Biological Determinants of Behaviour (Brain & Behaviour)

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Human Behaviour

- **Human behavior is the collection of behaviours exhibited by human beings.**

- **Behavior refers to the actions or reactions of an organism, usually in relation to the environment.**

- **Behaviour can be:**
  - **Conscious or Unconscious,**
  - **Overt or Covert,**
  - **Voluntary or Involuntary.**

Human behavior

- **The behavior of people falls within a "range" with some behavior being:**
  - **Common X unusual,**
  - **Acceptable X outside acceptable limits.**
- **Social behavior is behavior specifically directed at other people.**
- **The acceptability of behavior is evaluated relative to social norms and regulated by various means of social control**

Categories of human behavior

Four categories of human behavior:

1. **Behavior detectable i.e. something we can detect with our senses (see or hear) Versus behavior that can not be detected (e.g. Thinking).**
2. **Behavior purposive or goal-driven (action).**

Categories of human behavior (cont....)

3. **Category of performance (or skilled behavior)**

   Behavior that demonstrates skills of various kinds from work to sports.

4. **Category of instinctual behavior, having to do with the anatomical or physiological nature of the organism.Behavior in this category is determined by the need or desire to avoid pain and embrace pleasure.**

Human behavior

Human behaviour is influenced by:

Culture,
Emotions,
Ethics,
Rapport,
Persuasion
Genetics
Attitudes
Values
Authority
Hypnosis,
Coercion

Determinants of Behavior

- **Biological Determinants**
- **Learning**
- **Sociocultural factors**
- **Psychosocial factors**

Determinants of Behavior

- **Biological Determinants:**
  - **Genes**
  - **Structure of brain and nervous system**
  - **Brain chemistry**
- **Learning:** **Conditioning**

Determinants of Behavior

- **Sociocultural factors:**

  include the customs, morals, values, and demograp hic characteristics of the society in which the organ ization functions.

- **Psychosocial factors:**

  include social support, loneliness, marriage status, social disruption, bereavement, work environment, social status, and social integration.

The Brain and Behavior

- **The complexity of the behavior of an organism is related to the complexity of its nervous system.**
- **Generally, organisms with complex nervous systems have a greater capacity to learn new responses and thus adjust their behavior.**

Brain & Behavior

Scientific understanding of human behaviour and experience in health and disease requires knowledge about :

- **Functional Anatomy of the Neuron**
- **Functional Organization of the Brain**
- **Neurotransmitters**
- **Receptors**
- **Molecular Neurobiology**
- **Molecular Psychopharmacology**

Brain & Behavior

Advances in the understanding of the structure, organization, and function of the brain offer powerful new methods for:

- **evaluating behavior,**
- **diagnosing mental disorders,**
- **understanding pathophysiology of Mental Disorders,**
- **developing specific and effective therapies for mental disorders.**

Functional Anatomy of the Neuron

The *"Neuron"*

- **Is a cell type that is highly specialized, both anatomically and biochemically, to carry out the functions of information signaling and processing.**
- **Hundreds of specialized types of neurons, each type subserving specialized functions.**
- **Neurons do not divide once they are mature**

Functional Anatomy of the Neuron

- **Neurons are composed of 4 components:**
  - **Cell body (perikaryon)**
  - **Dendrites**
  - **Axon**
  - **Presynaptic terminal**

Structure of the Neuron

1.Cell body (Perikaryon):

Consists of:

- ***The nucleus*** **contains a nucleolus (plus a Barr body in females)**
- ***The cytoplasm*** **contains inclusions:**

- Nissl substance (involved in protein synthesis)

- Golgi apparatus (involved in synthetic activities?)

- Mitochondria (involved in energy productions)

- Microfilaments (unknown function)

- Microtubules (involved in transport of substances)

- Lisosomes (bodies containing powerful enzymes)

-Melanin pigment (found in neurons of the substantia nigra and locus coeruleus)

Cell Nucleus

- ***The nucleus has two main functions :***

➢ **Controls chemical reactions in the cell Cytoplasm *by controlling the formation of proteins and enzymes.***

➢ **Stores information needed when the cell division and *transcription of genes and mRNA splicing occurs.***

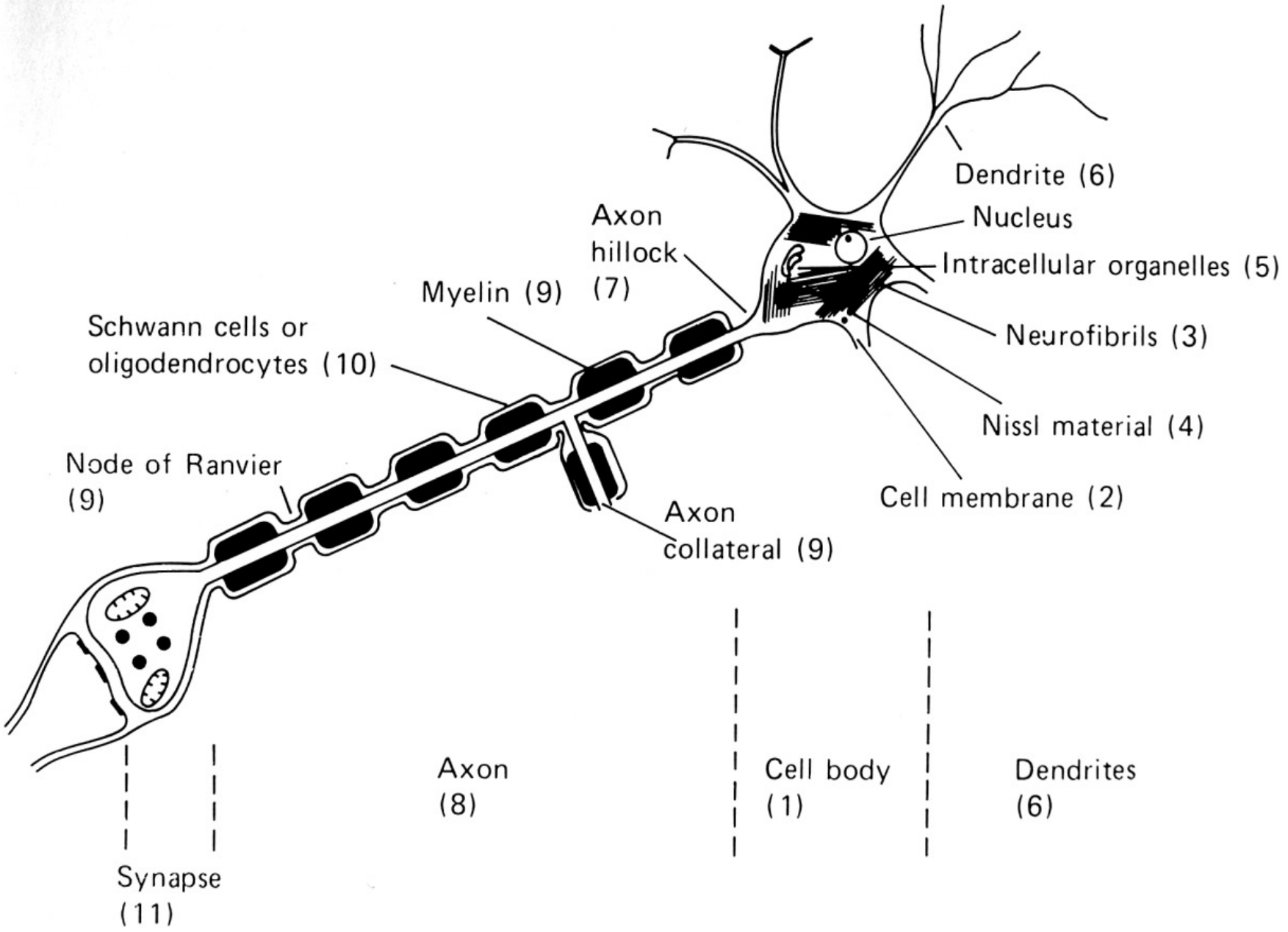
- ***The nucleus is surrounded by a double membrane:***
  - ***The outer membrane has ribosomes.***
  - ***Ribosomes are involved in protein biosynthesis, the process of translating RNA into protein.***
  - ***The inner and outer membrane fuse at regular spaces, forming nuclear pores***

Cell Nucleus

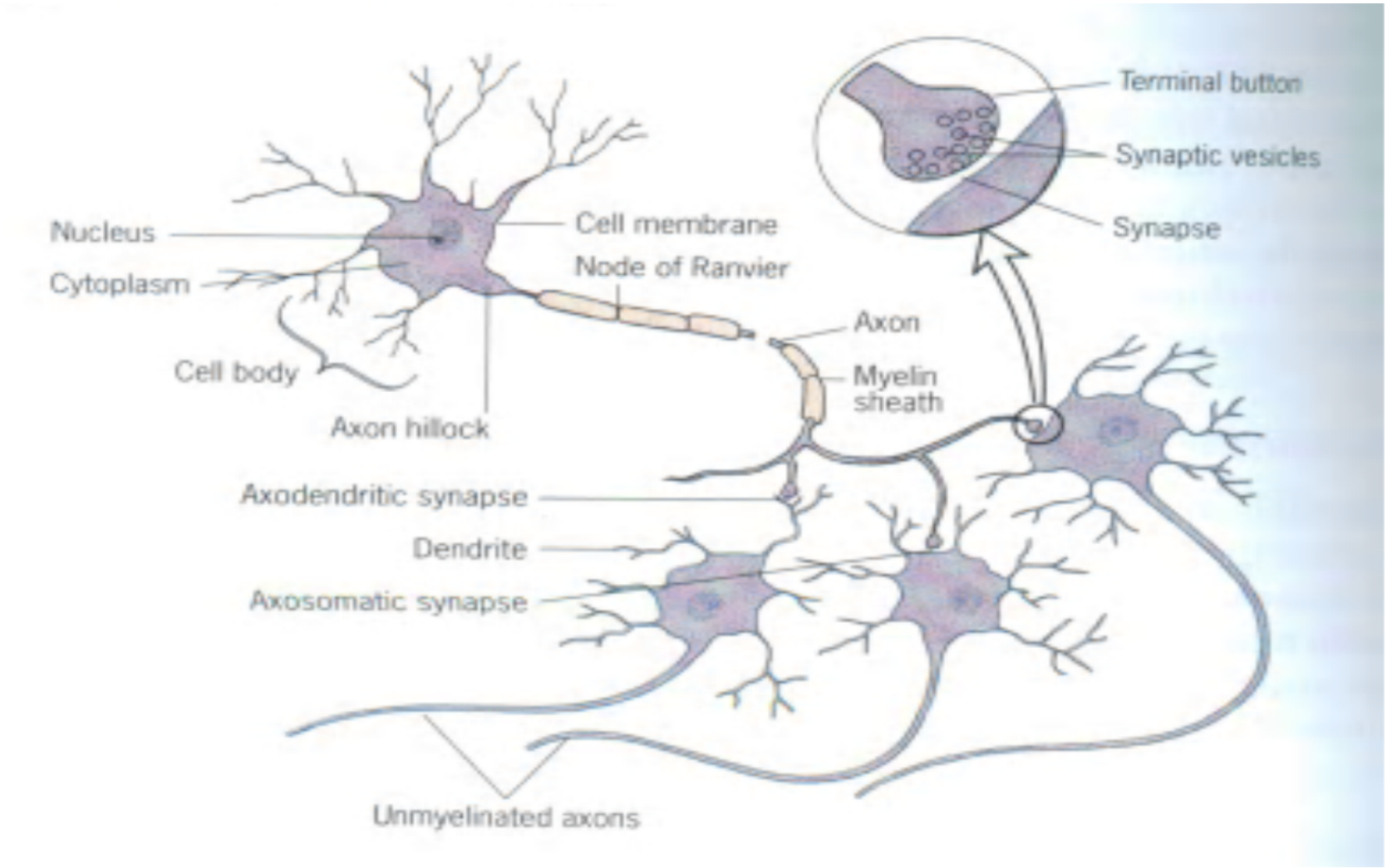
- ***The nucleus contains the chromosomes and nucleoli.***

- ***Chromosomes contain information encoded in (DNA) attached to proteins called histones and are usually arranged in to a dense network called Chromatin.***

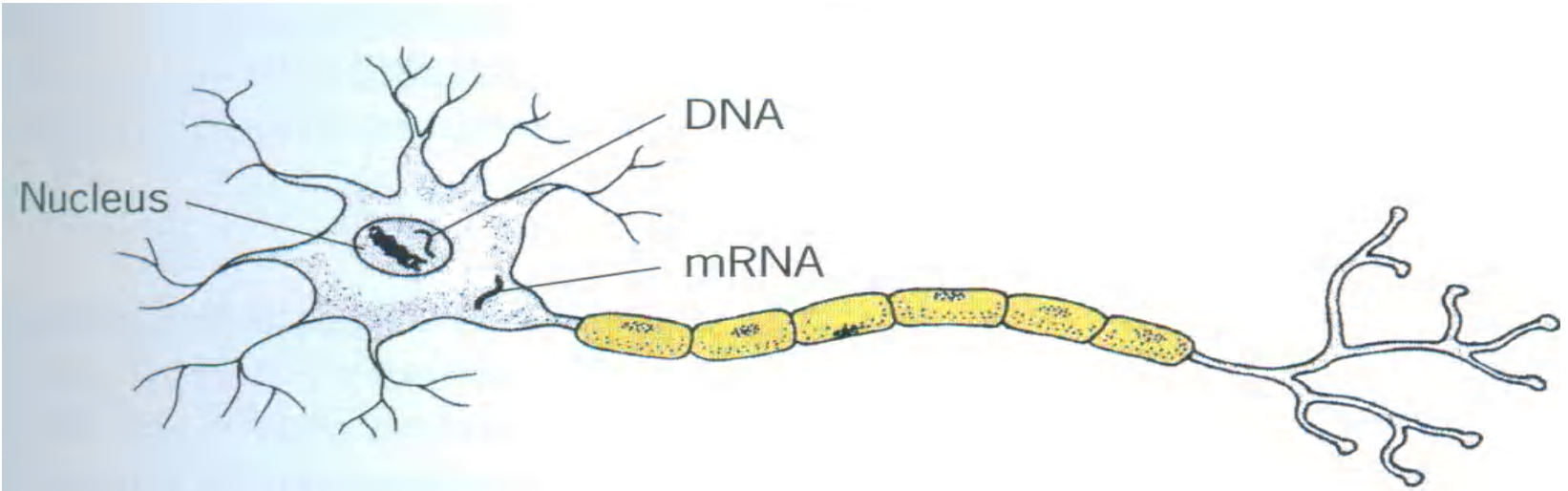
- ***Nucleoli are granular structures which make ribonucleic DNA (rDNA) and assemble it with proteins.***


Dendrite (6)
Nucleus
Intracellular organelles (5)
Neurofibrils (3)
Nissl material (4)
Cell membrane (2)
Axon hillock (7)
Myelin (9)
Schwann cells or oligodendrocytes (10)
Node of Ranvier (9)
Axon collateral (9)
Axon (8)
Cell body (1)
Dendrites (6)
Synapse (11)

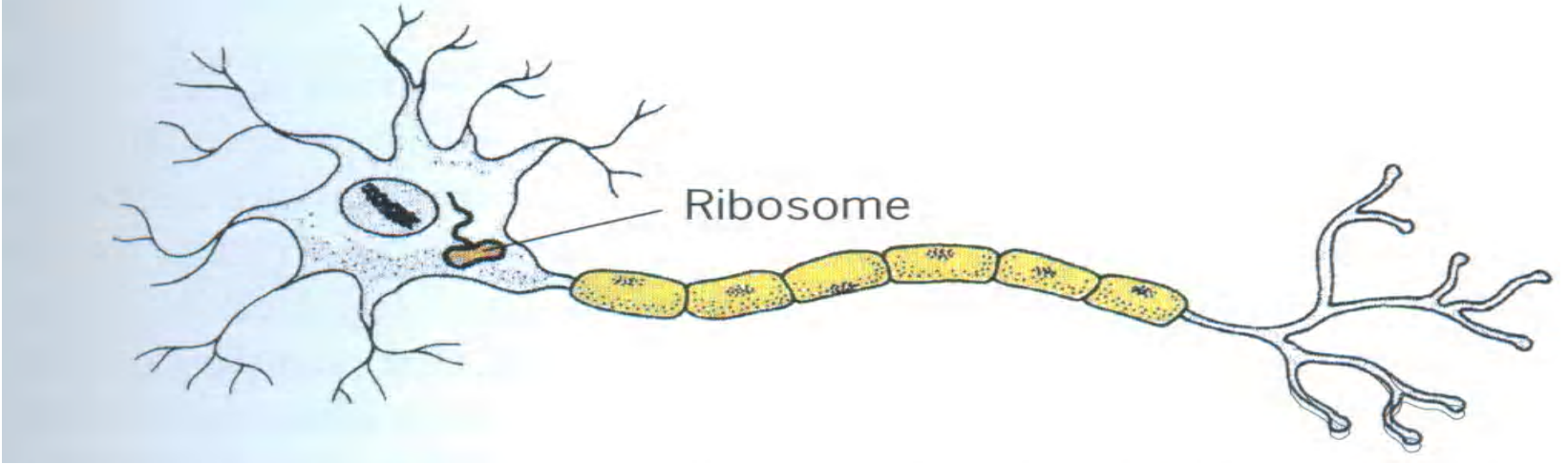
Structure of the Neuron



The Neuron



Step 2. In the cytoplasm, the strands of mRNA bind to ribosomes.



Structure of the Neuron

2. The Axon

- Usually single
- Myelinated and Unmyelinated
- The proximal portion is called the "Axon Hillock"
- Branches distally - each branch forms an outpouch at its end called the "Button"
- Conducts impulses away from the perikaryon

Structure of the Neuron

3. Dendrites

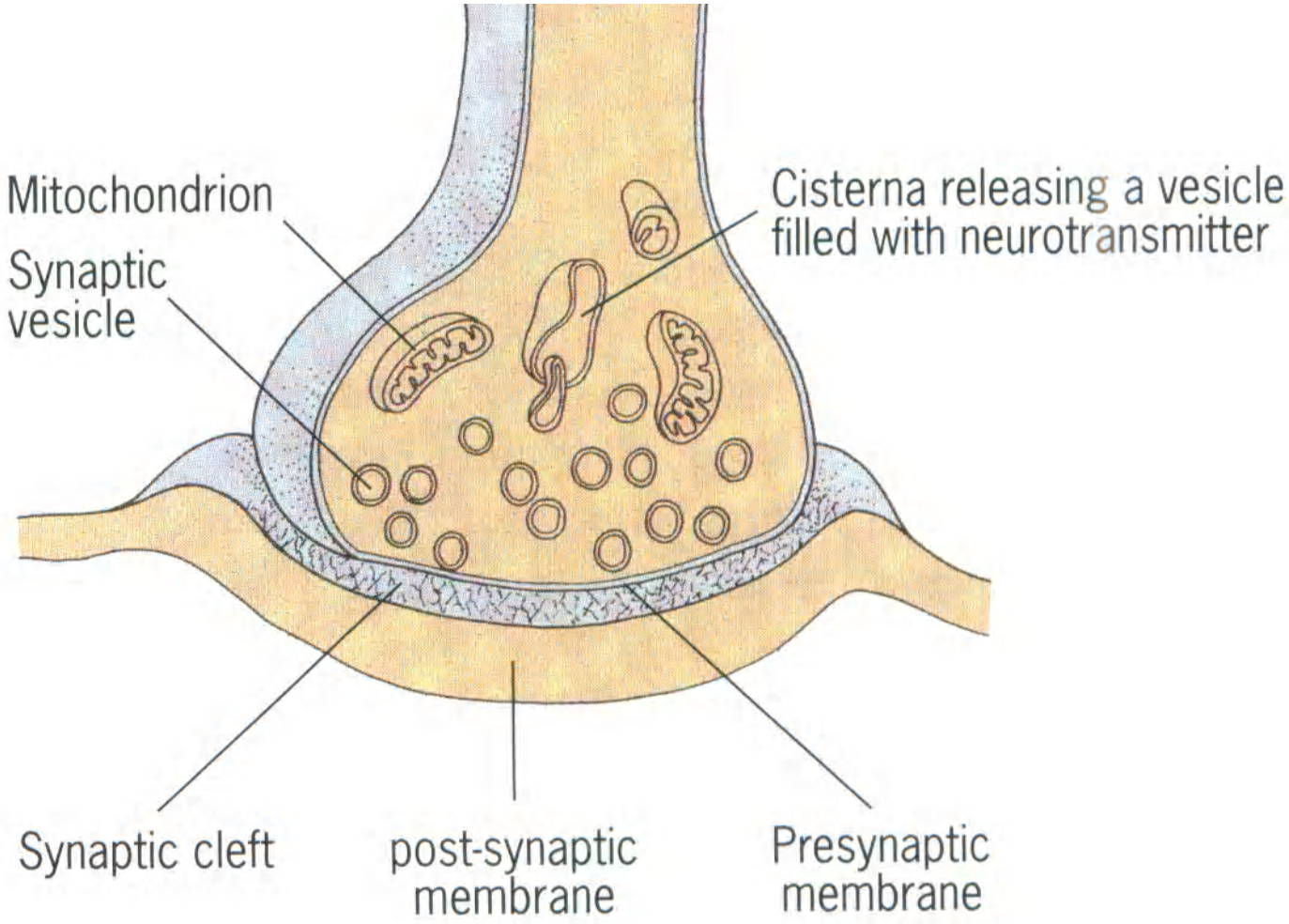
- **Usually more than one per neuron**
- **Contain Nissl substance**
- **Branched and studded with dendritic spines (sites for synaptic contact)**
- **Conduct information to the perikaryon**

The Synapse

- **Is a specialized structure involved in the transmission of information from one neuron to another**
- **The "Synapse consists of:**
  - **Button: outpouch of the terminal portion of a branch of the axon of the Presynaptic neuron**
  - **Dendritic membrane of the adjacent Postsynaptic neuron (specialized contacts)**

- **Transmission is accomplished by:**
- **Chemical Transmission**
  by messengers called "N*eurotransmitters (NTs)*"
- **Electrical Transmission**
  by ion exchange

The Synapse



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Receptors

- **The *dendritic membrane* at the synapse is markedly enriched with *"Receptors"* that respond to the neurotransmitter released by the terminal button of the *Presynaptic neuron.***
- **Neurotransmitter receptors are proteins that span the neuronal membrane.**
- **Receptors have:**

  - *ligand binding regions* that are accessible to extracellular messengers

  - *ligand-gated channels* consist of channel pores that allow passage of ions

Brain Organization

Brain structures as derivatives of the neural tube:

Primary vesicles	Secondary vesicles	Brain components
- Prosencephalon (forebrain)	Telencephalon	Cerebral Cortex Hippocampus Amygdala Striatum
	Diencephalon	Thalamus & subthalamus Hypothalamus Epithalamus
- Mesencephalon (midbrain)	Mesencephalon	Midbrain
- Rhombencephalon (hindbrain)	Metencephalon	Pons Cerebellum
	Myelencephalon	Medulla

Basic Organization of Brain(cont..)

- **Hemispheric lateralization: is a feature of higher cortical processing**
  - **The primary sensory cortices for touch, vision, hearing, smell, and taste are represented bilaterally.**
  - **Recognition of familiar and unfamiliar faces localized to the left inferior temporal cortex.**
  - **Processing of olfaction occurs in right frontal lobe.**

Basic Organization of Brain

- **Brodmann 47 areas each has an assigned function.**
- **3 processing blocks distinguished:**
  - **Brain Stem and thalamic reticular activating system - provides arousal and set up attention**
  - **Posterior Cortex - integrates perception and generates language**
  - **Frontal Cortex - generates programmes and execute plans**

Basic Organization of Brain(cont..)

- **Localization of language occurs in the left hemisphere (Dominant Hemisphere)**
- **Prosody (emotional and affective components of language "Body Language") localized in the right hemisphere.**
- **The limbic system is responsible for:**

  -Generating and modifying memories and for

  -Assigning emotional weight to sensory and recalled experience (Amygdala)

Functional Brain Systems

Three functional brain systems illustrate the relation between the organizational principles and the structural components of the human brain:

1. **Thalamocortical system**

2. **Basal ganglia system**

3. **Limbic System**

Thalamocortical system

- Connects the thalamus to the cortex and certain related structures.

- The Thalamocortical system comprises 3 subsystems, each with different pattern of functional circuity):

  - Sensory System,
  - Motor System,
  - Association System.

Sensory system

- Somatosensory
- Visual
- Auditory
- Olfactory
- Gustatory

Somatosensory system

- **Six somatosensory modalities**

  [Light touch, Pressure, Pain, Temperature, Vibration, Proprioception (position)].

- **The peripheral receptor organs generate coded neural impulses that travel proximally along the sensory nerve axons to the spinal cord.**

The Visual System

- **Visual images are transduced into neural activity within the retina and processed in highly specialized nerve cells in the visual cortex (occipital cortex).**

Cortical Visual Abnormalities include:

- **Prosopagnosia: inability to recognize faces, in the presence of preserved recognition of other environmental objects.**

-Results from disconnection of the Left inferior temporal cortex from the visual association area in the parietal lobe.

The Visual System

- **Visual Agnosia: Inability to identify items despite of preserved vision due to a lesion in the visual association area.**
- **Colour Agnosia: Inability to recognize a colour due to damage to the visual cortex (V40**
- **Colour Anomia: Inability to name a colour**
- **Anton's syndrome: Failure to acknowledge blindness in bilateral occipital lobe lesions**
- **Gertsman Syndrome: Agraphia + Acalculia + Right-Left disorientation + finger agnosia due to a lesion in the dominant parietal lobe**

Auditory System

Sounds produce air pressure changes and lead to neural impulse generation travelling to the brain stem - to the thalamus – to the primary auditory cortex

- **Word deafness:** Inability to recognize speech despite intact hearing due to left parietal lesion causing disconnection of the auditory cortex from Wernicke's area
- **Auditory Sound agnosia**: Inability to recognize non-verbal sounds such as horns or animal sounds in the presence of intact hearing and speech recognition due to right hemisphere lesion

Olfactory system

- **Smell is associated with sexual and reproductive responses.**
- **Human can recognize 10,000 different odors.**
- **Olfactory signals skip the thalamus and project directly to the frontal lobe and limbic system (especially pyriform cortex)**
- **Olfactory cues stimulate strong emotional responses and evoke powerful memories**

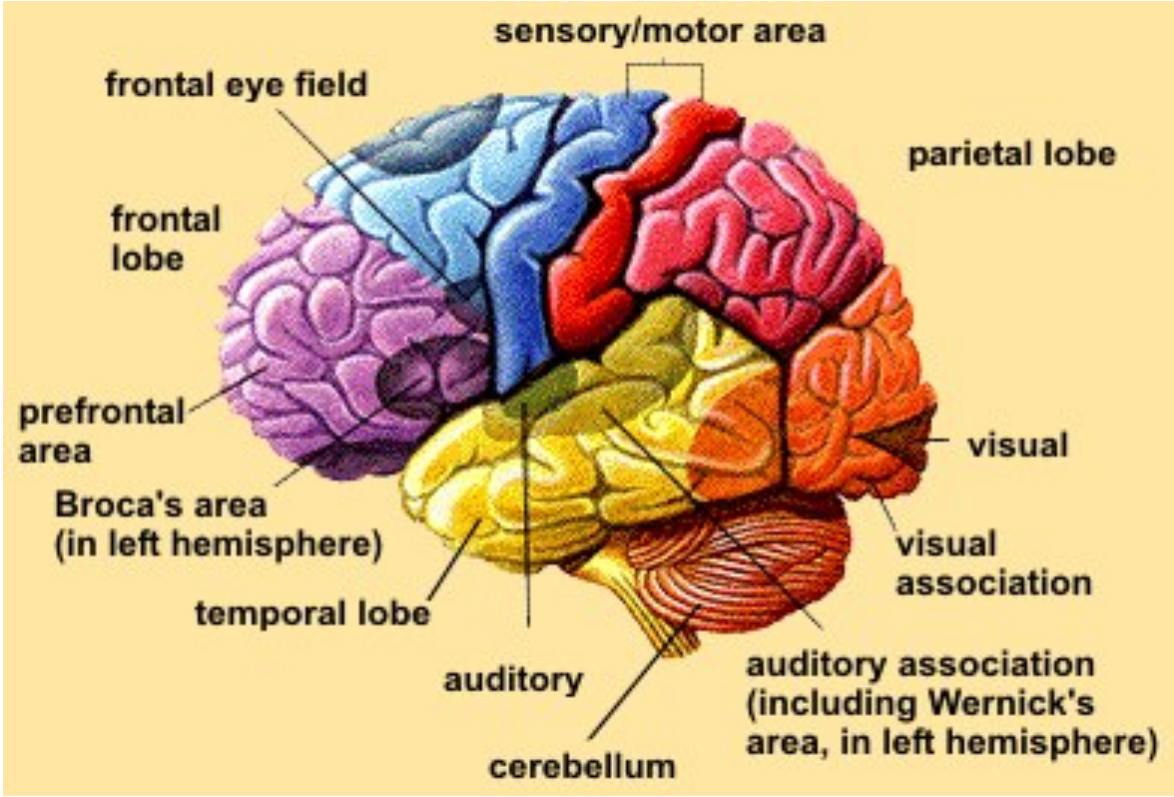
Gustatory System

- Taste receptors stimulate gustatory nerves that transmit impulses to nucleus solitarius in brain stem and end in medial temporal lobe

- Human discriminates 4 broad classes of taste stimuli: sweet, sour, bitter and salty

- Detection and discrimination of foods involve a combination of: taste + olfaction + touch + vision + hearing

Cerebral lobes & Areas



Motor system

Movement of body muscles are controlled

by the:

- **Motor System**
- **Basal ganglia**
- **cerebellum**

Motor system

Motor Cortex:

- Lies immediately anterior to the central fissure in each cerebral hemisphere.
- Individual cells within the motor strip cause contraction of single muscles in the opposite half of the body.
- The cerebral cortex immediately anterior to the motor strip is called "the supplementary motor area (Brodmann area 6)". It triggers complex movements.

Motor system

- Movement of body muscles are controlled by the LMN.
- Firing of LMN is regulated by UMN summated activity.
- The corticospinal tracts control fine movements.
- The motor cortex directs smooth execution of movements planned in the association areas of the brain in consultation with the basal ganglia and cerebellum.

Basal Ganglia System

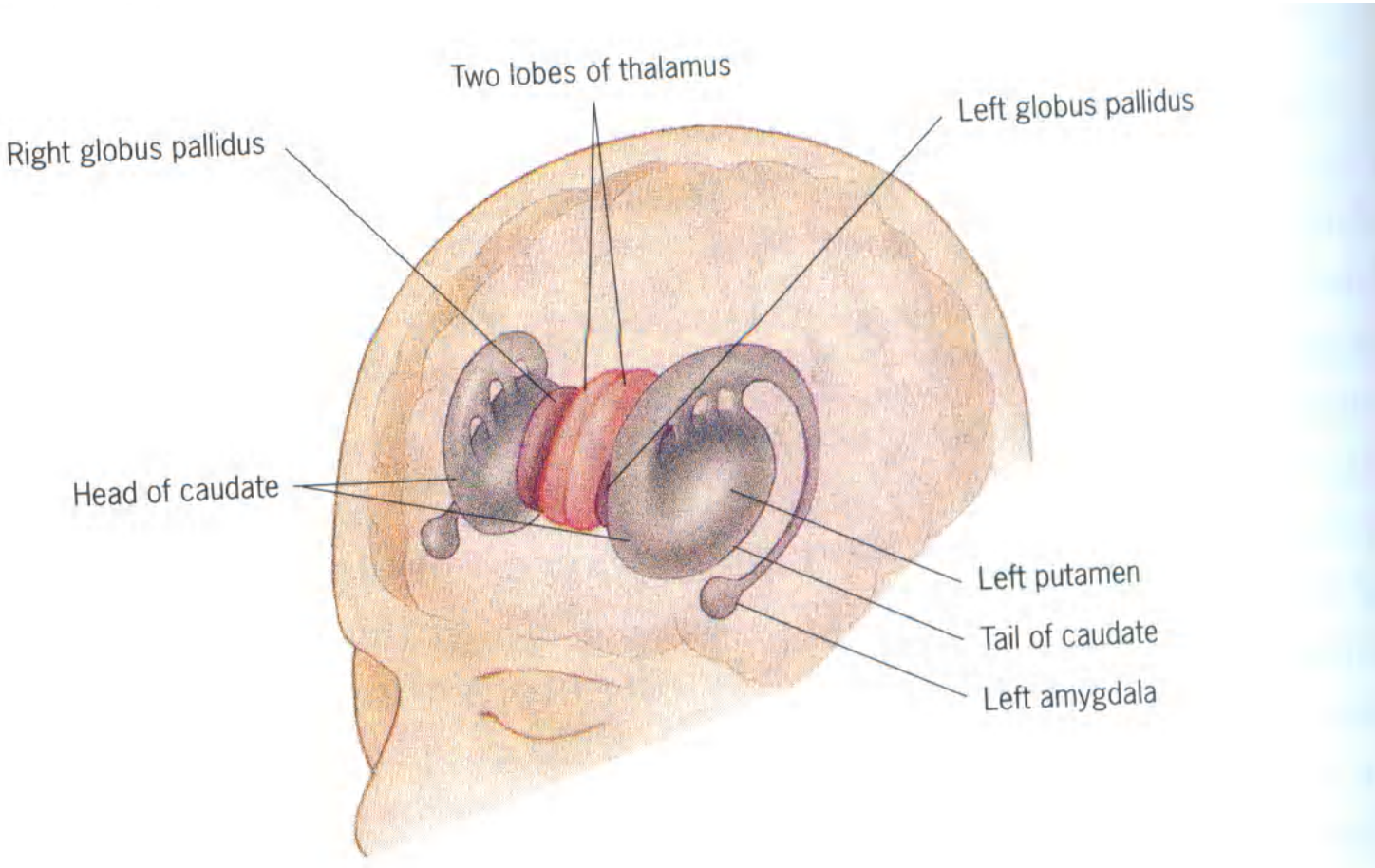
- A collection of nuclei grouped together on the basis of their interconnections
- Play an important role in:
  - regulating movement
  - cognitive functions such as nemory.

Basal Ganglia System

- **Major components:**
  1. **Caudate**
  2. **Lentiform nucleus = putamen + Globus pallidus (pallidum or paleo striatum)**
  3. **Subthalamic nucleus**
  4. **Substantia nigra**

[Striatum = all the above nuclei]

Basal Ganglia



Basal Ganglia:

- Mediate postural tone.
- Parkinson's disease results from overactivity of the striatum due to lack of dopamine inhibition.
- Huntington's disease results from shrinkage of the caudate nucleus.
- Decreased activity in caudate nucleus found in obsessive compulsive behavior and tics.

Basal Ganglia (cont..)

- The Caudate also influences associative or cognitive processes.
- The Globus Pallidum damaged in Wilson's disease and Co poisoning.
- Lesions of Substantia Nigra lead to rigidity and tremor as in Parkinson's disease with depression in over 30%.
- Subthalamic Nucleus lesions yield ballistic movements.

Motor system (cont..)

Cerebellum

- **Modulates tone of agonistic and antagonistic muscles by predicting relative contraction needed for smooth motion.**

- **Activity in the cerebellum detected several msec before a planned movement is initiated.**

- **Coarse intentional tremor results from cerebellar ablation.**

Cortical Association System

- **In most behaviors, sensory systems project to association areas, where sensory information interpreted in terms of internally determined memories, motivation and drives.**
- **The exhibited behavior results from a plan of action determined by the association components and carried out by the motor systems**

Autonomic System (ANS)

Monitors the basic functions necessary for life.

- **Consists of sensory and motor divisions.**
- **Sensory fibers that transmit the activity of visceral organs, blood pressure, cardiac output, blood glucose level, and body temperature.**
- **Most of the sensory information remains unconscious.**

Autonomic System (ANS) cont.

- **The Motor Component:**

  (sympathetic and parasympathetic divisions)
- **Have antagonistic roles.**
- **Innervate the same organs.**
- **The parasympathetic fibers slow the heart rate and begins the process of digestion.**
- **The sympathetic fibers mediate the " fight or flight response resulting in: increased heart rate, shunting of blood away from viscera, increased respiration.**

Autonomic System (cont.)

Motor Component (cont..)

- The sympathetic fibers are highly activated by sympathomimetic drugs (amphetamine, cocaine) and withdrawal of sedative drugs (benzodiazepines, alcohol, and opioids)
- Increased risk of heart attacks in presence of:
  - high levels of hostility,
  - chronic activation of sympathetic (fight or flight response)
  - elevated adrenalin secretion

Autonomic System (ANS)cont.

The Motor Component (cont..)

- **The ANS is controlled by the hypothalamus that controls:**

  - appetite and obesity

  - rage

  - temperature

  - blood pressure

  - perspiration

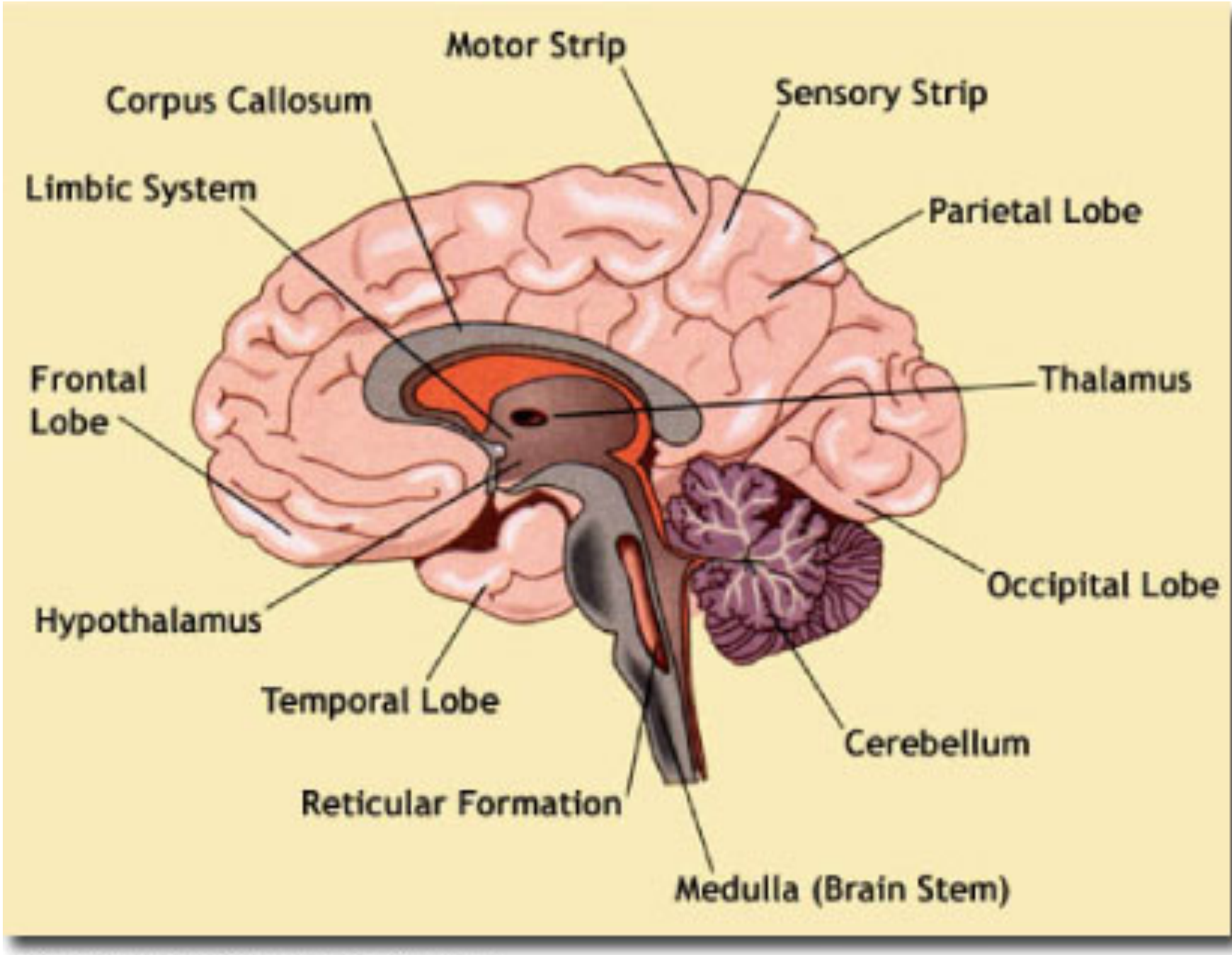
  - sexual drive

The Limbic System

[Limbic = Latin word "Limbus" (for border) applied by "*Pierre Broca*" more than 100 years ago]

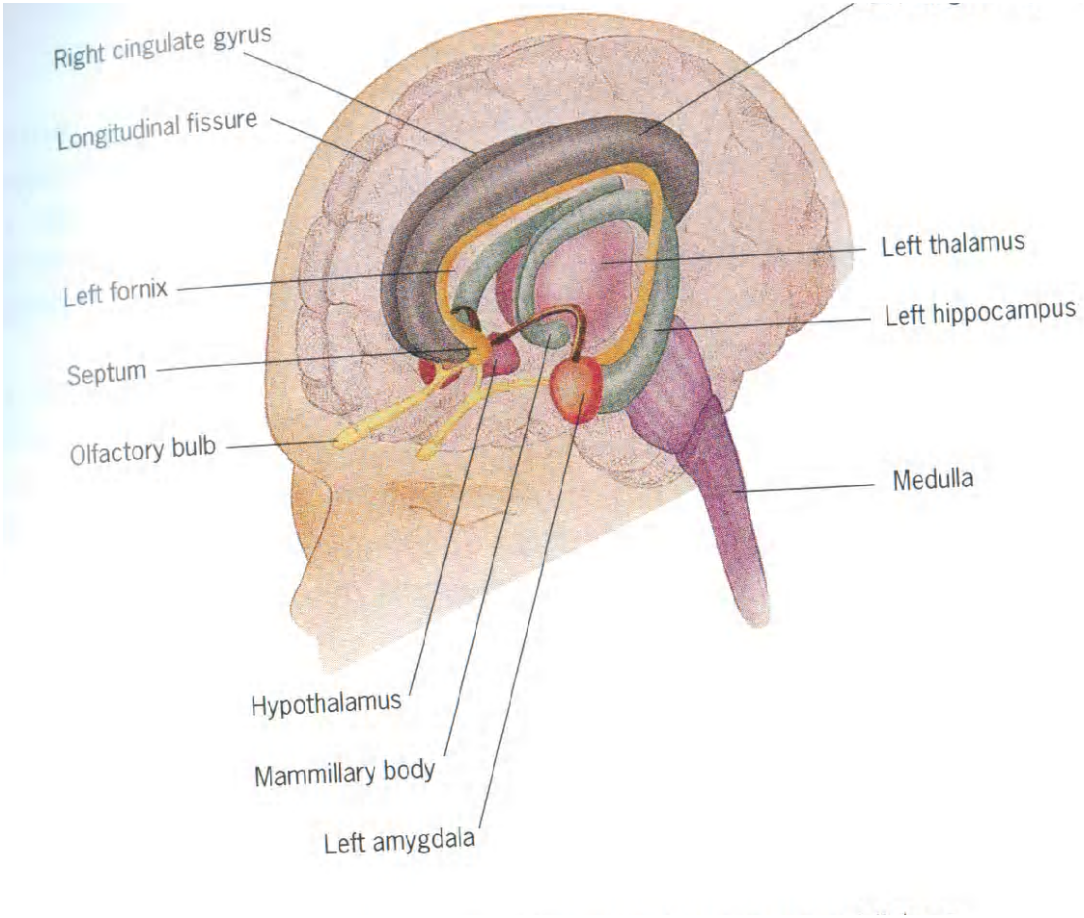
- **Limbic system** applied by "MacLean" to describe the circuity that relates certain telencephalic structures (including the hippocampus and Amygdala) and their connections with the hypothalamus and its output pathway (that control autonomic, somatic, and endocrine functions)

- Involved in the experience and expression of emotions, behaviour and long term memory.
- Limbic structures are closely associated with the olfactory



Brief Brain Anatomy

The Limbic System



Structures of the Limbic System (cont…)

- **Fornix: carries signals from the hippocampus to the Parahippocampus and septal nuclei.**

- **Hypothalamus: Regulates the autonomic nervous system via hormone production and release. Affects and regulates:**

➢ **blood pressure,**

➢ **heart rate,**

➢ **Hunger,**

➢ **Thirst,**

➢ **Sexual arousal,**

➢ **Sleep/wake cycle**

- **Thalamus: The "relay station" to the cerebral cortex**

Structures of the Limbic System

- **Amygdala:** Involved in signaling the cortex of motivationally significant stimuli such as those related to reward and fear in addition to social functions such as mating.

- **Hippocampus:** Required for the formation of long-term memories

  - **Parahippocampus gyrus:** Plays a role in the formation of spatial memory and is part of the hippocampus

- **Cingulate gyrus:** Autonomic functions regulating heart rate, blood pressure and cognitive and Attentional processing

Behavioural Aspects of the Limbic System

- **The Limbic system houses the emotional association areas, which direct the hypothalamus to express the motor and endocrine components of the emotional state**
- **Electrical stimulation produces "rage" reaction**
- **Electrical stimulation of the lateral hypothalamus cause fully satiated animals to eat vividly**

Other Limbic Structures

- **Mamillary body: Important for the formation of memory**
- **Pitutary gland: secretes hormones regulating homeostasis**
- **Dentate gyrus: contributes to new memories and to regulate happiness (Pleasure Centre).**
- **Entorhinal cortex and pyriform cortex: Receive smell input in the olfactory system.**
- **Olfactory bulb: Olfactory sensory input**
- **Nucleus accumbens: Involved in reward, pleasure, and addiction**
- **Orbitofrontal cortex: Required for decision making**

Functions of the Limbic System

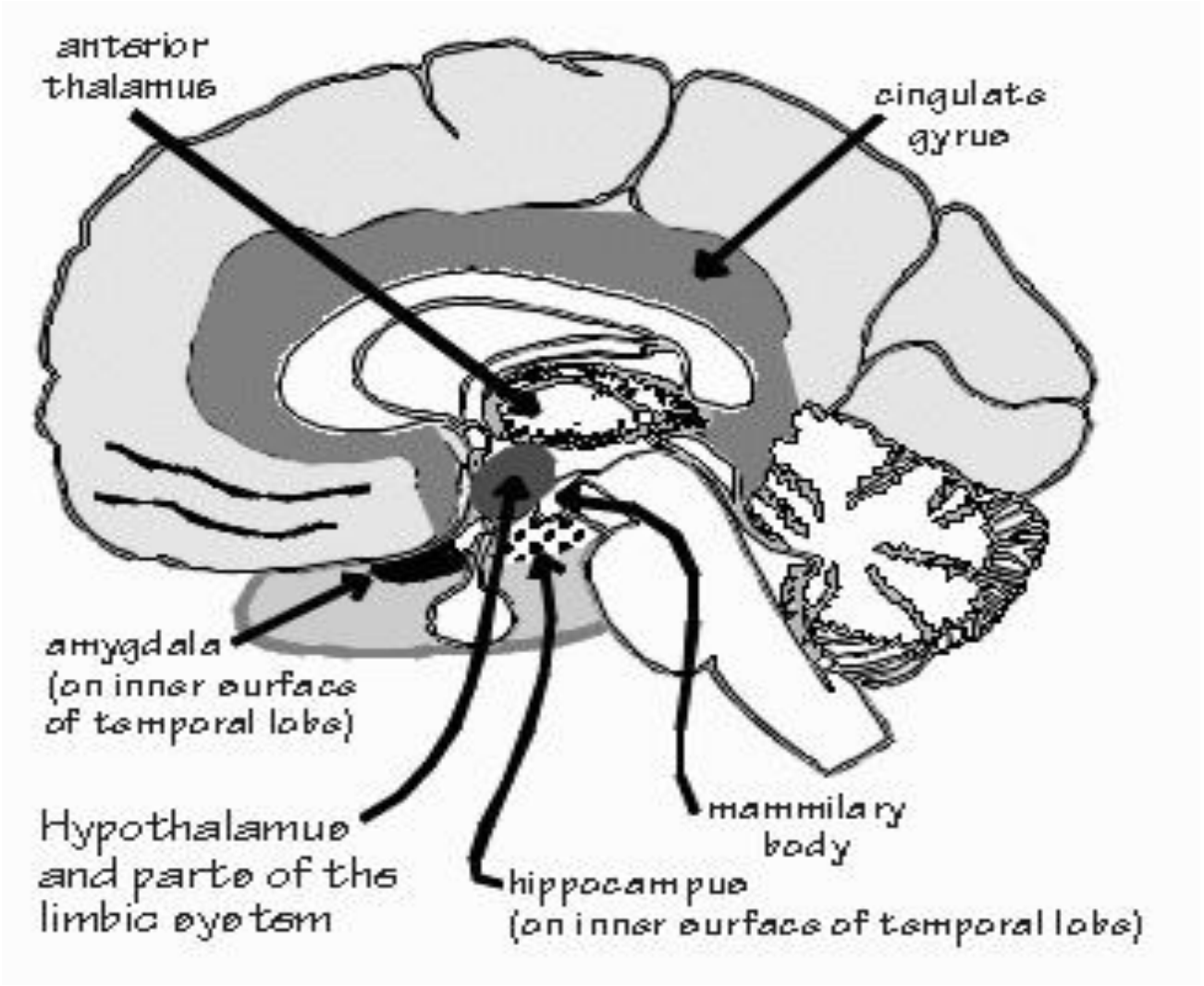
- **The limbic system operates by influencing the:**
  - **endocrine system**
  - **autonomic nervous system**

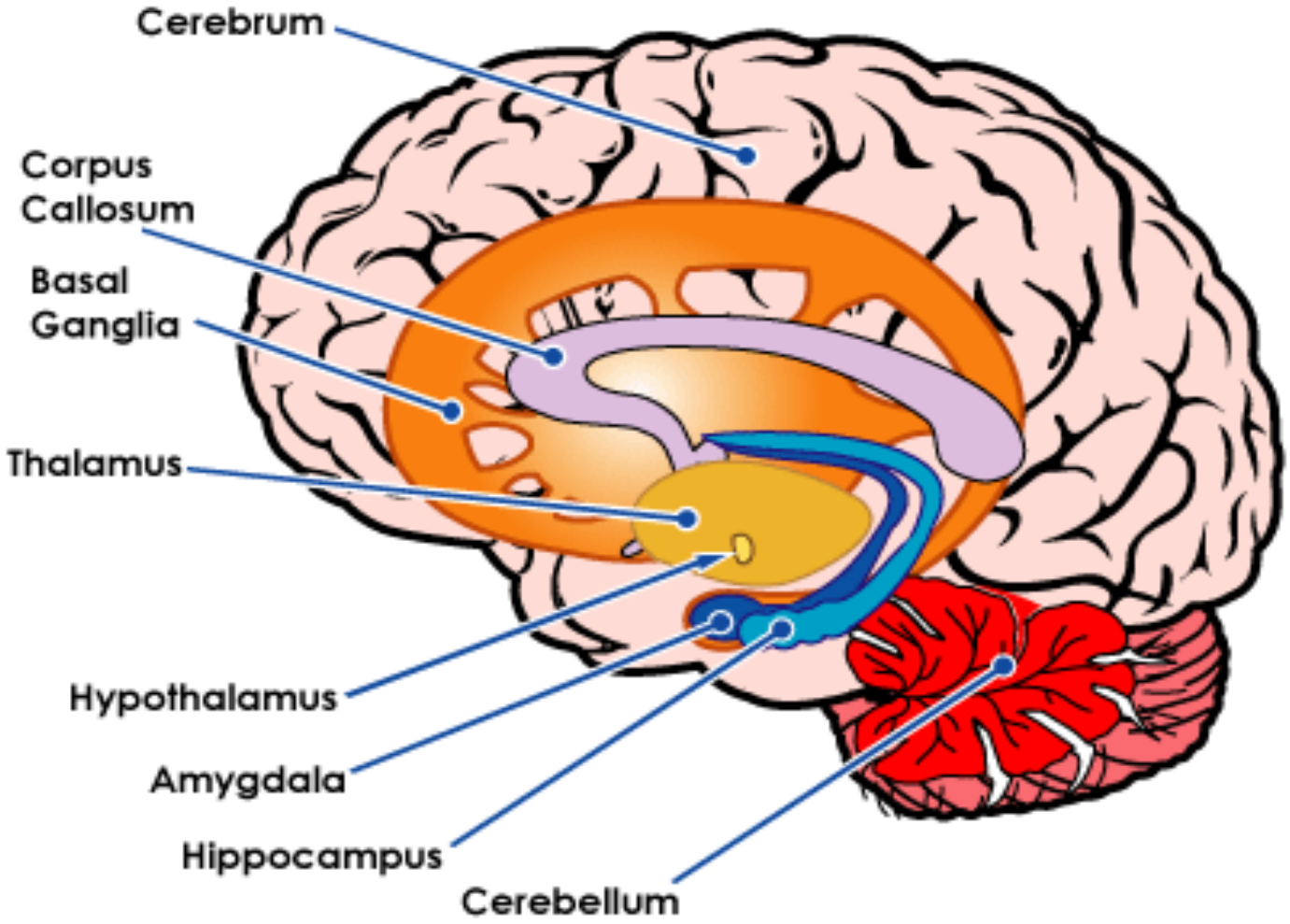
- **It is highly interconnected with the nucleus accumbens, the brain ‘s pleasure system’, which plays a role in sexual arousal and the "high" derived from certain recreational drugs.**

Functions of the Limbic System

- **The limbic system is also tightly connected to the prefrontal cortex. This connection is related to the pleasure obtained from solving problems.**
- **This connection sometimes surgically severed, a procedure of psychosurgery to cure severe emotional disorders ,**

- Patients who underwent this procedure often became passive and lacked all motivation.


anterior thalamus
cingulate gyrus
amygdala (on inner surface of temporal lobe)
Hypothalamus and parts of the limbic system
mammilary body
hippocampus (on inner surface of temporal lobe)


Cerebrum
Corpus Callosum
Basal Ganglia
Thalamus
Hypothalamus
Amygdala
Hippocampus
Cerebellum

Reticular Formation

- **The reticular formation is a poorly-differentiated area of the brain stem, that forms the core of the brainstem running through the mid-brain, pons and medulla; centered roughly in the pons.**
- **Neurons forming meshwork extending from the spinal cord to thalamus (Diencephalon) in the ventral core of the brain stem**
- **The area from the brain stem to the thalamus is called the "reticular formation proper"**
- **Neurons are neither sensory nor motor**

Reticular Activating systems

- **The ascending reticular activating system connects to areas in the thalamus, hypothalamus, and cortex,**
- **The descending reticular activating system connects to the cerebellum and sensory nerves.**
- **The reticular formation is involved in actions such as awaking/sleeping cycle, and filtering incoming stimuli to discriminate irrelevant background stimuli**

Functions of the Reticular Formation

- **It controls approximately 25 specific behaviours, including sleeping, walking, eating, urination, defecation, and sexual activity.**
  The reticular formation is an important regulator in the autonomic nervous system for such processes as respiration rate, heart rate and gastrointestinal activity.
- **It also plays an important role in sleep and consciousness as well as modulation of pain.**
- **The reticular formation also has been shown to play a major role in alertness, fatigue, and motivation to perform various activities.**

Cerebral Hemispheres

Right Hemisphere

- **Controls the left side of the body**
- **Temporal and spatial relationships**
- **Analyzing nonverbal information**
- **Communicating emotion**

Left Hemisphere

- **Controls the right side of the body**
- **Produce and understand language**

Corpus Callosum

- **Communication between the left and right side of the**

Cortical Sites (Cerebral Lobes)

- **Frontal lobes**
- **Parietal lobes**
- **Temporal lobes**
- **Occipital lobes**

Frontal Lobe

- **The frontal lobe contains most of the dopamine-sensitive neurons in the cerebral cortex**
- **The dopamine system is associated with reward, attention, long-term memory, planning, and drive.**
- **Dopamine tends to limit and select sensory information arriving from the thalamus to the fore-brain.**
- **Reduced dopamine activity in the prefrontal cortex is claimed to be found in conditions of poor performance and functioning of that brain region during working memory tasks, and slightly increases risk for schizophrenia.**

Frontal Lobe Functions

- **Behavior in general, Inhibition, Initiative**
- **Abstract thought processes, Problem solving**
- **Creative thinking**
- **Working memory**
- **Attention**
- **Judgment**
- **Coordination of movements**
- **Generalized and mass movements, some eye movements**
- **Skilled movements and some motor skills**
- **Sense of smell**

Frontal lobes damage results in:

- Impaired mental flexibility and spontaneity, but IQ is not reduced.
- Talking may increase or decrease dramatically.
- Perceptions regarding risk taking and rule abiding are impaired.
- Socialization can diminish or increase.
- Orbital frontal lobe damage can result in peculiar sexual habits.
- Dorsolateral frontal lobe damage reduces sexual interest.
- Creativity is diminished as well as problem solving skills.
- Distraction occurs more frequently.

Frontal Lobe Damage results in (cont…):

- **The dorsolateral frontal cortex is concerned with planning, strategy formation, and executive function.**
- **Patients with dorsolateral frontal lesions tend to have:**

➢ **apathy, personality changes, abulia, and lack of ability to plan or to sequence.**

➢ **poor working memory for verbal information (if the left hemisphere is affected)**

➢ **Poor working memory for spatial information (if the right hemisphere is affected).**

Frontal Lobe Damage results in(cont…):

- **The frontal operculum contains the center for expression of language.**
- **Patients with left frontal operculum lesion may demonstrate Broca aphasia and defective verb retrieval,**
- **Patients with exclusively right opercular lesions tend to develop expressive aprosodia.**

Frontal Lobe Damage results in (cont…):

Patients with orbitofrontal lesions tend to have:

- **disinhibition, emotional labiality, and memory disorders.**
- **personality changes include: impulsiveness, sexual disinhibition, and complete lack of concern for others.**
- **Patients with superior mesial lesions typically develop akinetic mutism.**
- **Patients with inferior mesial (basal forebrain) lesions tend to manifest anterograde and retrograde amnesia and confabulation.**

The parietal lobe

- **Integrates & comprehend sensory information from different modalities, particularly determining spatial sense and navigation.**
- **Sense of touch (tactile sensation) &Appreciation of form through touch (stereognosis)**
- **Response to internal stimuli (proprioception)**
- **Manipulation of objects.**
- **Some language and reading functions**
- **Knowledge of numbers and their relations.**
- **Portions of the parietal lobe are involved with visuospatial processing**

Parietal lobe damage results in:

- impairment of tactile sensation
- impairment of proprioception, i.e. postural sensation and sensation of passive movement
- loss of ability to identify objects based on touch (astreognosis)
- sensory and visual neglect syndromes, i.e. inability to pay attention to things in certain parts of the person's sensory or spatial environment. This can be as extreme as denial of a limb.
- loss of ability to read (dyslexia), write (dysgraphia) or calculate (dyscalculia)
- loss of ability to find a defined place (geographical agnosia)

Temporal lobe

- Involved in speech, memory, and hearing.
- The superior temporal gyrus includes the (primary auditory cortex) involved in hearing.
- Adjacent areas in the superior, posterior and lateral parts of the temporal lobes are involved speech (left temporal lobe in particular).
- Wernick's area, which spans the region between temporal and parietal lobes, also plays a key role in speech
- The functions of the left temporal lobe extend to comprehension, naming, verbal memory and other language functions
- Sound processing.

Temporal Lobes

- **Ventral part of the temporal cortices involved in visual processing of complex stimuli such as faces and scenes, and in object perception and recognition.**
- **The medial temporal lobes are thought to be involved in episodic memory (*memory* of autobiographical events (times, places, associated emotions) and declarative memory (*memory* that stores facts) .**
- **The hippocampi seem to be particularly important for transference from short to long term memory and control of spatial memory and behaviour.**

Temporal lobe damage results in:

- **Disturbance of auditory sensation and perception**
- **Disturbance of selective attention of auditory and visual input**
- **Disorders of visual perception**
- **Impaired organization and categorization of verbal material**
- **Disturbance of language comprehension**
- **Impaired long-term memory**
- **Altered personality and affective behaviour**
- **Altered sexual behaviour**

Occipital Lobe

- **Harbours the primary visual centre**
- **If one occipital lobe is damaged, the result can be homonymous vision loss from similarly positioned "field cuts" in each eye.**
- **Occipital lesions can cause visual hallucinations.**
- **Lesions in the parietal-temporal-occipital association area are associated with colour agnosia, movement agnosia, and agraphia.**

Hypothalamus

- **The hypothalamus contains a number of small nuclei with a variety of functions. located below the thalamus just above the brain stem.**
- **Links the nervous system to the endocrine system via the pituitary.**
- **The hypothalamus is responsible for certain metabolic processes and other activities of the autonomic nervous system.**
- **It synthesizes and secretes neurohormones, often called hypothalamic-releasing hormones, and these in turn stimulate or inhibit the secretion of pituitary.**
- **The hypothalamus controls:**

  Body temperature, hunger, thirst, fatigue, anger, and circadian cycles, mood and motivation, sexual maturation, and hormonal body processes

Pineal Body

- **Also called the "third eye".**
- **Is a small endocrine gland in the brain. It is shaped like a tiny pine cone (hence its name), and is located near to the centre of the brain, between the two hemispheres,**
- **It produces melatonin (a derivative of Tryptophan), a hormone that affects the modulation of wake/sleep patterns and photoperiodic (seasonal) functions**
- **Melatonin is involved in circadian rhythms of biological functions.**
- **Melatonin secretion during sleep at night is important for regeneration of cerebral neurons**

Pituitary Gland

- Hormonal body processes
- Physical maturation
- Growth (height and form)
- Sexual maturation &Sexual functioning

Posterior Fossa Structures

THE CEREBELLUM

- **Balance**
- **Posture**

THE BRAIN STEM

- **Motor and sensory pathway to body and face**
- **Vital centers: cardiac, respiratory, vasomotor**

Localization of Specific Brain Functions

Arousal:

- Is a physiological and psychological state of being awake or alert, or reactive to stimuli and readiness for action.
- It involves activation of the:
  - Reticular activating system in the brain
  - Autonomic nervous system
  - Endocrine system

Localization of Specific Brain Functions

Arousal:

The arousal system is formed of five neural systems, based on the neurotransmitters, that originate in the brain stem and project to the cerebral cortex:

- Acetylcholine
- Norepinephrine
- Dopamine
- Histamine
- Serotonin

Localization of Specific Brain Functions

Arousal:

Arousal is important in regulating:

- **Consciousness**
- **Attention**
- **Information processing**

Localization of Specific Brain Functions (cont..)

Memory

- The process in which information is:
  - **Encoded or registered**: receiving, processing and combining of received information.
  - **Stored**: creation of a permanent record of the encoded information
  - **Retrieved** (recall or recollection): calling back the stored information
- The loss of memory is called **forgetfulness** or **amnesia**

Localization of Specific Brain Functions (cont..)

Memory

Three periods of memory:

- **Sensory (Immediate)** – functions over a period of seconds
- **Short term (recent or working memory)** functions over a period of minutes to days
- **Long term (Remote)** – functions over a period of months to years:

Localization of Specific Brain Functions (cont..)

Long-term Memory

- Explicit (Conscious) Memory

  Declarative (facts & events):

  - Episodic (events, experiences)
  - Semantic (facts, concepts)

- Implicit (Unconscious) Memory
- Procedural (skills, tasks)

Localization of Specific Brain Functions (cont..)

Memory

- Brain structures critical to the formation of memories:
  - Temporal lobe involved in autobiographical and recognition memory
  - Parietal lobes involved in verbal short term memory and focusing attention
  - Basal ganglia are associated with learning, unconscious memory processes (implicit memory)
- *Alzheimer and Pick disease are examples of memory disorders*

Localization of Specific Brain Functions (cont..)

Memory

- Hippocampus contains cognitive maps, encoding, memory consolidation (process of converting short to long-term memory
- Cerebellum plays a role in procedural memory
- Amygdala involved in emotional learning and memory consolidation
- Frontal lobes are important in working memory and prospective memory

LANGUAGE (CONT..)

- 90% of people are Right handed.
  - ➢ 99% of them have left hemisphere dominance for language
- 10% left handed
  - ➢ 7% have left hemispheric dominance and 3% either mixed or right hemispheric dominance.
- Music is represented in the right hemisphere

Localization of Specific Brain Functions (cont..)

Language

- **Aphasias** are language disorders (inability to understand or produce language in the presence of normal articulation).
- **Broca's aphasia (non fluent aphasia):** Inability to form speech due to a lesion of inferior frontal lobe.
- **Wernicke's aphasia (fluent aphasia):** inability to comprehend speech due to a lesion of the left superior temporal lobe.
- **Developmental Dyslexia :**

Inability to learn in the context of adequate intelligence, motivation and education in children, due to right hemisphere dysfunction.

Localization of Specific Brain Functions

Emotions

- Emotion is often defined as a complex state of feeling that results in physical and psychological changes that influence thought and behavior and actions.

➢ There are only two basic emotions that we all experience,

- love and
- fear.

All other emotions are variations of these two emotions

Localization of Specific Brain Functions

Emotions

- Emotions derive from the basic drives that all animals share (feeding, sex, reproduction, pleasure, pain, fear, aggression)
- Human emotions are largely learned and include: affection, pride, guilt, pity, envy, and resentment.
- Emotions are represented in the prefrontal cortex and the limbic system namely the amygdala.
  - Lesion of the left prefrontal area produces depression
  - Lesion of right prefrontal produces laughter and euphoria

Thank You