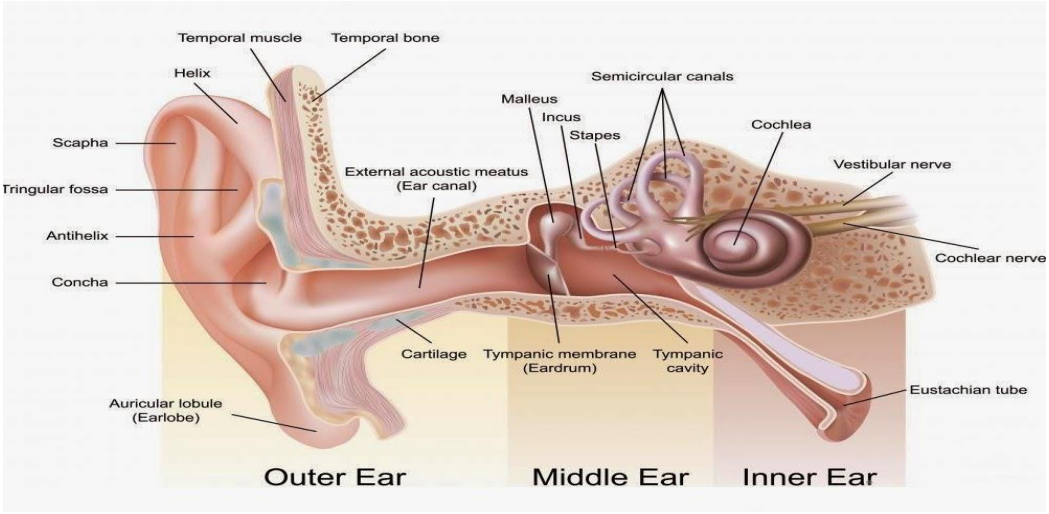
It turns out that both theories, the trichromatic theory as well as the opponent process theory, are needed to account for the complexity of colour vision. The trichromatic theory explains how the three

types of cones detect different light wavelengths, while opponent process theory explains how the cones connect to the ganglion cells.

9.4 Auditory Sensation

The auditory sensation is the process by which we receive information from the physical world through our ears. In this particular sensation our ears receives input from the physical world in the form of sounds. We can hear through solid, liquid as well as gaseous matter. The sounds are detected by ur ears in the form of mechanical waves which are vibrations detected by the ear. The vibrations which can be detected by human ear are measured in terms of frequency and it is quite vast. We can hear the sound ranging from about 20 to 20,000 Hz. Sound waves has 3 properties, namely, pitch, volume and timbre. The pitch of the sound is determined by the frequency, the loudness of the sound is determined by the amplitude of the wave- higher the amplitude, higher is the volume. The purity or timbre of the sound is determined by the wavelength of the sound waves.

The ear is a series of structures divided in three parts the outer ear, the middle ear and the inner ear.



The outer ear: the visible external part of the ear is known as the pinna. The pinna does the function of concentrating the sound waves towards the inside of the ear and also enables us to detect the direction of the sound. After the pinna the sound travels to the auditory canal or ear canal which ends at the tympanic membrane or the ear drum. When the sound waves reach the ear drum, it vibrates and makes the bones in the middle ear to oscillate.

The middle ear: the middle ear consists of auditory ossicles. The auditory ossicles are three tiny bones known as the hammer (malleus), anvil (incus) and stirrup (stapes). The malleus, incus and stapes are known as the smallest bones in the human body. These three bones amplify the vibration that they receive after the sound waves hit the ear drum. The stapes, which is the last in the chain, causes vibration in a membrane which covers the opening of the inner ear. This membrane is known as oval window.

The inner ear: the vibrations received by the oval window sets into motion a set of chain reactions inside the ear. The inner ear consists of a snail-shaped structure known as cochlea. Cochlea is a fluidfilled structure which has a membrane running all through the middle of it known as the basilar membrane. The basilar membrane houses the *organ of Corti* which has specialised hair-like cells which are the receptors for sound. It is at this place that the sound gets converted into neuronal signals and the message is sent to the brain with the help of auditory nerve.

9.5 Theories of hearing

Helmholtz or Place Theory:

According to this theory, different regions or places in the basilar membrane are sensitive to and respond to sound waves of different frequencies. Thus, the receptors in the basal end and near the three bones vibrate more when sound waves of high frequency enter.

The receptors at the top end or the end farthest from the three bones respond more to sounds of low frequency. This means that receptors of sound waves of different frequencies are placed at different places of the basilar membrane.

The theory also states that the experience of loudness of a sound depends on the total amount of the basilar membrane stimulated. Thus an intense sound would stimulate the membrane to a greater extent than a less intense sound.

Frequency Theory:

The hair cells of basilar membrane respond to the stimulus like the diaphragm of the telephone-vibrating to the frequency of the wave (i.e. pitch).

According to this theory, the pitch of a sound sensation depends on the frequency of the impulses reaching the auditory area of the brain rather than anything that happens at the basilar membrane.

Loudness would depend on the number of the nerve fibres which participate in the process. Thus, a weak sound would involve fewer fibres compared to a stronger sound.

Volley Theory:

This theory holds that the nerve fibres of the auditory nerve are activated in volleys or squads.

Different nerve fibres participate in different volleys. The volley theory therefore combines, in a way, the place theory and the frequency theory.

It, on the one hand, emphasises the fibres participating in a particular volley and on the other, the volley taking place at different levels and intensities.

It may therefore be seen that the volley theory explains more satisfactorily the different characteristics of auditory sensations by combining the advantages of the place theory as well as that of the frequency theory.

9.6 Summary

Through this unit, we got to know about the meaning of sensation and typically about vision and audition. Sensation is taking input from the outside world with the help of various sense organs that we have. We receive information through sensory receptors that are there in the sense organs like eyes, ears, nose, tongue and skin. The different sense organs have intricate biological mechanisms for receiving sensory information and transducing it into neuronal signals. Both vision and hearing has different mechanisms for completing their process. Each of these mechanisms are explained with the help of certain theories given by prominent physiologists after extensive researches. Through these theories we are able to understand the process of seeing and hearing.

9.7 Keywords

Sensation, threshold, adaptation, transduction, Vision, eye, photoreceptors, ear, auditory receptors, basilar membrane, cochlea, vestibular apparatus, theories of vision, theories of hearing

9.8 Review questions

1. What is light and how does it travel through the eye?
2. If light works like wave, does sound has similar properties?
3. Describe the internal structure of the ear.
4. What do we mean by sensory threshold?
5. Describe certain theories of hearing.

9.9 Self-assessment Questions

1. Which organ in the body facilitates the sensation of vision?
   a. Eye
   b. Ear
   c. Nose
   d. Tongue

2. What does transduction mean?
   a. Conversion of light to mechanical energy
   b. Conversion of sensory information to electrochemical energy
   c. Conversion of sensory energy into kinetic energy
   d. None of the above mentioned
3. Which of the following is responsible for night vision?
   a. Cones
   b. Rods
   c. Both a and b
   d. Crystalline lens
4. What are the 3 different types of cone cells in the human eye?
   a. Red, green and blue
   b. White, orange and yellow
   c. Red, orange and violet
   d. None of the mentioned
5. The cornea in the eye functions as
   a. Structural support
   b. Bend light before reaching the lens
   c. Change the shape of the lens
   d. Receptor site for rods and cones
6. The neurons of which type are found in the retina?
   a. Purkinje cells
   b. Schwann cells
   c. Neuroglial cells
   d. Amacrine cells
7. Which one of these is the characteristic of the fovea in the human eye?
   a. The optic nerve exits the eye
   b. Only rods are found
   c. More rods than cones are present
   d. High density of cones and no rods are present
8. The shape of the eye lens can be called as
   a. Concave
   b. Convex
   c. Biconcave
   d. Biconvex
9. Which part of the ear is very important but plays no role in hearing?
   a. Ossicles of ear
   b. Organ of Corti
   c. Eustachian tube
   d. Vestibular apparatus
10. _____ receives the vibrations of the sound and passes it on to the eardrum
    a. Outer ear
    b. Middle ear
    c. Inner ear
    d. Eustachian tube

Answer Key:

1	2	3	4	5	6	7	8	9	10
a	b	b	a	b	d	d	d	d	a

9.10 Suggested readings

1. Kalat, J.W.. (2008), Biological Psychology, 10th. Wadsworth.
2. Alexio, P & Baillon, M. (2008), Biological Psychology: An illustrative Survival Guide, Wiley.
3. John P.J. Pinel. Biopsychology, Prentice Hall, p.608, [ISBN: 0205832563].
4. Barnes, J. (2013), Essential Biological Psychology, Sage Publications Ltd., London, [ISBN: 1847875408].

Unit 10: Other Sensory Systems

CONTENTS

Objectives

After reading this unit, you will be able to:

- Learn about other sensory systems such as olfaction, gustation, vestibular sensation etc.
- Know that why Olfaction and gustation are known as chemical senses.
- Learn about the somatosenses and how pain is felt.

Introduction

In the previous unit we learnt about the two major sensory systems of the body which are vision and audition. All the other sensory systems will be discussed in this unit. The separation of the sensory systems clearly indicates the difference between the importance and complexity of the sensory systems. The vestibular system is the first thing that will be discussed in this unit as it is in continuation with the structure of ear. Then we will move on to the somato senses and then smell and taste.

10.1 The Vestibular System

The structure of the inner ear that we discussed in the last unit, also showed us a vestibular system which we could see had no role in hearing. The Vestibular system consists of two parts: the *semicircular canals* and the *vestibular sacs*.

The **vestibular sacs** are responsible for the detection of changes that occur when we tilt our head. The vestibular sacs respond to gravity to detect these changes and informs our brain about what is the orientation of our head. The **semicircular canals** are responsible for the detection of changes that occur when we rotate our head. The semicircular canals use the angular acceleration to detect these changes. Moreover, it should be noted that semicircular canals detect the changes in the rotation of our head and not the steady rotation. Both these components work together in sync and this is the reason why when we spin on the chair, we are still able to hold up our head when we stop.

Function of the Vestibular System

The functions of the Vestibular System are:

- Balance
- Maintenance of the upright position of the head

- Adjustment of eye movement w.r.t. the position of the head

The Vestibular Pathway

The vestibular nerve and the cochlear nerve are the two branches of the cranial nerve 8. Neurons from the vestibular nuclei sends out their information through the axons to the cerebellum, pons, medulla and spinal cord. There are also some vestibular projections in the temporal cortex. The feelings of nausea and vomiting when having motion sickness is the result of actions of certain vestibular projections in the lower brain. The people who have undergone any type of damage in the vestibular system, they are not able to see anything clearly while walking or running because their vestibular system is not able to coordinate and maintain balance with the other systems.

10.2 Somatosenses

The somatosenses can provide us information about what is happening on the surface of the body and due to which what is happening inside of it. When we talk about the touch sensation, we are talking about the somatosenses. We are referring to the skin and its receptors and how do they sense various things such as temperature and pain and pressure.

Receptors in the skin

Skin consists of subcutaneous tissue, dermis, and epidermis and contains various receptors scattered throughout these layers. The skin has various receptors namely, Merkel's disks, Ruffini corpuscles, Meissner's corpuscles, and Pacinian corpuscles. All of these receptors are responsible for the sensation we can feel through the skin.

Let us discuss the function of each receptor.

Merkel's disks: they are present on the upper layer of the skin. They are slow adapting receptors and can respond to light touch. By light touch we mean to say discriminative touch which can help us in pinpointing the location of the object. These receptor cells are very well defined and are very sensitive to edges which makes them best to be used for fine activities such as typing on the keyboard.

Meissner's corpuscles: these receptor cells are present on the upper dermis and are most abundant on fingertips and eyelids. They are rapidly adapting receptor cells which respond to fine touch and pressure and also respond to low frequency vibration and fluttering.

Ruffini endings: these are found in the base of the dermis. They are slow-adapting receptor cells and are able to detect the stretch in the skin and also the deformation in the joints. They provide us with the feedback on how strong or weak our grip is and if our finger and muscle movement is in control. Ruffini endings also detect warm temperatures.

Pacinian corpuscles: these receptor cells are present in the bone periosteum, joint capsules, pancreas and other viscera, breast, and genitals. They detect pressure and vibration.

10.3 Gustation

Taste buds are located on the surface of our tongues and are intended to detect substances in the mouth.The majority of taste buds are found on the tongue's top outer borders, but there are also receptors on the rear of the tongue, as well as on the mouth's walls and the back of the throat. As we all know, food dissolves in the mouth and reaches the taste buds, causing nerve signals that are conveyed to the brain.

Each of the 2,000 to 10,000 taste buds on the human tongue comprises between 50 and 100 taste receptor cells. Taste buds are engaged very quickly; even a tenth of a second of contact with a salty or sweet taste will cause a neuronal impulse.

The portion of the sensory cortex that responds to taste is extremely similar to the area that responds to smell, which helps to explain why the sense of smell also plays a role in our perception of food. You may recall having difficulties tasting meals when you were sick with a cold.

The taste bud is the primary taste organ. A taste bud is a collection of gustatory receptors (taste cells) found within the papillae, or bumps on the tongue (singular: papilla). There are various papillae that differ structurally. Filiform papillae are tactile papillae that run over the tongue and provide friction to help the tongue move substances. They do not include taste cells.Fungiform papillae, on the other hand, are found mostly on the tongue's anterior two-thirds and contain one to

eight taste buds as well as pressure and temperature receptors. The enormous circumvallate papillae, which create a V towards the tongue's posterior margin, contain up to 100 taste buds.

There are five basic tastes in humans, each of which has only one type of receptor. As with olfaction, each receptor is unique to the stimuli it receives (tastant). The five tastes are transmitted through various mechanisms that reflect the tastant's molecular composition.The sodium ions (Na^+) that enter the taste neurons are supplied by a salty tastant (containing NaCl). Acids that belong to the thermoreceptor protein family are known as sour tastants. When an acid or other sour-tasting chemical binds to the taste neurons, the ion channel changes, increasing hydrogen ion (H^+) concentrations and depolarizing them.A G-protein-coupled receptor is required for sweet, bitter, and umami tastes. These tastants attach to their specific receptors, causing the accompanying specialized neurons to fire.

10.4 Olfaction

Odorants (odor molecules) enter the nose and dissolve in the mucosa at the back of the nasal cavity, the olfactory epithelium. In humans, the olfactory epithelium is a collection of specialized olfactory receptors that spans about 5 cm^2 in the rear of the nasal cavity.When an olfactory receptor, which is a dendrite of a specialized neuron, attaches to molecules inhaled from the environment, it responds by sending impulses directly to the brain's olfactory bulb. Humans have around 12 million olfactory receptors, which are divided into hundreds of different types that respond to various aromas.

Bipolar neurons make up olfactory neurons (neurons with two processes from the cell body). Each neuron has a single dendrite buried in the olfactory epithelium, and 5 to 20 receptor-laden, hair-like cilia that trap odorant molecules extend from this dendrite. The cilia's sensory receptors are proteins. The receptors' sensitivity to diverse odorants is due to differences in their amino acid chains. Each olfactory sensory neuron has only one type of receptor on its cilia. Because the receptors are tailored to detect certain odorants, the bipolar neurons are also tailored.The sensory neuron associated with the receptor is triggered when an odorant attaches to a receptor that detects it. The only sensory input that directly reaches the cerebral cortex is olfactory stimulation; all other feelings are mediated through the thalamus.

10.5 Summary

This chapter discusses about the various sensory systems like the vestibular system which maintains our body balance and coordination along with the cerebellum and medulla. The touch receptor cells or the somatosensation that help us detects various changes on the skin. The olfactory system for our smell and gustatory system for our taste. And as we came to know how the stimulus gets attached to the receptor cells in both taste and smell sensation, we can clearly say that both these senses are chemical senses.

10.6 Keywords

Sensation, vestibular system, head rotation, angular acceleration, pain, temperature, touch, somatosensation, tase, smell, tastant, odorant

10.7 Review Questions

1. Describe the structures and functions of the vestibular system.
2. Describe the cutaneous receptors and their response to touch, temperature, and pain.
3. Describe the somatosensory pathways and the perception of pain.
4. Describe the five taste qualities, the anatomy of the taste buds and how they detect taste, and the gustatory pathway and neural coding of taste.
5. Describe the major structures of the olfactory system.

10.8 Self-assessment Questions

1. Which tongue papillae are not associated with taste buds?
   a. Fungiform
   b. Foliate
   c. Circumvallate

d. Filiform

2. Taste is also known as
   a. Mastication
   b. Gustation
   c. Olfaction
3. What are the five basic tastes?
   a. Sweet, spicy, sour, salty, umami
   b. Sweet, bitter, sour, salty, spicy
   c. Sweet, bitter, sour, salty, umami
   d. Sweet, bitter, spicy, salty, umami
4. Another name for olfaction
   a. Taste
   b. Touch
   c. Smell
   d. Hearing
5. The vestibular system can maintain body balance.
   a. True
   b. False
6. The vestibular sacs detect
   a. Head rotation
   b. Head orientation
   c. Ear rotation
   d. None of the above mentioned
7. The touch receptors are also known as
   a. Mechanoreceptors
   b. Chemoreceptors
   c. Photoreceptors
   d. None of the above mentioned
8. There are different types of skin receptor cells and all are present in the epidermis.
   a. True
   b. False
9. The olfactory receptors are present in
   a. Upper cavity of the nose
   b. At the tip of the nasal cavity
10. The taste is detected by the thread like projections on the tongue which we see in the mirror.
    a. True
    b. False

Answer Key:

1	2	3	4	5	6	7	8	9	10
d	b	c	c	a	a	a	b	a	b

10.9 Suggested Readings

1. Kalat, J.W.. (2008), Biological Psychology, 10th. Wadsworth.
2. Alexio, P & Baillon, M. (2008), Biological Psychology: An illustrative Survival Guide, Wiley.
3. John P.J. Pinel. Biopsychology, Prentice Hall, p.608, [ISBN: 0205832563].
4. Barnes, J. (2013), Essential Biological Psychology, Sage Publications Ltd., London, [ISBN: 1847875408].

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Unit 11: Cognitive functioning

Contents

Objectives

After reading this unit, you will be able to:

- Understand connections between learning
- Explain how memory is related to brain areas
- Explain the attention process and its biological basis

11.1 Introduction

Cognitive functioning is very essential for our living like learning, memory, attention, perception. In this chapter we will discuss the biological basis of few important cognitive processes.

11.2 LEARNING and MEMORY-

Learning changes our perception, action, thinking and feelings. It does so by changes in nervous system, especially circuits for perception, those related to control movement and their further connections.

In learning, the important two forms are classical conditioning and Instrumental Conditioning. As we already know these two conditionings.

Perceptual learning- this occurs because of changes in synaptic connections within association sensory cortex. Information first analyzed in ventral stream of association visual cortex and the location of stimuli is analyzed in dorsal stream.

Classical Conditioning- Classical conditioning changes the neurons response to conditioned stimulus (CS), this is according to recordings of single neurons in lateral nucleus of amygdala.

Long term- potentiation established in Lateral amygdala, this increases the responses of neurons to a particular stimulus. Blocker in lateral amygdala prevent classical conditioning.

Instrumental conditioning- In instrumental conditioning, we gain from experience. This is more related with outcome of the action. Action will occur again if result is positive and will occur less or not if result is negative. In instrumental conditioning basal ganglia plays an important role. We know that parts of brain cannot perform

function individually, rather it works in connections. There are circuits which detect the stimulus, there are circuits which helps in analyzing and circuits works for motor activities. For instrumental conditioning, there are 2 major pathways, sensory association cortex and motor association cortex. And there are direct cortical connections and via basal ganglia and via thalamus too.

Sensory and motor association cortex with direct connections involved in short term memory. And with hippocampus formation, they work for episodic memories.Trans-cortical connections are found to be involved in behavior with instructions.

Studies have revealed that learned behavior become later automatic and routine because that behavior is transferred to basal ganglia.Basal ganglia generally receive information from all cerebral cortex regions. In addition, it also receives information from frontal lobes related to movements (planned or in progress).Basal ganglia send output to frontal cortex and then information goes to premotor and supplementary motor cortex and then to primary motor cortex and execute finally.

Studies have found that damage to basal ganglia disrupt the instrumental conditioning. But this damage does not affect the other forms of learnings.Further studies indicated that Basal ganglia also involves in automatic learning. This is because evidences revealed that people with some disease of Basal ganglia showed difficulties in automatic learning responses.

Reinforcement-

There are several neurotransmitter playing roles in reinforcement, and the major one is dopamine.

Reinforcement results when neural circuits detect reinforcer and activation is in dopaminergic neurons in ventral tegmental area. Dopaminergic neurons cell bodies are in ventral tegmental area and the axons also project to nucleus acumbens,amygdala and prefrontal cortex. And stimulation in these three areas has a reinforcing effect.

Relational learning-

Anterograde amnesia is the inability to learn new information after the damage/accident.

Retrograde amnesia is the inability to remember event happened before brain damage. Korsakoff's syndrome is like severe anterograde amnesia. It is due to chronic alcoholism.

Very initial explanation about anterograde amnesia was that patient's brain is not able to consolidate short term memory to long term memory was damaged. But, perception, stimulus-response connection and motor learnings are intact. But declarative learning is not intact.

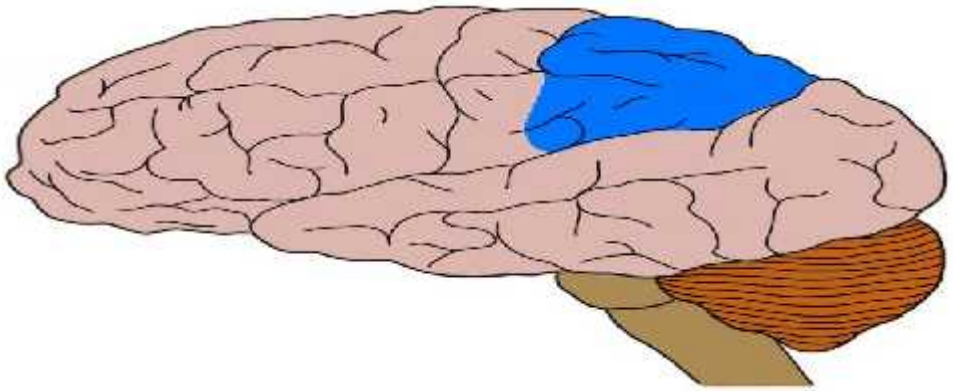
Further studies showed that damage in hippocampus formation makes people unable to learn spatial relations.Anterograde can be caused if there is damage in temporal lobes, hippocampus. Further studies revealed that people with anterograde amnesia are not able to form properly declarative memories.

11.3 Attention We know that Physiology and Psychology go hand in hand. Same in cognitive psychology, if we talk about attention process, we can't negate the role of biology in it. Now a days number of sophisticated tools or machines or apparatuses are available to understand the biological basis of attention. Studies have found the network of neurons or areas working for attention. Examples of stroop effect, our front of cerebral cortex plays an important role.

Posterior network is activated when we are involved in attending location in space. It covers the parietal part of the brain (parietal cortex).

Some relay on cerebral- blood-flow technique. Blood flow in particular region means that area is active. And this showed that there is increase of blood flow in parietal region when involved in attention to special locations.

Other important method is to study those with brain lesion or any kind of damage by stroke, or accident etc. And the studies revealed that those with damage to right parietal region had difficulty in noticing new stimulus in left side of the vision and those had damage in left parietal side had difficulty in noticing stimulus in right side of the visual field.



11.4 Summary

- Here we can conclude that various areas of brain such as hippocampus, amygdala, hypothalamus and various important neurotransmitters plays a vital role in cognitive functioning such as learning, memory, reinforcement and attention.

11.5 Keywords

Classical and instrumental conditioning

Learning and brain

Biological basis of attention

11.6 Self-Assessment Questions

Q1 What are the important forms of learning?

a) Classical conditioning
b) Instrumental conditioning
c) Both a and b
d) Neither a nor b

Q2 Anterograde is the result in damage to

a) Temporal lobes
b) Hippocampus
c) Both a and b
d) Neither a nor b

Q3 In perceptual learning the information first analyzed in

a) ventral stream
b) dorsal stream
c) rostral stream
d) caudal stream

Q4 Long term- potentiation established in

a) Lateral amygdala
b) Dorsal amygdala
c) Central amygdala
d) All the above

Q5 Damage to _____ area disrupt the instrumental conditioning.

a) hippocampus
b) basal ganglia
c) amygdala
d) endocrine glands

Q6 Anterograde amnesia is the inability to learn new information after the damage/accident.

a) Retrograde amnesia
b) Anterograde amnesia
c) Both a and b
d) Neither a nor b

Q7 _____is the inability to remember event happened before brain damage.

A) Retrograde amnesia
B) Anterograde amnesia
C) Both a and b
D) Neither a nor b

Q8 Damage in hippocampus formation makes people unable to learn _____relations.

a) Human
b) Spatial
c) People
d) Memory

Q9 In stroop effect, our _____ cerebral cortex plays role.

a) Parietal
b) Frontal
c) Occipital
d) Temporal

Q10 _____network is activated when we are involved in attending location in space.

a) Anterior
b) Posterior
c) Internal
d) External

Q11 Learning is a _____change.

a) Temporary
b) Permanent
c) Medial
d) Fixed

Q12 Which of the following area is working for memory?

a) Amygdala
b) Limbic system
c) Hypothalamus
d) Hippocampus

Q13 Which of the following comes under cognition?

a) Memory
b) Attention
c) Learning
d) All the above

Q14 Which of the following is not the sub field of psychology?

a) Cognitive
b) Biological
c) Social
d) None of the above

Q15 Perceptual learning occurs because of changes in synaptic connections within association_____ cortex.

a) Motor
b) Neurons
c) Sensory
d) None of the above

Answer Key

1C. 2C. 3A. 4A. 5B. 6B. 7A. 8B. 9B. 10B. 11B. 12D. 13D. 14D. 15C.

11.7 Review Questions 

Define classical and instrumental conditioning.

Discuss the brain areas for reinforcement.

How attention is linked with brain?

11.8Further Readings

Carlson, N. R. (2005). *Foundations of physiological psychology*. Pearson Education New Zealand.

Kalat, J. W. (2015). *Biological psychology*. Cengage Learning.

Unit 12 :Endocrine Glands

Contents

Objectives

After reading this unit, you will be able to:

- Understand the functioning of Endocrine glands
- Learn about the different hormones they secret
- Explain how they are responsible for normal body functioning

12.1 Introduction

Endocrine Glands are also a major role player in our lives. It is also because of the endocrine glands we are able to live a normal life. We will discus this in detail in next sections how it works. Firstly, it is very important to understand the overall endocrine glands. Endocrine glands are pipe less glands, it is also known as ductless glands because it runs in t the blood stream. And it secrets hormones. These hormones play an important role in every organ and part of the body. The major endocrine glands are- Thyroid, Parathyroid, Adrenal, Pancreas, Pituitary, Gonads, Penial Gland.

Let's discuss these all one by one

12.2 Thyroid Gland- the location of this gland is on the sides of windpipe i.e., trachea. Thyroid gland secrets hormone Thyroxin. Thyroxin hormone is manufactured by the combination of amino acid and iodine. It is necessary for the normal energy and activity level, it helps in maintaining the metabolic rate. The minimum level of thyroxin is required in our body for normal energy level.

Hypothyroidism – when thyroid is not able to produce the required amount of thyroxin the condition is called hypothyroidism. If it occurs in childhood, it causes cretinism. I fin adult, it causes myxedema.

Cretinism is cretin fails to develop normally either psychologically or mentally. Dwarfness, fragile bones, protruding tongue, feebleminded because the nervous system is not developed properly

Myxedema gives an individual a puffy bloated appearance. It reduces the BMR rate to 35 to 40 percent. Results in inability to maintain temperature, it also reduce the muscle tone. Can also result in CNS deterioration.

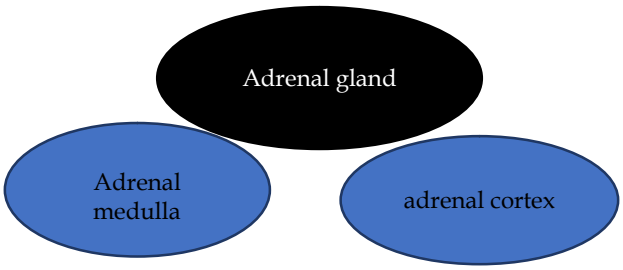
Hyperthyroidism- this is the over production of thyroxin. BMR above normal and an individual becomes hyperactive, they have huge appetite but they cannot gain weight.

12.3 Parathyroid Glands- these are four tiny organs and shaped like a flattened peas and somehow are attached to thyroid gland. The hormone secreted by parathyroid is parathormone. This parathormone is very essential in controlling calcium level and also calcium to phosphorus ratio. Calcium and calcium to phosphorus ratio are very much working for the nerve and muscle cell functioning. We need to keep in mind that high calcium level in blood results in less excitability of muscles and nervous system and low calcium level results in tissue irritability and causes convulsive seizures. So, the major role of parathormone is to increase the calcium in blood to decrease the nerve as well as muscle excitability. Other important point to consider is that parathyroid requires vitamin D to regulate the calcium and phosphorus levels.

Hyposecretion- this condition is rare in man and can be easily treatable with vitamin D or parathormone.

Hypersecretion- it is usually associated with tumors that enlarge the glands.

12.4 Adrenal Gland-this gland is divided into two parts.



Adrenal cortex- cortex means covering. Location is at the to of kidney, but it is not directly linked with it. The hormone it produces is steroids. These steroids are called corticoids. It regulates the sodium and potassium levels, govern the carbohydrates. Corticoids promote the sodium retention and potassium loss through the kidneys. Thus, it helps in maintaining the cell excitability.

Hyposecretion- it results in Addison's disease because of excess sodium elimination and excess retention of potassium by kidneys.

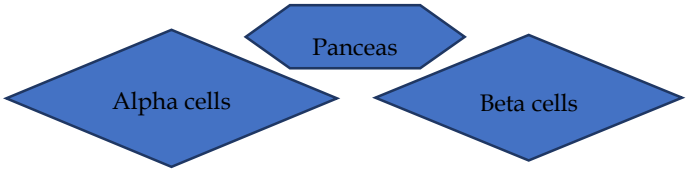
Hypersecretion- the sexual effects are more visible features. Like sexual precocity in children and masculinity in females.

Adrenal Medulla- this is the core. It is related to autonomic nervous system. The gland secrets norepinephrine and epinephrine. This is related to the arousal at the time or danger or stress. Some

evidences reported that epinephrine predominates in the state of fear and norepinephrine in the state of rage.

Hyposecretion- inability to tolerate stress, not able to maintain body temperature especially in cold and response to stimulus reduced in this case.

12.5 Pancreas-location is in the curve of the gut and between stomach and small intestine. It has two cells.



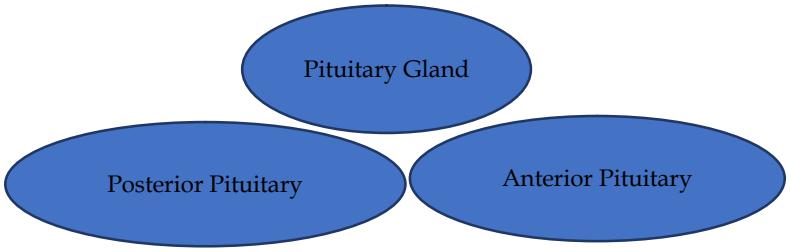
Alpha cells - these produces hormone called glucagon. They produce it by stimulating the liver. It is produced in the response to low glucose in blood.

Beta cells- it produces insulin, and it inhibits liver in making and releasing blood glucose. It also further helping lowering blood glucose by increasing the utilization of it by muscles and other tissues. Beta cell releases insulin when there is high glucose in body

Hyposecretion- of insulin causes disorder called diabetes mellitus.

Hypersecretion- results in hypoglycemia.

12.6 Pituitary gland- Pituitary gland is also known as master gland. The location of Pituitary gland is at the base of the brain and it is connected with Hypothalamus. It is divided into two parts, Posterior Pituitary and Anterior Pituitary.



Posterior Pituitary Gland- PPG secrets two hormones that is oxytocin and vasopressin. These hormones have following similar effects- (i) they increase the blood pressure by constricting the blood vessels in small arteries. It is called pressor effect.

(a) They also stimulate the contraction of smooth muscles, particularly uterus.

(b) They also help in stimulating ejection of milk.

(c) They also stimulate kidney to reabsorb water from the urine.

Vasopressin is more related to pressor and antidiuretic effects (controlling the water level in the body) and oxytocin is more related to contractions of uterus and milk production. Oxytocin also play a role in uterine contractions of labor in the childbirth.

Combination of vasopressin and oxytocin aid childbirth.

Hyposecretion of posterior gland leads to diabetes and excrete large amount of water.

Anterior Pituitary Gland- it controls the three "target" endocrine glands output with five "trophic hormones. This control is through the complex relationship between nervous system and feedback from other endocrine glands. It controls- adrenal cortex, thyroid and three activities of gonads i.e., growth of germ tissues, sex hormone production and pregnancy hormones. In addition, anterior pituitary gland also produces additional hormone STH (Somatotrophic hormone) to stimulate growth of the body.

Hyposecretion of STH inhibits growth and it results in pituitary dwarf.

12.7 Gonads and Pineal Gland-

Gonads is having two function one involves in maturation of reproductive organs and secondary sexual characteristics development. Second is growth and development of germ tissues or cells in both males and females and also work in orderly reproductive events in females.

Pineal gland, the shapeis like small pea at the top of posterior part of 3ed ventricle of the brain. It secrets hormone melatonin, it acts to beach the skin pigment cells. Pineal gland governs the activity of reproductive system but in response to light

12.8Summary

1. Endocrine glands are ductless glands.
2. Endocrine glands target all organs and tissues in body.
3. Endocrine glands secrets hormones.
4. Six major endocrine glands are- thyroid, parathyroid, adrenal, pancreas, pituitary, gonads and pineal gland.

12.9Self-Assessment Questions

Q1 _____ vitamin and hormone acts together in maintaining calcium levels but in opposition on phosphorus levels.

(a) A

(b) B

(c) C

(d) D

Q2 Addison's disease results in

(a) excessive elimination of sodium and chlorine and excess elimination of potassium

(b) excessive retention of sodium and chlorine and excess retention of potassium

(c) excessive retention of sodium and chlorine and excess elimination of potassium

(d) excessive elimination of sodium and chlorine and excess retention of potassium

Q 3 Which gland secretes norepinephrine and epinephrine when stimulated by sympathetic nervous system

(a) adrenal medulla

(b) adrenal cortex

(c) pituitary medulla

(d) pituitary cortex

Q 4 Which cells produces insulin to inhibits the liver in either making or releasing blood glucose

(a) alpha cells

(b) beta cells

(c)gama cells

(d) delta cells

Q 5 Which gland regulates the output of three target endocrine glands with five trophic hormones through complex relationship with nervous system.

(a) posterior pituitary gland

(b) anterior pituitary gland

(c) parathormone anterior gland

(d) thyroid posterior gland

Q6 Alpha cells produce by

(a) thyroid

(b) parathyroid

(c) pancreas

(d) pituitary gland

Q 7 Oxytocin and vasopressin both are produced by

(a) anterior pituitary gland

(b) posterior pituitary gland

(c) pancreas

(d)thyroid gland

Q 8 Which gland is known as master gland

(a) thyroid

(b) parathyroid

(c) pituitary gland

(d) gonads

Q 9 Thyrocalcitonin is secreted by

(a) thyroid gland

(b) thyroxin

(c) parathyroid gland

(d) parathorome

Q 10 Larynx is

(a) wind pipe

(b) voice box

(c)sliva gland

(d) digestive pipe

Q11 Hormones are secreted by

(a) Brain glands

(b) Spinal cord

(c)actocrine glands

(d) endocrine glands

Q 12 Which of the following are ductless glands

(a) endocrine glands

(b) exocrine glands

(c)pipeless glands

(d) none of the above

Q13 In case of adult, hypothyroidism is called

(a) Cretinism

(b) Myxedema

(c) Sodium-potassium balance

(d) All the above

Q14 Which gland is on the top of the posterior part of the 3rd ventricle of the brain

(a) Pineal gland

(b) Thyroid gland

(c) Parathyroid gland

(d) Gonads

Q15 Ductless means?

(a) with pipes
(b) without pipes
(c) both a and b
(d) neither a nor b

Answer Key

1D. 2D. 3A. 4B. 5A. 6C. 7B. 8C. 9A. 10B. 11D. 12A. 13B. 14A. 15B.

12.10 Review Questions

Discuss hypo and hyper conditions of Thyroid gland.

Whatpituitary gland is called master gland?

Explain the functioning of Adrenal gland.

12.11Further Readings

Carlson, N. R. (2005). *Foundations of physiological psychology*. Pearson Education New Zealand.

Kalat, J. W. (2015). *Biological psychology*. Cengage Learning.

Unit 13: Sleep

Contents

Objectives

After reading this unit, you will be able to:

- Understand and explain the physical and behavioral description of sleep
- Explain disorders of sleep
- Explain physiological mechanisms of sleep and waking

13.1Introduction

We all love sleep. According to some humans this is their best hobby to go for sleep. When we as someone what is sleep? It seems a bit difficult question to understand. Actually, sleep is a behavior, because there are behavioral changes going on while sleep. Numerous researches had proved that there are few stages of sleep. So, let's discuss those stages to understand sleep.

13.2 Stages of Sleep:- when we are awake according to EEG report normal person will show two basic activity pattern: *alpha and beta.* Alpha consist of frequency with medium waves (8-12Hz). This activity is when a person is at resting state. Mean quietly resting without engaging anywhere mentally. It is more prevalent when the eyes are closed, although may occur when eyes are open too. Other activity is beta, these are irregular and low waves (13-30Hz). This occurs when an individual is active and alert to his/her environment.

The comes stages of sleep- stage1,2,3,4

Stage 1- this is a transition b/w sleep and wakefulness. Here is the presence of theta activity.The eyelids open and close very slowly and also eyes roll up and down. 10 minutes later the person moves or enter stage 2 of sleep.

Stage 2- this stage consists of sleep spindles and k complexes. This stage is irregular. If we talk about sleep spindles, it is of short bursts of waves that occurs b/w 2 to 5 times a minute during sleep stages 1to 4. There are researches who believed that

sleep spindles contain mechanisms which helps in remain in the sleep. K-complexes sharp sudden waves and found only in stage 2 of sleep. According to researches, k complexes are the forerunner of deeper level of sleep, that is delta waves.

Stage 3- after about 15 minutes later, person enters the third stage of sleep. This is of high amplitude called delta activity. It is not clearly defined the distinction between 3rd and 4th stage, but stage 3 contains 20to 50 percent of delta activity and stage 4 consist of more than 50 percent of it.

Now above 90 minutes over, there is an abrupt change in the physiological measure. The eyes started darting back and forth in closed eyelids. This activity can be seen with the help of EOG (electrooculogram). And with the help of EMG (electromyogram) we can see that it is silent, means the muscle tonus loss. Here, the person becomes paralyzed during REM sleep. This stage is known as REM stage (rapid eye movement stage).

Stage 1 to 4 are called Non-REM sleep and stage 3 and 4 are called slow-wave sleep. Stage 4th is the deep sleep stage.

So, cycle consist of approx. 90 minutes, containing 20-30 minutes bout of REM sleep.

13.3 Sleep Disorders-

What is insomnia? Approximately 25 percent of population occasionally and 9 percent. There is no proper definition of insomnia because sleep requirement varies person to person. Some people will feel fresh and fine after 5 hours sleep and some don't feel fresh even after 8 hours sleep. Surprisingly, important cause of insomnia is medication for sleep and this is called drug dependency insomnia. Insomnia is actually a symptom.

One form of insomnia is caused by inability to breath while sleeping. This is called sleep apnea.

Narcolepsy- this is a neurological disorder. This is characterized by sleep at inappropriate times. One of the major symptoms of narcolepsy is sleep attack. Another symptom is cataplexy. During this attack the person fall in sleep suddenly and fall on floor like sack. Here REM sleep's muscle paralysis occurs. This cause inhibition of motor neurons in spinal cord.

Basically, human narcolepsy is genetic disorder and environmental factor is unknown.

REM sleep behavior disorder- this is also a neurological disorder and here the person does not become paralyzed during REM sleep and act out in his/her dream.

Problems associated with slow-wave sleep- some mal-adaptive behavior occur during stage four. These includes- bed wetting(nocturnal enuresis), sleepwalking(somnambulism) and also night terror(pavornocturnus). These all basically occurs in children and there are no evidences of association with mental disorder or any type of personality disorder.

Why do we sleep?

People generally feel or believe that sleep is very much required for the body. To give rest to body one should sleep properly. But evidence had shown us different results. Numerous experiments revealed that sleep is not required for body but it is required for the mental activity. When a person is mentally engaged they required more sleep as compared to physical exertion day.

13.4Physiological Mechanisms of sleep and waking- sleep is not the result of tired neurons, sleep occurs when certain particular circuits become active.

There are important five systems of neurons that plays an important role in alert or active wakefulness- acetyl-cholinergic system of pons and basal forebrain, noradrenergic system of

locus coeruleus,serotonergic system of raphe nuclei, histaminergic neurons of tuberomammillary nucleus, hypocretinergic system of lateral hypothalamus.

Slow-wave sleep occurs when neurons in ventrolateral preoptic area is active.

REM sleep is related to the activity of acetylcholinergic neurons in the peribrachial area increases.

So, above are some important materials related to sleep.

13.5 Summary

- Sleep is very essential for our mental activity
- There are 4 stages of sleep and 2 activity alpha and beta.
- Insomnia is not a disorder, it is symptom
- There numerous brain areas and neurotransmitters responsible for sleep and waking.

13.6 Keywords

Sleep

Sleep stages-alpha, beta, theta and delta

Insomnia, sleep apnea

cataplexy,narcolepsy

13.7 Self-Assessment Questions

1. sleep is a
   a) emotion
   b) action
   c) behavior
   d) cognition

2 .sleep is very essential for
   a) consciousness
   b) mental activity
   c) physical activity
   d) all the above

3.Full form of EMG is?

a) electromyogram

b) electromicrogram

c) electromacrogram

d) none of the above

4.EOG stands for?

a) electroogram

b) electrooculogram

c) electroogramatic

d) electrooculogramy

5. How many stages of sleep are?

a) 5

b) 4

c) 3

d) 2

6.Beta activity is linked to?

a) drowsy condition

b) sleep stage

c) sleep disorder

d) wakeful stage

7. Alpha activity is related to?

a) before stage 1

b) after stage 1

c) before stage 2

d) after stage 2

8. The deepest wave is?

a) alpha

b) beta

c) theta

d) delta

9.K complex are in which of the following stage?

a) stage 1

b) stage 2

c) stage 3

d) stage 4

10. Full form of REM is ?

a) rapid emotional movement

b) rapid endocrine movement

c) rapid eye movement

d) none of the above

11. Sleep cycle consist of approximately?

a) 80 minutes

b) 90 minutes

c) 60 minutes

d) 50 minutes

12._____ is the another name of nocturnal enuresis?

a) bed wetting

b) night terror

c)sleepwalking

d) none of the above

13.____ is sleep walking.?

a) nocturnal enuresis

b) somnambulism

c) pavornocturnus

d) all the above

14. Slow-wave sleep occurs when neurons in _____area is active.

a) ventrolateral thalamus

b) ventrolateral amygdala

c) ventrolateral preoptic

d) all the above

15.In REM sleep_____ occurs?

a) muscle paralysis

b) muscle activation

c) both a and b

d)nor a neither b

Answer Key

1C. 2B. 3A. 4B. 5B. 6D. 7A. 8D. 9A. 10C. 11B. 12A. 13B. 14C. 15A.

