PERIPHERAL NERVOUS SYSTEM

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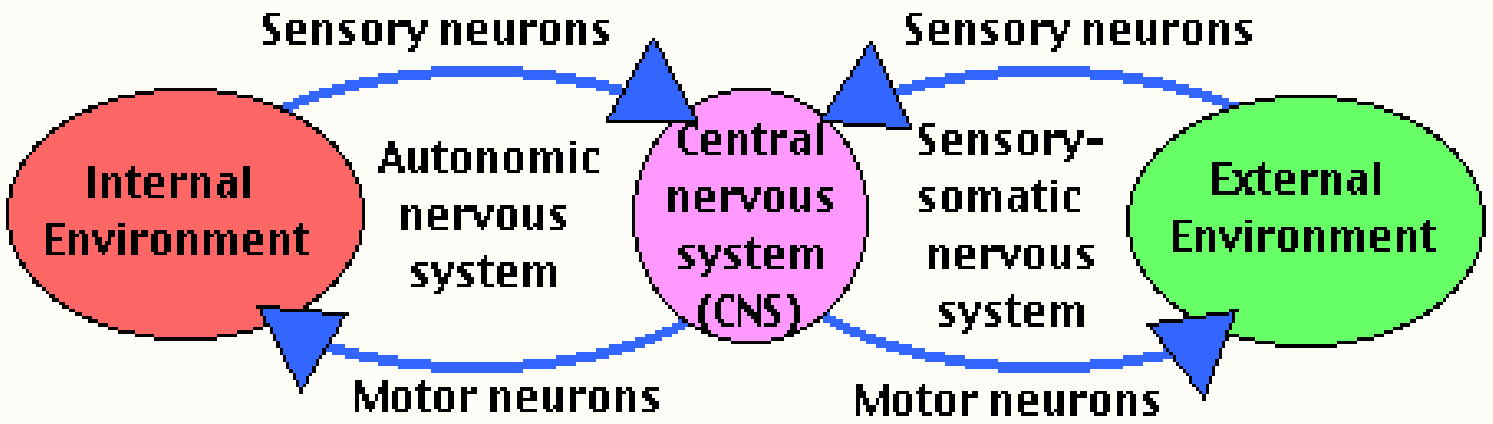
LECTURER MEDICAL TECHNOLOGY

INTRODUCTION:

- The **peripheral nervous system** (**PNS**) is the part of the nervous system that consists of the nerves and ganglia on the outside of the brain and spinal cord
- The main function of the PNS is to connect the central nervous system (CNS) to the limbs and organs,
- The **PNS** consists of:
  - **Sensory neurons** running from stimulus **receptors** that inform the CNS of the stimuli
  - **Motor neurons** running from the CNS to the **muscles and glands** - called **effectors** - that take action

SUBDIVISION:

- The **peripheral nervous system** is subdivided into the
  - **Sensory-somatic nervous system**
  - **Autonomic nervous system**



PERIPHERAL SENSORY RECEPTOR:

- Receptors are either dendritic ends of sensory neurons that monitor general sensory information over wide areas,

- Receptors may also associate with cells that transfer the signal to a sensory neuron (merkel cells) and monitor specialized senses by existing in localized regions.

CLASSIFICATION BY LOCATION OF SENSORY RECEPTORS:

1. Receptors that receive stimulus from the environment are sensitive to pressure, pain, smell, sight, and hearing are called **exteroceptors**.
2. Receptors that are sensitive to the body's internal changes, either visceral or chemical changes, taste, and temperature are called **interoceptors**.
3. Receptors found within skeletal muscles, tendons, joints, and ligaments monitor the amount of stretching and send input on movement. They are called **proprioceptors**.

CLASSIFICATION BY STIMULUS DETECTED:

1. **Mechanoreceptors** are stimulated by mechanical forces such as touch, pressure, etc.
2. **Thermoreceptors** are stimulated by temperature changes
3. **Chemoreceptors** respond to chemicals changes in blood, taste, or smell.
4. **Photoreceptors** respond to light such as those found in the eye.

SENSORY SOMATIC NERVOUS SYSTEM:

- The **somatic** nerve cells carry messages from the outer areas of the body having to do with the senses. It is like a passageway from the environment to the central nervous system
- The sensory-somatic system consists of:
- 12 pairs of **cranial nerves**
- 31 pairs of **spinal nerves**.

