**Autonomic Nervous System Dr. Gary Mumaugh – Campbellsville University**

**Peripheral Nervous System**

* The peripheral nervous system is divided into two systems:
* **SENSORY SYSTEM**
* **MOTOR SYSTEM -** The motor system is further divided into:
  + Somatic Nervous System
    - Under voluntary control
    - Example: contraction of the biceps brachii
  + Visceral Nervous System – aka Autonomic Nervous System
    - Under involuntary control
    - Example: contraction of visceral organs
    - Divided into three branches:
      * Sympathetic Nervous System
      * Parasympathetic Nervous System
      * Enteric Nervous System

**A diagram of nervous system

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**Somatic Nervous System Fibers/Neurons**

* It only takes one motor neuron (a.k.a. somatic motor fibers, alpha motor neurons) to reach its target/effector organ
* Origin: anterior horn of the spinal cord
* Target: skeletal muscles
* At the synaptic level, the neuron releases acetylcholine, which binds to the nicotinic receptors on muscles to stimulate contraction

**Visceral Nervous System (ANS) Fibers/Neurons**

* It takes two motor neurons to reach its target/effector organ
  + **Timeline

    Description automatically generated**Pre-ganglionic neuron
    - Origin: brainstem/spinal cord
    - Target: synapses with a ganglion
  + Post-ganglionic neuron
    - Origin: ganglion
    - Target: effector organ (e.g., skeletal muscle, viscera, etc.

**Remember Key Neuron Terms**

* Synapse
  + Site of transmission of electrical/chemical; signals between two neurons
* Ganglion
  + A group of neuron cell bodies in the PNS
* Pre-ganglionic nerve fibers
  + Fibers which originate from the brain/spinal cord and synapses with a ganglion
* Post-ganglionic nerve fibers
  + Fibers which originate from the ganglion and travels to the target/effector organ
* Splanchnic nerve fibers
  + Any of several nerves of the sympathetic part of the ANS that innervates viscera and blood vessels

**Autonomic Nervous System**

* Sympathetic Nervous System
  + “Fight, Flight, or Fright stage”
  + Activated in stressful situations
  + Location: Spinal Cord, T1 – L2 (thoracolumbar)
  + Action potentials/signals from the sympathetic nervous system pass through this thoracolumbar outflow
* Parasympathetic Nervous System
  + “Rest and Digest stage”
  + Location: Brainstem (CN III, VII, IX, X) and Spinal Cord, S2-S4 (craniosacral)
  + These cranial nerves have parasympathetic activity
  + Action potentials/signals from the parasympathetic nervous system pass through this craniosacral outflow

**Remember Main Divisions**

* Sympathetic Nervous System
  + Thoracolumbar outflow
  + Spinal cord, T1 – L2
* Parasympathetic Nervous System
  + Craniosacral outflow
  + Brainstem and spinal cord, S2-S4

**Ganglionic Neurons/Fibers**

* Sympathetic Nervous System Pathway:
  + Short pre-ganglionic neurons
    - Cholinergic fibers
      * Releases Ach at the synaptic junction to stimulate post-ganglionic neuron
    - Sympathetic ganglia
      * Are located far from the target organs.
  + Long post-ganglionic neurons
    - Adrenergic fibers - release norepinephrine at the synaptic junction

**Ganglionic Neurons/Fibers**

* Parasympathetic Nervous System Pathway:
  + Long pre-ganglionic neurons
    - Cholinergic fibers
      * Travel until they reach the target organ
    - Terminal / Intramural ganglia
    - The only type of parasympathetic ganglia
    - Located at or inside the target organ
  + Short post-ganglionic neurons

**Key Points to Remember**

* Sympathetic Nervous System
  + Short pre-ganglionic neurons: cholinergic
  + Long post-ganglionic neurons: adrenergic
* Parasympathetic Nervous System
  + Long pre-ganglionic neurons: cholinergic
  + Short post-ganglionic neurons: cholinergic