13.8 Review Questions

Define sleep.

Discuss the various sleep disorders.

Explain the stages in sleep.

13.9 Further Readings

Carlson, N. R. (2005). *Foundations of physiological psychology*. Pearson Education New Zealand.

Kalat, J. W. (2015). *Biological psychology*. Cengage Learning.

UNIT 14: Human Behavior & Immune System

CONTENTS

Objectives: -

After completion of this unit, students will be able to:

- Understand different components of Human Behavior and Immune System
- Know different facets of Genetics, adoption and degeneration
- Familiarize with various approaches of Immune system

Introduction:

Mark Scalars has mentioned the term Behavioral Immune System to infer psychological mechanisms which gives the individual organism to diagnose the potential presence of infectious parasites or pathogens to the immediate surroundings. Behavior Immune System has been referred to different animal species, including human. Theoretically, behavioral immune system is only referred to disease causing pathogens.

There is a deep connection between immune system and behavior. Many behavioral disorders like Autism, Schizophrenia, and depression are linked with immune system dysfunction which indirectly relate to neural functions. Extensive studies have been conducted in neurological disorders where recently the emerging role of immune system has been observed.

14.1 The Behavioral Immune System

With this idea in mind, Schaller designed a complementary defense system in 2006: the behavioral immune system (Schaller, 2006).

BIS is considered a motivational system that was developed to change behavior and reduce contact with infectious agents. It is described as a coordinated set of detection mechanisms that allow individuals to identify potential sources of pathogens, as well as emotional and cognitive mechanisms that respond to those signals and guide behaviors that move the i

individual away from contagious sources (Schaller & Park, 2011). In 2006, with this idea, Schaller conceived a complementary defense system: the behavioral immune system (Schaller, 2006). BIS is considered a motivational system that was developed to change behavior and reduce contact with infectious agents. It is described as a coordinated set of detection mechanisms that allow

individuals to identify potential sources of pathogens, as well as emotional and cognitive mechanisms that respond to those signals and guide behaviors that move the individual from infectious areas (Schaller and Park, 2011).

The behavioral immune system likely has deep evolutionary roots. It appears in a wide variety of species: from insects to amphibians and mammals. Social locusts and bullfrog tadpoles recognize and avoid their congeners infected with a deadly pathogen (Kiesecker et al., 1999; Behringer et al., 2006). In mice and rats, several studies indicate that healthy people keep their distance and reduce interactions with people whose immune system is activated (through injections of the bacterial extract LPS) (Arakawa et al., 2011; Boillat et al., 2015) . Baboon monkeys avoid caring for their infected congeners and dispense with feces (Poirotte et al., 2017). Different groups of animals have developed behavioral strategies to recognize and limit contact with pathogens and infectious individuals.

In humans, the strongest evidence for the existence of BIS comes from extensive studies of the emotional and physical response commonly known as "disgust" (Curtis et al., 2004, 2011; Oaten et al., 2009; Tybur et al., 2013).). We distance ourselves, grimace and sometimes vomit in response to the sight and smell of corpses, rotting food, bodily exudates, etc. Disgust often arises in response to potentially infectious elements and generally drives us away.

Studies showing that we can recognize sick people through various signals provide additional support for the existence of BIS in humans. For example, the clothing of test persons whose immune system has been activated (using LPS) can be sniffed (Olsson et al., 2014; Regenbogen et al., 2017) and their gait and physical appearance may be perceived as less healthy (Sundelin et al., 2015) and desirable (Regenbogen et al., 2017). Although not experimentally tested, these signs are believed to result in less exposure to potentially contagious people. One study found that training with signs of illness led people to identify as less outgoing and less open to new experiences (Mortensen et al., 2010).

Since social psychologists were the principal investigators of the BIS, the field naturally focused on human beings and their main interests became their impact on the social impact of misidentifications (e.g., social categorization, prejudice and xenophobia, differences intercultural) (Park et al., 2003, 2007; Faulkner et al., 2004; Miller and Maner, 2012). Little experimental attention has been paid to changing the behavior of BIS toward infectious individuals and the health consequences of these dynamics.

The understanding that immunity could be strengthened in the general population (for example, through vaccination interventions) supported global advances in the epidemics of acute infectious diseases in the 18th, 19th, and 20th centuries. However, in the 21st century , the world population faces epidemics of chronic diseases. Research shows that illnesses are largely the result of risky health behaviors. Understanding how health behaviors, such as the biological immune system, can be boosted in the general population could support advances in the 21st century. In order to investigate how health behavior can be strengthened in the general population, the authors present a theoretical model of population health behavior. The model operationalizes health behavior as a system of functions that, like the biological immune system, is present in all members of the population.

CURRENT SITUATION- COVID-19

Despite the recent infectious outbreaks of COVID19, chronic diseases remain the leading cause of death (Chartier and Cawthorpe, 2016) and have a strong association with human behaviors. Epidemiological research has shown that a low number of behavioral risk factors (e.g., Smoking, alcohol abuse, unhealthy diet, inactivity) and non-environmental risk factors (e.g., Exposure to infectious pathogens) are the leading cause of disability-adjusted life years (DALYs) and premature deaths in the population (Mokdad et al., 2018). Health behavior plays an important role in the prevention of acute and chronic diseases (Kretzer and Larson, 1998). This crisis awakens the need for a model that can explain the relationship between disease and behavior. The present manuscript

proposes a behavioral immune system, an adaptive behavioral immune system as a model for the health behavior of the population. Similar to the works compiled by Steinberg et al. (1981) the focus of this proposal is on integrated functions and not on separate

Future directions of the ABIS: messaging in the population. Not only can the integration of research be supported in, but the parallels between the biological and behavioral immune systems may also be useful in creating messages about the health of the population. Tangible parallels between the biological and behavioral immune systems can be helpful in tailoring intervention messages to populations. For example, not everyone in the population can immediately understand how immune receptors work. However, a larger portion of the population will be willing to understand how interventions support their ability to see the pros and cons, costs, and benefits of health changes.

By creating messages about important steps for the immunity of the population, researchers can use the logic to explain the interventions: Well-dosed vaccines (for example, the COVID19 vaccine) support the capacity of the biological immune system:

1 detect a new virus;

2. organize a useful sequence of biological responses to the virus; and.

3. Release antibodies to help these reactions over time.

Tailored behavior changes interventions (for example, using TTM Stages of Change and Decision Balance) support the ability to:

1. to recognize the advantages and disadvantages of a behavior,

2. to organize useful sequence changes in one lead a healthy lifestyle

Philosophy of Health (2020) parallels behavioral change and biological immunity, suggesting that healthy and sustained behavior change may be better understood as strengthening behavioral immunity. To do this, we present how behavior change and biological immunity show common paths of change through the functions of variation and precision (Saad and Prochaska, 2020):

1. Variation is observed in the area of the capacities of a system that has "variabilities" that maintain health under conditions that currently change.

2. Accuracy is observed when a system prioritizes and organizes variations that will maintain health in future changing conditions.

Healthy habitual patterns of breathing, drinking, eating, and moving) supports and reinforces the development of functional decisions. Complementarily, the precision of good decisions prioritizes functional variability in one's habits, leading to the development of healthy "lifestyle".

New environmental conditions (e.g., changes in temperature) impact our habits (e.g., our rhythms of breathing) each moment, leading them to vary from moment to moment. When we detect these changes, our decisions can act to prioritize functional variations in our habits so that our "lifestyle" is balanced. If variability in our habits is maintained by our decisions without the spread of an addiction, our decision-making is reinforced as "good". Why? Healthy habits, support healthy lifestyles that reinforce (i.e., make easier) healthy decisions. When functional, variation in habits and precision of decisions reciprocally integrate to support behavioral immunity.

Activation of the biological and behavioral immune system

Plants, animals and humans are exposed to the threat of pathogens. To survive and pass genes to the next generation, organisms must have avoidance mechanisms to reduce exposure to harmful pathogens, defense mechanisms to reduce the likelihood of dangerous pathogens entering vital systems, and attack mechanisms that are active as soon as pathogen is detected in the body.

To be effective, these mechanisms must be flexible enough to respond to new information in the external environment, as well as to an ever-changing variety of pathogens. This system would have to be nearly fool proof in processing and responding to stimuli, even if there are signals suggesting contradictory conclusions. For example, visible environmental cues may indicate that a particular food is good to eat, but the food may also produce odors that tell the brain that the product is bad.

Finally, while human lifestyles require an alert, adaptable, and fool proof system, these processes cannot consistently consume large amounts of energy if people also support the cognitive abilities

they possess. This system would have to be incredibly complex to regulate so much with little power. The various processes that together make up the immune system are not sufficient by themselves to meet the requirements for human survival. Psychology has collectively referred to these adaptive behaviors as the behavioral immune system (Schaller and Park, 2011).

The adaptability of BEH may be particularly important in humans, since its high daily interpersonal exchange increases the risk of infection by pathogens. The BEH is perhaps more active in the modern world in than at the beginning of its development; today, humans can cover great distances very quickly and carry pathogens with them.

The complexity of the human immune system is not without reason: infectious diseases pose an incredibly dangerous threat to human life, and the effects of deadly diseases are evident throughout history (Wolfe, Dunavan& Diamond, 2007) .

The ability to avoid an incurable disease before reproduces and has offspring would have been a vital skill for the survival of the human species as a whole. Therefore, the complexity of the dual immune system and the number of cognitive and physiological resources dedicated to its function is evidence of how the threat of disease and infection has changed the evolution of humanity (Oaten et al.,2009)

14.2 Genetics

MEANING- Genetics is the study of how genes influence health, behavior, and physical appearance. By learning how genes work, we can better understand the extent to which certain traits such as intelligence are inherited (passed down biologically from our parents).In other words, the branch of biology that is concerned with the mechanisms and phenomena of heredity and the laws that determine inherited traits. Our genetic destiny is not necessarily set in stone; It can be influenced by a number of factors, such as social factors and the environmental factors we live under, including light and temperature from exposure to chemicals. The environment in which a person grows up can trigger the expression of a behavior to which a person is genetically predisposed, while the same person who grew up in a different environment can exhibit different behavior.

ITS RELATION WITN BEHAVIORAL IMMUNE SYSTEM-

Nearly three quarters of immune traits are influenced and affected by genes, updated research from King's College London shows.

The study, published today in Nature Communications, adds a growing body of evidence that the genetic impact on our immune system is significantly greater than previously thought.

King's researchers, supported by the NIHR Center for Biomedical Research at Guy's and St Thomas` Foundation Trust and King`s College London, analyzed 23,000 immune characteristics in 497 adult twins from the TwinsUK cohort. They found that adaptive immune traits, the more complex responses that develop after exposure to a particular pathogen like chickenpox, are primarily influenced by genetics.

They also underscore the importance of environmental influences, such as our diet, in shaping innate immunity (the simple basic immune response that occurs in all animals) in adult life

The findings could help better understand the immune system and the interplay of environmental factors. It could also form the basis for future research on the treatment of various diseases, consisting rheumatoid arthritis and psoriasis.

Dr Massimo Mangino, Principal Investigator at King's College London, said: "Our genetic analysis produced some unusual results in which adaptive immune responses, which are inherently much more complex, appear to be more influenced by variations in the genome than we are" . Thought in advance. In contrast, variation in innate responses (the simple nonspecific immune response) arose more frequently from environmental differences. This discovery could have a significant impact on the treatment of a number of autoimmune diseases ".

Professor Tim Spector, Director of the TwinsUK Registry at King's College London said: 'Our results surprisingly showed how most immune responses are genetic, very personalized and finely

tuned. What this means is that we are likely to respond in a very individualized way to an infection such as a virus -- or an allergen such as a house dust mite causing asthma. This may have big implications for future personalized therapy.'

A twin study by researchers at Stanford University School of Medicine shows that our environment, more than our heredity, plays an important role in determining the state of our immune system, the body's main defense or shield against disease. This is mainly true as we age and grow, the study shows.

Much has been made of the role of genes in human health. Amazing advances in gene sequencing technologies, coupled with their decreasing costs, have drawn the attention of many scientists to tiny variations in the genome, the complete toolbox of genes found in virtually every cell in the human body, with the hope of predicting human health in the future. . These studies have shown a genetic contribution to health outcomes. But, with a few notable exceptions, very few individual genetic variants contribute a lot to certain health conditions.

"The idea in few circles were that if you sequenced a person's genome, you could tell what diseases they will have 50 years later," said Mark Davis, PhD, professor of microbiology and director of the Stanford Institute for Immunity, Transplantation and Infections. But while genome variation clearly plays a key role in some diseases, the immune system must be highly adaptable to cope with unpredictable episodes of infection, injury, and tumor formation.

While living in social groups offers many benefits, it is associated with higher levels of communicable diseases. The behavioral immune system. It is believed to have been developed as a first line of defense against these types of infections. It works by minimizing the contact of yet uninfected hosts with potential pathogens. BIS has been observed in a wide variety of animals, including insects, amphibians, and mammals, but most research has focused on humans, where BIS is guided by complex cognitive and emotional processes. When researchers discuss the evolutionary origin of BIS, they evaluate how individual fitness increases. But what if we turned our attention to the evolutionary unit of selection: the gene?

Success would be measured by changes in the prevalence of the gene in the population, and we would notice additional behaviors, those that benefit loved ones, that is, behaviors that increase inclusive fitness. A widely recognized example of inclusive BIS is social immunity, which is widespread among eusocial organisms such as bees and ants. Their colonies exert a collaborative protective behavior, Keeping and removing infected members from the nest.

Another example may be illness behaviors, which include the behavioral, cognitive, and emotional symptoms associated with infection, such as fatigue, loss of appetite, and social concern. My colleague and I recently suggested that disease behavior evolved by reducing direct and indirect contact between an infected host and its healthy relatives and improving inclusive fitness. These additional behaviors are not carried out by healthy individuals, but in the first case by entire communities and in the second case by already infected individuals. Since they go beyond the classic definition of BIS, it may make sense to broaden the term to include the inclusive BIS.

14.3 Adoption

MEANING-

The legal process by which an infant or child is permanently placed with a family other than his or her birth family. An adoption may be private, in which a birth parent voluntarily plans for the placement of the child with adoptive parents through intermediaries, or public, in which a child removed from his or her birth parent(s) because of neglect or abuse is placed with adoptive parents through public child welfare agencies. Adoptions may also be closed, allowing no contact between the birth and adoptive parents, or open, permitting varying degrees of pre- and postplacement contact and making possible a relationship between all three parties.

ITS RELATION WITH BEHAVIOURAL IMMUNE SYSTEM-

Adoption and twin studies can support to make sense of the impact of the environment and genes. Studies of adult twins are used to examine the meaning of their genetic makeup. Twins raised apart incline to be similar in intelligence and, in few cases, life events and situations, when studied years later, even when raised separately.

However, researchers have revealed that the phenotype (or the noticeable expression of a gene) of identical twins develops apart as they age and grow. In adoption studies, identical twins raised by different families can provide insight into the nature-diet debate. Since the child is raised by parents who are genetically different from his biological parents, the influence of the environment shows how similar the child is to his adoptive parents or siblings. Adoption studies speak strongly in favor of environmental impact, while twin studies speak strongly in favor of genetic influence

14.4 Degeneration

MEANING- deterioration or decline of organs or tissues, especially of neural tissues, to a less functional form.

ITS RELATION WITH BEHAVIORAL IMMUNE SYSTEM-

Your immune system helps protect or shield your body from foreign or harmful substances. Some examples are bacteria, viruses, toxins, cancer cells, and someone else's blood or tissue. The immune system produces cells and antibodies that destroy these pollutants.

CHANGES IN AGING AND THEIR EFFECTS ON THE IMMUNE SYSTEM

As you age, your immune system stops working as well. The following changes in the immune system can occur:

- The immune system reacts more slowly. This increases your risk of getting ill. Flu shots or other vaccines may not help or work as well or protect you for the expected time.
- An autoimmune disease may develop. This is a serious disease in which the immune system unexpectedly attacks, damages, or destroys healthy body tissues.
- Your body can not heal quickly. There are lesser immune cells in the body to induce healing.
- The immune system's ability to recognize and correct cell defects is also declining. This can lead to an increased risk.

PREVENTION

To decline the risks from immune system aging:

- Get vaccines to ward off the flu, infections, as well as any other vaccines your doctor recommends.
- Daily exercise. Exercise supports and boost your immune system.
- Eat a balanced diet and healthy foods. Good nutrition keeps your immune system fit and strong.
- Reduce smoking habits. Smoking weakens the immune system.
- Reduce your consumption of alcohol. Ask your doctor how much is it safe for you.
- Look into safety measures to prevent falls and injuries. A weak immune system can slow healing.