CRANIAL NERVES:

- **Cranial nerves** are the nerves that emerge directly from the brain (including the brainstem), in contrast to spinal nerves (which emerge from segments of the spinal cord).
- Cranial nerves relay information between the brain and parts of the body, primarily to and from regions of the head and neck
- Originate from nuclei in inferior surface of brain, some are sensory, some motor and some are mixed.

Nerves	Type	Function
I Olfactory	sensory	olfaction (smell)
II Optic	sensory	vision (Contain 38% of all the axons connecting to the brain.)
III Oculomotor	motor*	eyelid and eyeball muscles
IV Trochlear	motor*	eyeball muscles
V Trigeminal	mixed	Sensory: facial and mouth sensation Motor: chewing
VI Abducens	motor*	eyeball movement
VII Facial	mixed	Sensory: taste Motor: facial muscles and salivary glands
VIII Auditory	sensory	hearing and balance
IX Glossopharyngeal	mixed	Sensory: taste Motor: swallowing
X Vagus	mixed	main nerve of the parasympathetic nervous system (PNS)
XI Accessory	motor	swallowing; moving head and shoulder
XII Hypoglossal	motor*	tongue muscles

FUNCTION:

- The cranial nerves provide motor and sensory innervation mainly to the structures within the head and neck.
- The sensory innervation includes both "general" sensation such as temperature and touch, and "special" innervation such as taste, vision, smell, balance and hearing
- The vagus nerve (X) provides sensory and autonomic (parasympatheic) motor innervation to structures in the neck and also to most of the organs in the chest and abdomen.

SMELL (I):

- The olfactory nerve (I) conveys the sense of smell.
- Their sensory receptors and fibers originate in the upper part of the mucous membrane of the nasal cavity
- Damage to the olfactory nerve (I) can cause an inability to smell (anosmia), a distortion in the sense of smell (parosmia), or a distortion or lack of taste

- **VISION (II):**
- The optic nerve (II) transmits visual information
- The fibers originate in the retina of the eyes and they combine to form the optic nerves

EYE MOVEMENT (III, IV, VI):

- The oculomotor nerve (III), trochlear nerve (IV) and abducens nerve (VI) coordinate eye movement.
- Oculomotor nerve supplies to the extrinsic and intrinsic (intraocular) muscles of eyes
- Trochlear nerve supply superior oblique muscles of eye
- Abducen nerve supply lateral rectus muscle of eye balls causing abduction.

TRIGEMINAL NERVE (V):

- The trigeminal nerve (V) is composed of three distinct parts:
  - The Ophthalmic (V1),
  - The Maxillary (V2),
  - The Mandibular (V3) nerves

- Combined, these nerves provide sensation to the skin of the face and also controls the muscles of mastication (chewing)

FACIAL EXPRESSION (VII):

- Facial nerve coordinate facial movement
- Motor fibers supply the muscle of facial expression
- Sensory fibers convey impulses from taste buds of tongues to the taste perception area in cerebral cortex

HEARING AND BALANCE (VIII):

- The vestibulocochlear nerve (VIII) splits into the vestibular and cochlear nerve.
- The vestibular part is responsible for innervating the vestibules and semicircular canal of the inner ear;
- this structure transmits information about balance, and is an important component of the vestibuloocular reflex, which keeps the head stable and allows the eyes to track moving objects.
- The cochlear nerve transmits information from the cochlea, allowing sound to be heard.

ORAL SENSATION, TASTE, AND SALIVATION (IX):

- The glossopharyngeal nerve (IX) innervates the stylopharyngeus muscle and provides sensory innervation to the oropharynx and back of the tongue.
- **VAGUS NERVE (X):**
- Motor nerve supply the smooth muscle and secretory glands of larynx, pharynx, trachea, bronchi, heart and blood vessels in the thoracic and abdominal cavities
- Sensory nerve convey the impulses from membrane lining of same structure to the brain

SHOULDER ELEVATION AND HEAD TURNING (XI):

- Accessory nerve
- Supply the sternocleidomastoid and trapezius muscles

- **TONGUE MOVEMENT (XII):**
- Hypoglossal nerves
- Supply the muscle og tongue ad surrounding muscle of hyoid bone
- Contribute to swallowing and speech

AUTONOMIC NERVOUS SYSTEM:

- The autonomic nervous system consists of sensory neurons and motor neurons that run between the central nervous system (especially the **hypothalamus** and **medulla oblongata**) and various internal organs such as the:
- heart
- lungs
- viscera
- glands (both exocrine and endocrine)

Contd...