**Diagram

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Timeline

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* **Differences Between the Somatic and Autonomic Nervous Systems**
  + Somatic is voluntary and part of the peripheral nervous system
  + ANS is involuntary and is divided into sympathetic and parasympathetic
* **Divisions of the Autonomic Nervous System**
  + Sympathetic division speeds things up
    - Fight or flight mechanism
  + Parasympathetic slows things down
    - Rest and repose
  + The enteric nervous system
    - Controls the gastrointestinal system
* **Cholinergic and Adrenergic Neurons**
  + Cholinergic neurons
    - What fires in the parasympathetic nervous system
    - Ach (acetylcholine) as the neurotransmitter
  + Adrenergic
    - What fires in the sympathetic nervous system
    - Adrenaline as the neurotransmitter
* **Two Types of Cholinergic Receptors**
  + Nicotinic receptors
    - Part of the cholinergic receptors
    - Respond faster than muscarinic receptors
  + Muscarinic receptors
    - Part of the cholinergic receptors
    - Respond slower than nicotinic receptors
* **Two Types of Adrenergic Receptors**
  + Also called sympathetic or adrenergic receptors
  + Alpha receptors
    - Alpha 1 - Stimulatory
      * Found in all smooth muscle, glands and tissues of the sympathetic nervous system
      * Stimulates peripheral blood vessels to constrict, muscles to contract and glands to constrict and release
    - Alpha 2 – Inhibitory
      * Found in all presynaptic terminals
* **Two Types of Adrenergic Receptors - continued**
  + Beta receptors
    - Beta 1 – Stimulatory
      * Found in heart and kidney
      * Stimulate heart to increase cardiac output and stimulates kidneys to raise blood pressure via the renin complex
    - Beta 2 – Inhibitory
      * Found in all smooth muscle, glands and tissues of the sympathetic nervous system
      * Stimulates peripheral blood vessels to dilate, muscles to relax and glands to relax and not release
* **Effects of the Sympathetic Nervous System on the Body**
  + **Sympathetic Effects “Stress” on the Visceral Organs**
    - Generally increases the activity of most visceral organs to meet the increased energy demands associated with stress
    - Stimulates catabolic biochemical processes to increase the availability of O2 and glucose to active tissues, and to increase the generation of ATP (cell respiration)
  + “ **E SITUATIONS”**
    - **E**xercise
    - **E**xcitement
    - **E**mergency
    - **E**mbarrassment
* **Effects of the Parasympathetic Nervous System on the Body**
  + **Parasympathetic Effects “Rest and Digest” on the Visceral Organs**
    - Generally inhibits the activity of of most visceral organs to conserve energy
* Stimulates anabolic biochemical processes for growth and repair of body tissues
* Visualize: The body’s internal state after leisurely enjoying a large dinner and then relaxing with a movie.
* “**S L U D D”**
  + - * + **S**alivation
        + **L**acrimation
        + **U**rination
        + **D**igestion
        + **D**efecation

**Parasympathetic Sympathetic**

**“Rest & Digest” “Stress”**

|  |  |
| --- | --- |
| **ACh** | **Epinephrine & Norepinephrine** |
| **(Muscarinic Cholinergic)** | **(Adrenergic, Catecholamines)** |
| **Purpose Decreased Energy Demands** | **Purpose Increased Energy Demands** |
| Liver glycogenesis >> hypoglycemia | Liver glycogenolysis >> hyperglycemia |
| Lipogenesis in fat cells | Lipolysis in fat cells |
| Decreased rate & depth of breathing | Increased rate & depth of breathing  (Diaphragm is a skeletal muscle) |
| Bronchoconstriction | Bronchodilation |
| Increased bronchial secretions | Decreased bronchial secretions |
| Decreased rate & force of cardiac contraction  Bradycardia Decreased contractility | Increased rate & force of cardiac contraction  Tachycardia Increased contractility |
| Vasoconstriction to heart and skeletal muscle  Causing decreased blood flow | Vasodilation to heart and skeletal muscle  Causing increased blood flow |
| Generalized vasodilation to the other blood vessels of the body causing increased blood flow to the GI tract and kidneys | Generalized vasoconstriction to the other blood vessels of the body causing decreased blood flow to the GI tract and kidneys |
| Decreased blood pressure | Increased blood pressure |
| Pupillary constriction | Pupillary dilation(Mydriasis) |
| Increased salivation | Decreased salivation |
| Emptying of urinary bladder | Inhibits emptying of urinary bladder (retention) |
| Decreased CNS alertness | Increased CNS alertness |
| Sexual arousal (penile erection) | Orgasm (ejaculation) |
|  | Increased sweating causing heat loss  (From Increased Cell Respiration) |

Diagram

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