OTHER MOTIFICATIONS

As you develop and grow older, you will have other changes, including in your:

- Hormone production
- Organs, tissues, and cells

Autoimmune diseases roughly fall into two categories: "organ-specific" means that one organ is affected, while "non-organ-specific" diseases can affect multiple organs or body systems.

There are about 80 different autoimmune diseases, the severity of which ranges from mild to disability, depending on which body system is attacked and to what extent. For unknown reasons, women are more vulnerable than men, especially of childbearing age. Sex hormones are believed to be at least partially responsible for this. There is usually no cure, but the symptoms of autoimmune diseases can be treated.

Types of autoimmune disorders

- Diabetes (type I): affects the pancreas. Symptoms are thirst, frequent urination, weight loss, and increased susceptibility to infection.
- Graves' disease: affects the thyroid gland. Symptoms include weight loss, increased heart rate, anxiety, and diarrhea.
- Inflammatory bowel disease: Consists ulcerative colitis and possibly Crohn's disease. The symptoms are diarrhea and abdominal pain.
- Multiple sclerosis: affects the nervous system. Depending on the part of the nervous system affected, symptoms can include numbness, paralysis, and blurred vision.
- Psoriasis: affects the skin. Features include the development of thick, reddish skin scales.
- Rheumatoid arthritis: affects the joints. Symptoms are swollen and deformed joints. The eyes, lungs, and heart can also be attacked.
- Scleroderma: affects the skin and other structures and causes the formation of scar tissue. Features include thickening of the skin, skin ulcers, and stiff joints.
- Systemic lupus erythematosus: affects connective tissue and can affect any organ system in the body. Symptoms include joint inflammation, fever, weight loss, and a characteristic rash.

Risk factors for autoimmune diseases

The exact causes of autoimmune diseases are unknown. Risk factors include:

- Genetics: predisposition to autoimmune diseases appears to run in families. However, family members can be affected by various disorders; For example, one person may have diabetes while another has rheumatoid arthritis. It appears that genetic susceptibility alone is not sufficient to trigger an autoimmune response, and other factors must contribute.
- Environmental factors: A family's susceptibility to autoimmune diseases may be related to general environmental factors, possibly related to genetic factors.
- Gender: About three-quarters of people with autoimmune diseases are women.
- Sex Hormones: Autoimmune diseases occur in childbearing years. Some medical conditions appear to be influenced for better or worse by major hormonal changes such as pregnancy, childbirth, and menopause.
- infection - Some conditions seem to be triggered or worsened

Diagnosis of autoimmune diseases

Diagnosis of autoimmune diseases It can be difficult to diagnose an autoimmune disease, especially in its early stages and when multiple organs or systems are involved.

Depending on the condition, diagnostic methods may include:

- physical examination
- medical history blood tests
- autoantibodies
- biopsy
- x-rays.

Treatment of autoimmune diseases –

Autoimmune diseases generally cannot be cured, but in many cases they can be controlled. Historically, treatments have included:

- anti-inflammatory drugs -to reduce inflammation
- pain corticosteroids - to reduce inflammation.
- Analgesic drugs - such as paracetamol
- codeine immunosuppressants - to suppress the activity of the immune system
- physical therapy - to promote mobility treatment of deficiency –
- for example, insulin injections for diabetes surgery
- The use of medications to suppress the immune system (in doses necessary to treat cancer or prevent rejection of transplanted organs) has recently been tested with promising results.
- Particularly with early intervention, the possibility of a cure for some of these diseases seems possible

Conclusion

All types of pathogenic bacteria, viruses and parasites, it is clear that pathogens pose a great threat to human health. Our immune systems give us some powerful weapons to fight them, but they are not infallible; Infectious diseases remain a major challenge in health care. However, with careful application of the scientific method, we can understand more about the nature of pathogens and use this information to develop new strategies to address the deadly threat that represent. infectious diseases kill about 10 million people worldwide each year and are caused by pathogens.

There are more than 1,400 different pathogens that cause human disease, but only about 20 cause two-thirds of human deaths from infection. Pathogens are of many types, including multicellular parasites, single-celled protists, yeast and bacteria, viruses, and prions. pathogens can be transmitted directly or indirectly. Direct methods included contact transmission, sexual transmission, and mother-to-child transmission. Indirect methods are transmission by air, water, or food, such as the focal-oral route, and environmental contamination. Causes of infectious diseases include biological susceptibility, the social and economic conditions in which people live, and behaviors that affect the spread of infection.

The symptoms of a disease can only be perceived by the person suffering from it, while the signs of a disease can be observed by others. Infectious diseases can be acute and lead to recovery or death within a few weeks, or they can be chronic and progress slowly over months or years; a chronic condition can include an acute episode. The application of the scientific method was of central importance in humanity's fight against infectious diseases and is characterized by observation, measurement, experimentation, and the systematic formulation, testing, and modification of hypotheses.

Early examples of the use of the scientific method include John Snow's experiment to remove the handle from the Broad Street pump, which showed that cholera was transmitted in contaminated water almost 30 years before bacteria were identified, and the experiment Smallpox Vaccination by Edward Jenner. A person's defense against pathogens begins with physical and chemical barriers such as intact skin; When injured, we rely on our immune systems to fight infection. The immune system has two distinct branches: innate and adaptive immunity, each of which uses different types of leukocytes. The innate immune system is nonspecific; the involved leukocytes cannot differentiate between different types of pathogens. In contrast, leukocytes, which are involved in adaptive immunity, are specific for different pathogens. Some leukocytes of the adaptive immune system have a "memory." This leads to more effective immune responses with each exposure to the pathogen.

Keywords

Genetics, immune system, adoption, degeneration, auto immune disorders

Self-Assessment

1. The protein, produced by B cells that binds to a specific antigen is

a. phagocyte

b. leukocyte

c. vaccine

d. antibody

2. Which of the following characteristics are common in lymphocytes, macrophages, and neutrophils?

a. They are all part of the nonspecific immune response in vertebrates

b. They are all part of the specific immune response in vertebrates

c. They are all part of the internal defenses of nonvertebrates

d. They are all types of white blood cells

3. Which of the following blood proteins can destroy pathogens?

a. Major histocompatibility complex

b. Platelets

c. Fibrinogen

d. Complement system

4.Which of these is part of the lymphoid system in humans?

a. Liver

b. Stomach

c. Tonsils

d. Kidneys

5.What type of B cell is like a tiny factory that produces antibodies identical to the B cell receptor that bind to the original antigen?

a. T cells

b. Memory cells

c. Plasma cells

d. Macrophages

6. What is the result of invasion of a body by pathogens?

a. Infection

b. Inflammation

c. Swelling

d. Pus

7. In a fetus, where are lymphocytes produced?

a. In the spleen

b. In the bone marrow

c. In the liver

d. In the heart

8.What is the behavior in which T cells and B cells constantly travel throughout the body seeking out and destroying foreign substances?

a. Antibody-mediated immune response

b. Immune surveillance

c. Cell-mediated immune response

d. Vaccination

9. Which of the following produces the antibodies employed in the specific immune response of vertebrates?

a. B lymphocytes

b. T lymphocytes

c. Neutrophils

d. Macrophages

10. Which of the following is not part of the vertebrate immune system?

a. Lymphocytes

b. Antibodies

c. Cardiac glycosides

d. Lymph nodes

11. The maturation of T cells and the production of particular T cell receptors occurs in the

a. thyroid gland

b. thymus gland

c. testes

d. all of these

12. Which of the following provide specific defense against viruses and bacteria?

a. T cells

b. B cells

c. Complement

d. inflammation

13. Lack of reaction to our own human leukocyte antigens (HLAs) is known as?

a. autoimmunity

b. complement system

c. clonal selection

d. tolerance

14. Which of the following components of the vertebrate immune response occurs first upon invasion by a virus or bacterium?

a. Activation of killer T lymphocytes

b. Activation of B lymphocytes

c. The inflammatory response

d. Mobilization of complement proteins

15. A cell which defends against body cells in which viruses are reproducing is

a. Exotoxin

b. Cytotoxic T cell

c. Endotoxin

d. Suppressor T cell

Scoring Key

1 d 2 d 3 d 4 c 5 c 6 a 7 c 8 b 9 a 10 c 11 b 12 b 13 d 14 c 15 b

Review Questions

Define biological basis of behavior

What is immune system

How many types of autoimmune disorders?

Define covid 19

Why is important immune system

Further Readings

- BIOLOGICAL PSYCHOLOGY. JAMES W. KALAT. CENGAGE LEARNING
- PHYSIOLOGY OF BEHAVIOR. NEIL R. CARLSON. PEARSON
- COGNITONMARGARET W. MATLIN. WILEY

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