- It is responsible for monitoring conditions in the internal environment and bringing about appropriate changes in them. The contraction of both smooth muscle and cardiac muscle is controlled by motor neurons of the autonomic system
- The actions of the autonomic nervous system are largely **involuntary** (in contrast to those of the sensory-somatic system). It also differs from the sensory-somatic system is using two groups of motor neurons to stimulate the effectors instead of one.

Contd...

- The first, the **preganglionic neurons**, arise in the CNS and run to a ganglion in the body.

- Here they synapse with **postganglionic neurons**, which run to the effector organ (cardiac muscle, smooth muscle, or a gland).

SUBDIVISION OF ANS:

- The autonomic nervous system has two subdivisions,

1. The **sympathetic nervous system**

- Also called thoracolumbar outflow
- (stressful condition)

2. The **parasympathetic nervous system**

- Craniosacral outflow
- (resting condition)

SYMPATHETIC NERVOUS SYSTEM:

- The **preganglionic** motor neurons of the sympathetic system (shown in black) arise in the spinal cord. They pass into sympathetic ganglia which are organized into two chains that run parallel to and on either side of the spinal cord.
- The preganglionic neuron may do one of three things in the sympathetic ganglion:synapse with **postganglionic** neurons which then re-enter the spinal nerve and ultimately pass out to the sweat glands and the walls of blood vessels near the surface of the body.
- pass up or down the sympathetic chain and finally synapse with postganglionic neurons in a higher or lower ganglion

Contd...

- Leave the ganglion by way of a cord leading to special ganglia (e.g. the solar plexus) in the viscera.
- Here it may synapse with postganglionic sympathetic neurons running to the smooth muscular walls of the viscera.
- However, some of these preganglionic neurons pass right on through this second ganglion and into the **adrenal medulla**.
- Here they synapse with the highly-modified postganglionic cells that make up the secretory portion of the adrenal medulla.

Contd...

- The neurotransmitter of the preganglionic sympathetic neurons is **acetylcholine** (**ACh**). It stimulates action potentials in the postganglionic neurons.
- The neurotransmitter released by the postganglionic neurons is **noradrenaline** (also called **norepinephrine**).
- The action of noradrenaline on a particular gland or muscle is excitatory is some cases, inhibitory in others. (At excitatory terminals, ATP may be released along with noradrenaline.)

Contd...

- The **release of noradrenaline** stimulates heartbeat
- raises blood pressure
- dilates the pupils
- dilates the trachea and bronchi
- stimulates glycogenolys is the conversion of liver glycogen into glucose

Contd...

- In short, stimulation of the sympathetic branch of the autonomic nervous system prepares the body for emergencies: for "**fight or flight**" (and, perhaps, enhances the memory of the event that triggered the response).
- Activation of the sympathetic system is quite general becausea single preganglionic neuron usually synapses with many postganglionic neurons;
- The release of **adrenaline** from the adrenal medulla into the blood ensures that all the cells of the body will be exposed to sympathetic stimulation even if no postganglionic neurons reach them directly

PARASYMPATHETIC NERVOUS SYSTEM:

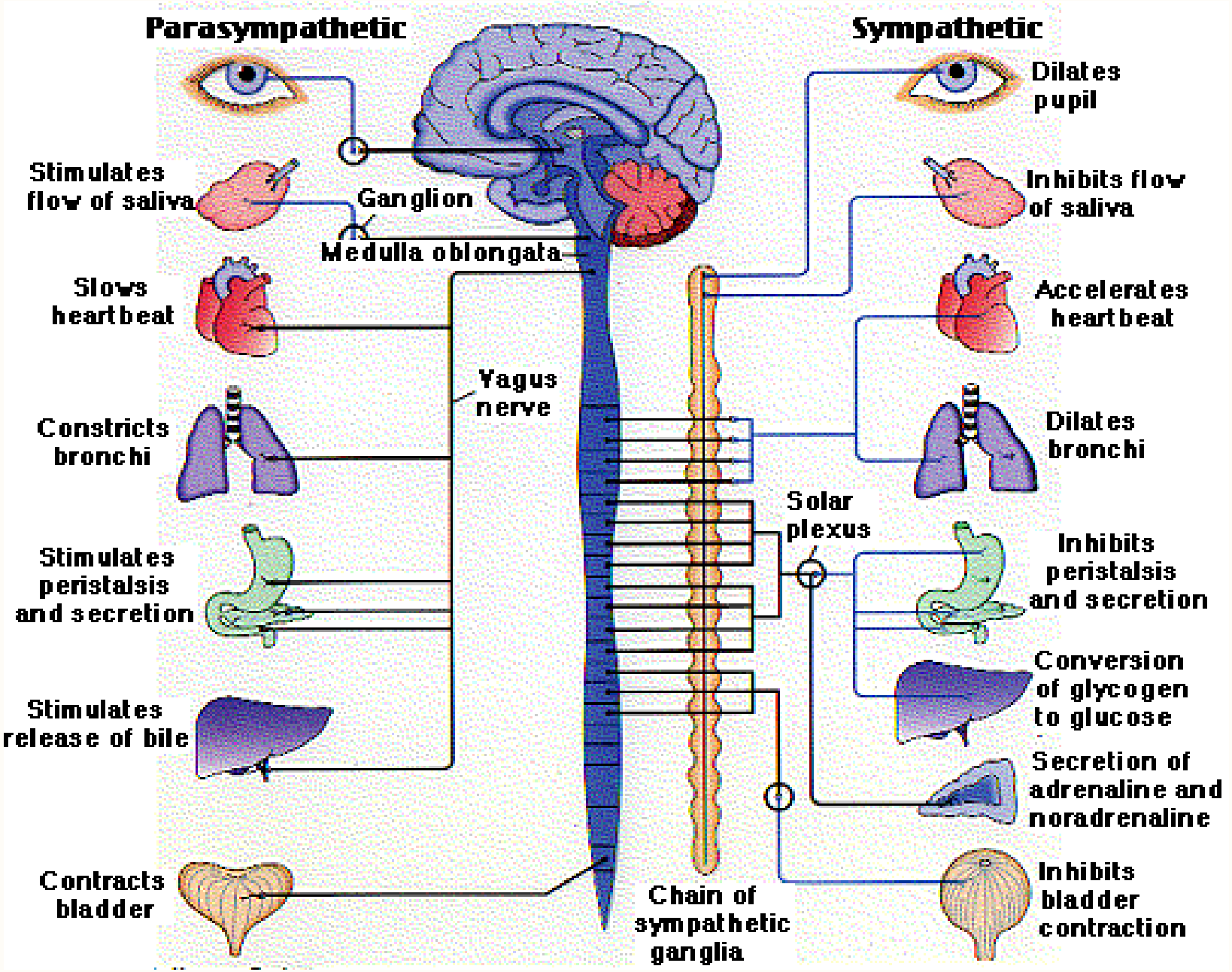
- The main nerves of the parasympathetic system are the tenth cranial nerves, the **vagus nerves**. They originate in the **medulla oblongata**.
- Other preganglionic parasympathetic neurons also extend from the brain as well as from the lower tip of the spinal cord.
- Each preganglionic parasympathetic neuron synapses with just a few postganglionic neurons, which are located near or in the effector organ, a muscle or gland.

Contd...

- **Acetylcholine** (**ACh**) is the neurotransmitter at all the pre- and many of the postganglionic neurons of the parasympathetic system. However, some of the postganglionic neurons release nitric oxide (NO) as their neurotransmitter.

Parasympathetic stimulation causes

- slowing down of the heart beat
- lowering of blood pressure
- constriction of the pupils
- increased blood flow to the skin and viscera
- peristalsis of the GI tract


Parasympathetic
Sympathetic
Stimulates flow of saliva
Ganglion
Medulla oblongata
Slows heartbeat
Yagus nerve
Constricts bronchi
Stimulates peristalsis and secretion
Stimulates release of bile
Contracts bladder
Chain of sympathetic ganglia
Solar plexus
Dilates pupil
Inhibits flow of saliva
Accelerates heartbeat
Dilates bronchi
Inhibits peristalsis and secretion
Conversion of glycogen to glucose
Secretion of adrenaline and noradrenaline
Inhibits bladder contraction

EFFECTS OF AUTONOMIC STIMULATION: