

Chapters 11: Introduction to the Nervous System and Nervous Tissue

Nervous system – controls our perception and experience of world

Directs _____ movement

Seat of consciousness, personality, learning, and memory

Regulates _____

Module 11.1: Overview of the Nervous System

Anatomical Divisions of the Nervous System

[2 Anatomical Div. = CNS, PNS]

1. _____ – includes **brain** and **spinal cord**
2. _____ – consists of all **nerves** in body outside protection of skull and vertebral column (cranial nerves, spinal nerves)

Functional Divisions of the Nervous System

[3 Functional Div. = Sensory, Integrative, Motor]

1.

– **sensory receptors** gather information about internal and external environments

- **afferent division** carries information toward CNS

a. _____ **sensory division**

– signals from _____, bones, joints, and skin;

- **special sensory div.** (vision, hearing, taste, smell, and balance)

b. _____ **sensory division**

– signals from _____ (organs)

2. _____ **functions** – analyze and interpret incoming sensory information and determine response

3. _____ functions

– actions performed in response to integration

- _____ **division** carries information away from CNS

a. _____ nervous system – info to skeletal muscle

b. _____ nervous system (ANS) – information to smooth muscle, cardiac muscle, glands

Module 11.2: Nervous Tissue

Neurons

Neurons – excitable cell type responsible for sending and receiving signals in form of **action potentials** (AP)

A. Structure of neurons

1.

nucleus, cytoplasm with organelles, _____ (RER, gray color)

2. Cytoplasmic extensions (processes):

_____ – **receive** information from other neurons, conduct impulse toward soma

_____ (nerve fiber) – conducts impulse **away from soma**, includes axon hillock, axon terminals (synaptic knobs)

Poliovirus and Retrograde Axonal Transport

- _____ – caused by poliovirus; infection that impacts CNS (especially SC) → deformity and paralysis
- No cure exists, but prevented by vaccination
- Virus accesses CNS by entering muscle cells → motor neurons at NMJ → **retrograde axonal transport** until reaching SC
- Other viruses (**herpes simplex**, **rabies**) and toxins (**tetanus**) can to invade via this method

Classification of Neurons

- **Structural:**

_____ **neurons** – single axon and multiple dendrites, > 99% of all neurons
(**motor**)

_____ **neurons** – one axon, one dendrite, and cell body between them; found
in eye and olfactory epithelium (**sensory**)

_____ **neurons** – have only one fused axon that extends from cell body and
divides into two processes (**sensory**)

- **Functional :**

_____ (**afferent neurons**) – carry information toward CNS; pseudounipolar or
bipolar

_____ (**association neurons**) – relay information within CNS between
sensory and motor neurons; make up most of neurons in body; multipolar

_____ (**efferent neurons**) – carry information away from cell body in CNS to
muscles and glands; multipolar

Neurons

- Specific neuron components group together:

CNS:

_____ – clusters of neuron cell bodies

_____ – bundles of axons

PNS:

_____ – clusters of neuron cell bodies

_____ – bundles of axons

Neuroglia

- _____ – provide support and protection for neurons, maintain their environment, divide and fill space when a neuron dies
- CNS:
 - **Oligodendrocytes**
 - **Ependymal cells**
- PNS:
 - **Schwann cells**
 -
- **CNS:**
 - _____ – large star-shaped cells
 - Facilitate transport of nutrients and gases between blood vessels and neurons; form **blood-brain barrier (BBB)**
 - _____ – form **myelin in CNS**
 - _____ – activated by injury into phagocytic cells
 - _____ **cells** – ciliated cells that manufacture and circulate **CSF**
- **PNS:**
 - _____ **cells** – produce **myelin**
 - _____ **cells** – supportive functions

The Myelin Sheath

_____ = repeating layers of phospholipid plasma membrane, insulation

Nodes of Ranvier = gaps between myelin sheaths

_____ = myelinated axons

_____ = neuron cell bodies, unmyelinated processes

Regeneration of Nervous Tissue

Regeneration nearly nonexistent in CNS and is limited in PNS

- **Regeneration** steps:
 1. Degeneration of axon and myelin sheath **distal** to injury (**Wallerian degeneration**)
 2. _____ from proximal end of axon
 3. Schwann cells form **regeneration tube**
 4. **Single growth process grows** into regeneration tube
 5. **New axon is** _____ to its target cell

Gliomas and Astrocytomas

- **Primary brain tumors** – originate in brain; most are _____ (caused by abnormally high rate of division of glial cells)
- **Predisposing conditions** – exposure to ionizing radiation and certain diseases
- Most commonly affected cell is _____ → tumor is called _____

Range in severity from mild with good prognosis to highly aggressive with very poor prognosis

Treatment – varies with tumor type, age, and health of patient; usually involves surgical removal of mass with chemotherapy and perhaps radiation therapy

Module 11.3: Electrophysiology of Neurons

Introduction to Electrophysiology of Neurons

- All neurons are excitable or responsive to stimuli (chemical, electrical, and mechanical)
- Stimuli generate electrical changes across plasma membrane (PM)

_____ **potentials** – travel short distances

_____ **potentials** – travel entire length of axon; begin at trigger zone → axon terminal

- Ion channels – ions must rely on specific protein channels for diffusion
- Resting Membrane Potential (**RMP**) = - _____
due to difference in distribution of ions across PM

Principles of Electrophysiology: Types of Ion Channels

- _____ - Ions follow conc. gradient
- _____ - Open in response to specific chemical binding
- _____ - Open or close due to changes in voltage across PM
- _____ - Open or close due to mech. stim. (stretch, press., vibration)

Principles of Electrophysiology

RMP =

Cell is polarized (positive on outside, negative on inside of PM)

Diffusion of ions across PM determined by **Electrochemical Gradient**:

- Electrical gradient:
_____ on _____, _____ on _____ of plasma membrane
- Chemical Gradient:
_____ outside > Na⁺ inside
_____ inside > K⁺ outside

How Do Positive Ions Create a Negative Resting Membrane Potential

- A neuron that has no membrane potential; charges are distributed equally across plasma membrane
- Now, imagine that a potassium ion diffuses out of cytosol down concentration gradient through a leak channel...
- Six positive charges are now outside membrane and four positive charges inside; makes overall charge inside **cytosol -1** and in **extracellular fluid +1**—a membrane potential has been created

- Imagine that many thousands of potassium ions exit through leak channels; causes membrane potential to become progressively more negative

Changes in Resting Membrane Potential: Ion Movements:

- _____ – **Na⁺** channels open, Na⁺ flow into cell; membrane potential becomes more positive
- _____ – K⁺ ion channels open; K⁺ flow out of cell; cell becomes more negative, returning to RMP
- _____ – cell becomes more negative than normal RMP due to efflux of K⁺ plus influx of Cl⁻

Local Potentials

_____ potentials – serve as triggers for long-distance **AP**

- May cause:
 - _____ – positive charges enter cytosol and make membrane potential less negative (–70 to –60 mV)
 - _____ – either positive charges exit or negative charges enter cytosol; makes membrane potential more negative (–70 to –80 mV)
- Sometimes called _____ potentials because vary greatly in size

Action Potentials

- Events in an Action Potential:
 1. Local potential must be able to depolarize axon strongly enough to reach _____ (usually –55 mV)
 2. **Depolarization** – sodium ions rush in (_____)
 3. _____ – potassium ions rush out (_____)
 4. **Hyperpolarization** may occur

Local Anesthetic Drugs

- **Local anesthetics** – (like _____) commonly administered agents for surgical or dental procedures; produce temporary numbness in specific area
- Block voltage-gated sodium channels of neurons in treated area; prohibits depolarization and therefore action potentials relaying pain are not transmitted to CNS
- Nonselective; also affect sodium channels in muscles of area; causes temporary paralysis; reason for crooked smiles and drooling following dental work

Refractory Period

- _____ **period** – period of time, after neuron has generated an AP, when neuron cannot be stimulated to generate another AP
- _____ **refractory period** – when no additional stimulus (no matter how strong) is able to produce additional AP
- _____ **refractory period** – immediately after absolute refractory period; only a strong stimulus can produce AP

Local and Action Potentials Compared

Graded local potentials produce variable changes in membrane potentials

_____ **potentials** cause a maximum _____ to +30 mV

- **All-or-none principle** – AP that either happens completely or not at all

If a neuron does not depolarize to threshold then no AP will occur

AP are not dependent on strength, frequency, or length of stimulus like local potentials

Propagation of Action Potentials

APs **conducted** (_____) along entire length of axon =

- unidirectional
- Each AP triggers next section of axon, usually starting at trigger zone and ending at axon terminals

Conduction speed – influenced by both axon diameter and presence or absence of myelination

-
- Presence or absence of _____ gives rise to 2 types of conduction:
 - _____ **conduction** – myelinated processes exhibit “jumping” type of conduction, _____ **rate**
 - _____ **conduction** – unmyelinated processes, _____ **rate** of conduction

Saltatory conduction – **myelinated axons** increase speed of conduction; AP only depolarize nodes of Ranvier and “jump over” _____

Continuous conduction – in **unmyelinated axons** every section of axolemma from trigger zone to axon terminal **must** propagate AP; slower conduction speed

- **Classification of Axons by Conduction Speed:**

Type A fibers – _____ diameter (120 m/sec or **250 mi/h**); (5–20 μ m) and _____; sensory and motor axons associated with skeletal muscle and joints

Type B fibers – _____ diameter, slower conduction speeds (15 m/sec or **32 mi/hr**); mostly _____ with intermediate diameter axons (2–3 μ m); ANS efferent fibers, some sensory

Type C fibers – _____ diameter, slowest conduction speeds (0.5–2 m/sec or **1–5 mi/hr**); (0.5–1.5 μ m); _____ ANS efferent fibers and sensory axons (transmit pain, temperature, and pressure)

Multiple Sclerosis

- **Multiple sclerosis (MS)** – certain cells of immune system attack myelin sheaths within CNS; type of _____ (patient’s own immune system attacks part of body)
- Causes progressive loss of myelin sheath; in turn causes loss of current from neurons

- **Symptoms** – result from progressive slowing of AP propagation; symptoms depend on region of CNS affected; most exhibit changes in sensation (e.g., numbness), alterations in behavior and cognitive abilities, and motor dysfunction, including paralysis

Module 11.4: Neuronal Synapsis

Overview of Neuronal

- _____ – where a neuron meets its target cell (in this case another neuron) is called a **neuronal synapse**
 - electrical (gap junctions) – breathing, cardiac & SMC
 - _____ – most synapses
 - can occur between an axon of one neuron and another part of another neuron (dendrite, soma, axon)
 - **Presynaptic neuron** → _____ → **Postsynaptic neuron**

Chemical Synapses

- **Events at a Chemical Synapse:**
 - multiple neurons secreting many different types of excitatory or inhibitory neurotransmitters
1. AP in presynaptic neuron triggers _____ **ion channels** in axon terminal to open
 2. _____ **of calcium ions** causes synaptic vesicles to release neurotransmitter into synaptic cleft
 3. Neurotransmitters **bind to** _____ on postsynaptic neuron
 4. **Ion channels open, leading to a local potential and possibly an AP** if threshold is reached

Postsynaptic potentials – can be **Excitatory** or **Inhibitory**:

- a. **Excitatory postsynaptic potential (EPSP)** = Membrane potential moves _____ **to threshold**
- b. **Inhibitory postsynaptic potential (IPSP)** = Membrane potential moves _____ **away from threshold**

Arthropod Venom

- **Venomous arthropods** (in United States) include **spiders** and **scorpions**; many of their venoms affect neuronal synapses; termed **neurotoxins**
 - _____ (Latrodectus mactans) – toxin causes massive release of neurotransmitter leading to repetitive stimulation of postsynaptic neuron
 - _____ – most lethal of 40 species in United States; venom prevents postsynaptic sodium channels from closing; membrane remains polarized and continues to fire action potentials
- Mechanisms are different but result is similar; both lead to overstimulation of postsynaptic neuron;
- **Common symptoms** – muscle hyperexcitability, sweating, nausea and vomiting, and difficulty breathing
- **Treatment and prognosis** – depends on amount of venom received and availability of medical care; severe cases usually require _____ to block effects of toxin

Neural Integration

- Neurons receive input, both inhibitory and excitatory, from multiple neurons, each of which influences whether an action potential is generated
- _____ – process in which postsynaptic neuron integrates all incoming information into a single effect

Module 11.5: Neurotransmitters

Neurotransmitters

- Over 100 known neurotransmitters

4 groups:

1. _____ (acetylcholine)- E [_____]

2. Biogenic amines: E

Catecholamines (NE, Epi (adrenaline), dopamine) [_____]

Serotonin

3. Amino acids: (Glutamate – E; GABA- Inhib.)

4. Neuropeptides: E and I (endorphins)

Psychiatric Disorders and Treatments

- **Psychiatric disorders** affect thought processes; generally treated by modifying synaptic transmission to change how neurons communicate
- **Psychopharmacology** (study of drugs that affect higher brain functions) targets either AP generation or some aspect of neurotransmitter physiology:

_____ – repetitive **psychotic episodes** (periods during which patient is unable to appropriately test beliefs and perceptions against reality); thought to result from excessive release of dopamine; management involves blocking postsynaptic dopamine receptors

_____ **disorders** – marked by disturbances in mood; decreased levels of serotonin, norepinephrine, and/or dopamine; most widely used antidepressants are **selective serotonin reuptake inhibitors (SSRIs)**

_____ – characterized by exaggerated and inappropriate fear responses; abnormalities in norepinephrine, serotonin, and GABA transmission; drugs for treatment include antidepressants, GABA activity enhancers

_____ – characterized by episodes of abnormal elevated mood (mania) followed by depression; treatments involve decreasing ease of AP generation

Module 11.6: Functional Groups of Neurons

Neuronal Pools

- Groups of interneurons within CNS:
 - Composed of neuroglial cells, dendrites, and axons in one location and cell bodies in another location
 - Connections between pools allow for complex mental activity (planned movement, cognition, and personality)

Neuronal Circuits

- **Neural circuits** – patterns of synaptic connection between neural pools
 - _____ **circuits**
 - one neuron sends impulses to multiple postsynaptic neurons
 - incoming sensory information sent from SC to different neuronal pools in brain for processing
 - _____ **circuits**
 - axon terminals from multiple neurons converge onto a single postsynaptic neuron
 - respond to sensory information

Chapter 12: The Central Nervous System

CNS =

- involved in **movement**, interpreting **sensory**, maintaining **homeostasis**, and functions relating to **mind**

Module 12.1: Overview of the Central Nervous System

Overview of CNS Functions

- Functions of nervous system:
 - _____ **functions** muscles contract, glands secrete (**PNS**)
 - _____ **functions** –sensations in and outside body (**PNS**)
 - _____ **functions** – include decision-making processes (**CNS**)
 - **Interpretation** of **sensory** information
 - Planning and monitoring **movement**
 - Maintenance of **homeostasis**
 - Higher mental functions such as **language and learning**

Basic Structure of the Brain and SC

- **Brain** – soft, whitish-gray organ in cranial cavity, continuous with SC
 - mostly nervous tissue; some epithelial and CT
 - _____ filled with **cerebrospinal fluid** (_____)
 - ~20% of cardiac output; requires large amounts of O₂, glucose, and nutrients

4 divisions of brain:

- _____
 - left and right **hemispheres**
 - higher mental functions, sensory & motor

- _____ - deep to hemispheres
 - process, integrate & relay; homeostasis; bio rhythms
- _____ - inferior to occipital lobe
 - voluntary motor activities
- _____ = midbrain, pons, medulla oblongata
 - reflexes, homeostasis, relay information

_____ – located in **vertebral cavity**

- Extends from foramen magnum to L1 & L2
- Length ~ 45 cm (17–18 inches)
- Diameter 0.65–1.25 cm (0.25–0.5 inches)
- _____ – CSF filled cavity within SC, continuous with brain's ventricles

White matter – found in both brain and SC; (_____ axons)

_____ = bundles of white matter (processes in CNS)

_____ = clusters of cell bodies and dendrites (gray matter)

_____ **matter** – found in both brain and SC;

(cell bodies, dendrites, and unmyelinated axons)

1. Cerebral cortex is gray matter
2. Center H (butterfly)-shape of SC

Module 12.2: The Brain

The Cerebrum

- _____ – shallow grooves on surface of cerebrum
- _____ - elevated ridges found between sulci
- **Corpus callosum** – connects right & left hemispheres

- _____ **fissure** – deep groove that separates left and right cerebral hemispheres
- **Transverse fissure** – separates occipital lobe from cerebellum
- _____ – CSF-filled cavities, one in each hemisphere

- Five lobes are found in each hemisphere:
 - **Frontal lobe** (motor, complex mental fcn.)
 - **Parietal lobe** (_____)
 - **Temporal lobe** (_____)
 - **Occipital lobe** (_____)
 - **Insula** (_____)

- **Cerebral Cortex** = gray matter, covers cerebral hemispheres
- All neurons in cortex are interneurons
- Functions of neocortex (most recently evolved part of brain) include conscious processes as planning **movement**, interpreting incoming **sensory** information, and **complex higher functions**

- **Gray Matter: Cerebral Cortex:**
 - Neocortex is divided into three areas: [**Motor, Sensory, Association**]
 1. _____ **motor cortex** – plans and executes movement
 - located in frontal lobe (pre-central gyrus)
 - _____ **cortex** – anterior to primary motor cortex, plan and carry out movement
 - _____ **eye fields** -back and forth eye movements as in reading
 2. **Primary sensory cortices** – receive and process sensory input
 - Somatosensory areas– in postcentral gyrus of parietal lobe; cutaneous (temp. & touch)
 - Visual areas –
 - Auditory areas –

- Gustatory cortex – insula and parietal
- Olfactory cortex –

3. **Association areas** integrate different types of information

- _____ – produce speech sounds
- **Prefrontal cortex** – most of frontal lobe, fcn. in behavior, personality, learning, memory
- **Parietal & temporal association cortices** – integrate sensory info, attention

- **Basal nuclei**

- masses of gray matter deep within each hemisphere

-

- **Caudate nuclei**

- **Putamen**

- **Globus pallidus**

- **Limbic system**

- includes limbic lobe, hippocampus, amygdala

- connect these regions of gray matter with rest of brain

- Found only within mammalian brains

-

The Diencephalon

Diencephalon – located in center of brain between hemispheres above brainstem

- 4 parts: Thalamus, Hypothalamus, Epithalamus, Subthalamus
-

Gateway for sensory info. to cerebral cortex

Receives all sensory (except smell)

-

Regulation of ANS, sleep/wake cycle, thirst and hunger, and body temperature

Secretes hormones that reg. pituitary & other glands

- _____ – superior to thalamus; includes endocrine gland called **pineal gland** that secretes **melatonin**; hormone involved in sleep/wake cycle
- _____ – inferior to thalamus; functionally connected with basal nuclei; together, they control movement

Cerebellum

Cerebellum

- located inferior to occipital lobe
-
- arbor vitae

The Brainstem

Brainstem

-
- vital to our immediate survival
- Includes midbrain, pons, medulla oblongata
- - surrounds **cerebral aqueduct** (connects third and fourth ventricles)
 - **Superior** and **inferior** _____: involved in visual and auditory reflexes respectively
 - **Substantia nigra** – works with basal nuclei to control movement; produces dopamine
- _____ – inferior to midbrain

- Regulation of movement, breathing, reflexes, and complex functions associated with sleep and arousal
- _____ – most inferior structure of brainstem
 - Regulation of breathing, and other vital activities

Module 12.3: Protection of the Brain

Brain Protection

Three features protect delicate brain tissue:

1. _____ – three layers of membranes that surround brain
 2. **Cerebrospinal fluid (CSF)** – fluid that bathes brain and fills cavities
 3. **Blood-brain barrier** – prevents many substances from entering brain and its cells from blood
- **Cranial meninges**
 - composed of three layers:
 - superficial to deep:
 - epidural space
 - a. _____
 - subdural space
 - b. _____ (weblike)
 - subarachnoid space (CSF filled)
 - c. _____ (in contact with brain tissue)

The Ventricles and Cerebrospinal Fluid

- **Four ventricles** within brain (1st & 2nd = lateral ventricles, 3rd and 4th ventricle connected via cerebral aqueduct)

continuous with central canal of spinal cord

Lined with _____ **cells**

Filled with _____

- **CSF** (similar to plasma)

Produced by _____

Reabsorbed by arachnoid villi (granulations)

~800ml produced daily, only 150ml at any time

Cushions brain, maintains temp., removes wastes, provides buoyancy

Infectious Meningitis

- Potentially life-threatening infection of meninges in subarachnoid space; **inflammation** occurs, causing classic signs: headache, lethargy, stiff neck, fever
- **Diagnosis** – examination of CSF for infectious agents and white blood cells (cells of immune system); bacteria and viruses are most common causative agents:

_____ – generally mild; resolves in 1–2 weeks

_____ – can rapidly progress to brain involvement and death; aggressive antibiotic treatment necessary; some most common forms are preventable with vaccines

Module 12.4: The Spinal Cord

The Spinal Cord

- _____ – composed primarily of nervous tissue; responsible for both relaying and processing information (reflexes)
- Spinal Meninges (similar to cranial meninges)

_____ **space** – space between meningeal dura and walls of vertebral foramina; filled with veins and adipose tissue; cushions and protects spinal cord

_____ **space** – between arachnoid and pia mater; filled with CSF; base of spinal cord contains a large volume of CSF useful site for withdrawing samples laboratory testing

Epidural Anesthesia and Lumbar Punctures

- **Epidural (spinal) anesthesia** – local anesthetic medication is injected into epidural space through an inserted needle
 - Causes “**numbing**” (inability to transmit motor or sensory impulses) of nerves extending off spinal cord below level of injection
 - Commonly given during childbirth and other surgical procedures
- _____ (**spinal tap**) – needle inserted into subarachnoid space between L4 and L5; avoids possibility of injuring SC
 - CSF is withdrawn for analysis; used to assess conditions like **meningitis**, **encephalitis** and **multiple sclerosis**

External Spinal Cord Anatomy

- _____ – extends from between L1 and L2 to coccyx
 - composed of spinal pia mater
- _____ = bundle of spinal nerves contained in vertebral canal
- **Spinal nerves** (PNS); carry sensory and motor impulses to and from SC
 - **Posterior (dorsal) nerve root** –
 - **Anterior (ventral) nerve root** -

Internal Spinal Cord Anatomy

- Butterfly (H) -shaped spinal _____ matter is surrounded by tracts of white matter; _____ – filled with CSF; seen in center of spinal cord
- **Anterior (ventral) horn** – motor neurons to skeletal muscle
- **Posterior (dorsal) horn** – sensory information
- **Lateral horn** – motor, visceral efferent (ANS)

Module 12.5: Role of the CNS in Sensation

General Somatic Senses

- **Role of Cerebral Cortex in Sensation, S1 and Somatotopy:**
 - _____ relays most incoming information to **primary somatosensory cortex (S1)** in postcentral gyrus

Each part of body is represented by a specific region of S1, a type of organization called _____

More S1 space is dedicated to hands and face; represents importance of manual dexterity, facial expression, and speech to human existence

Phantom Limb Pain

- **Phantom limb** – occurs after amputation of limb, digit, or even breast; patients perceive body part is still present and functional in absence of sensory input; small percentage develop **phantom pain** (burning, tingling, or severe pain) in missing part
- Difficult to treat due to complex way CNS processes pain; supports idea that S1 has “map” of body that exists independently of PNS
- Over time, map generally rearranges itself so body is represented accurately; phantom sensations decrease

Module 12.6: Role of the CNS in Voluntary Movement

Role of Brain in Voluntary Movement

- **Role of Cerebral Cortex** in Voluntary Movement:

Primary motor cortex is organized somatotopically; certain body regions have disproportionately more cortical area devoted to them (especially lips, tongue, and hands); signifies importance of vocalization and manual dexterity to human survival

Parkinson's Disease

- One of most common movement disorders
- **Hypokinetic** = movement is difficult to initiate and once started, difficult to terminate
- **Symptoms** – minimal facial expression, shuffling gait, no arm swing, resting tremor
- **Cause** – degeneration of _____-secreting neurons of substantia nigra; genetics suspected in ~10% of cases
- **Treatment** – medications that increase level of dopamine

Module 12.7: Role of the CNS in Maintenance of Homeostasis

Role of CNS in Maintenance of Homeostasis

_____ is defined as maintenance of a relatively stable internal environment in face of ever-changing conditions

- **Homeostatic functions** include maintaining fluid, electrolyte, and acid-base balance; BP; BG and [O₂]; biological rhythms; and body temperature

Endocrine system secretes _____ into blood; regulates functions of other cells (long term)

Nervous system sends _____; excite or inhibit target cells (immediate)

Homeostasis of Vital Functions

- **Autonomic nervous system** (_____)
 - Maintain vital functions (HR, BP, digestion)
 - Although ANS is a component of PNS, mainly controlled by hypothalamus
- _____ is one of few vital functions not under ANS control; regulated by Pons and Medulla
- **Body Temperature** – reg. by _____

Fever

- Elevation of body temperature can accompany variety of infectious and noninfectious conditions
- Due to _____ (chemicals) secreted by cells of immune system and by certain bacteria; cross BBB and interact with hypothalamus (control temp.)
- Pyrogens increase hypothalamic set point to higher temperature; feedback loop triggers shivering and muscle aches due to increased muscle tone; VC of blood vessels to skin
- _____ (**acetaminophen** and **aspirin**)- work by blocking formation of pyrogens; hypothalamus returns to normal set point

Dementia

- Patients with **dementia** exhibit a progressive loss of recent memory, degeneration of cognitive functions, and changes in personality
- No proven method for prevention or cure of dementia exists; some drugs may slow progression of Alzheimer's disease in certain patients but do not reverse changes that already exist; ineffective in other forms of dementia
- Common (most to least) forms of dementia include:
 - **Neurofibrillary tangles** (aggregates of proteins in neurons), **senile plaques** (extracellular deposits of specific protein around neurons)
 - **Vascular dementia**
 - **Lewy body dementia**
 - **Pick's disease**

Learning and Memory

Two basic types of memory:

1. _____ (**fact**) – readily available to consciousness
ex. – phone number, a quote, or pathway of corticospinal tracts
 2. _____ (**procedural or skills**) – unconscious association
ex. – how to enter phone number on a phone, how to move your mouth to speak, and how to read this chapter
- Declarative and nondeclarative memory classified by length of storage time
 - _____ **memory** – stored only for a few seconds; is critical for carrying out normal conversation, reading, and daily tasks
 - _____ (**working**) **memory** – stored for several minutes; allows you to remember and manipulate information with a general behavioral goal in mind
 - _____ **memory** – a more permanent form of storage for days, weeks, or even a lifetime

Chapter 13: The Peripheral Nervous System

PNS:

1. _____ (Afferent)
 - a. Somatic Sensory Div. (special senses, skin, skeletal muscle)
 - b. Visceral Sensory Div. (viscera)
2. _____ (Efferent)
 - a. Somatic Motor Div. (to skeletal muscle)
 - b. Visceral Motor Div. (ANS)

Module 13.1: Overview of the Peripheral Nervous System

Overview of Peripheral Nerves

- **Peripheral nerves** = axons of many neurons bound together by CT
 _____ **nerves** – contain both sensory and motor neurons
Sensory nerves –
Motor nerves -
 2 types of nerves:
 Spinal nerves (_____)

 Cranial nerves (_____)
- **Spinal nerves**
 _____ (ventral) root - motor neurons from anterior horn
 _____ (dorsal) **root** - sensory neurons from posterior horn
 _____ - collection of cell bodies of sensory neurons
- Structures associated with spinal nerves: **Epineurium** – outermost layer of CT, holds motor and sensory axons together
 _____ – CT that surrounds **fascicles** (bundles of axons)
 _____ – CT surrounds individual axon

Module 13.2: The Cranial Nerves

The Sensory Cranial Nerves

- Sensory only cranial nerves:

_____ (I)

_____ (II)

_____ (VIII)

The Motor Cranial Nerves

Oculomotor (III) – 4 of extraocular muscles, pupil constriction, opens eyelid, lens shape

_____ (IV) – 1 of extraocular muscles (sup. oblique)

_____ (VI) – 1 of extraocular muscles (lat. rectus)

Accessory (XI) – larynx, trapezius, SCM

Hypoglossal (XII) – tongue muscles

The Mixed Cranial Nerves

_____ (V) – supplies skin of face, muscles of mastication

_____ (VII) – facial expressions, taste ant. 2/3 tongue

Glossopharyngeal (IX) – taste post. 1/3 tongue, BP changes, swallowing, salivary glands

_____ (X) – thoracic and abdominal viscera, main nerve of PSN

Trigeminal Neuralgia (tic douloureux)

- Chronic pain syndrome
- Involves one or more branches of trigeminal nerve (CN V)
 - Certain stimuli may trigger attacks (chewing, light touch, vibrations)
 - Cause: idiopathic
 - Treatment: pain medications, sever nerve

Bell's Palsy Facial nerve (CN VII)

- Cause: virus, tumor, trauma, or idiopathic
- Weakness or complete paralysis of facial muscles (unilateral)

Treatment - anti-inflammatory medication, antiviral medication, PT, and surgery; even without treatment

Many individuals recover function of paralyzed muscles in about 3 weeks

Module 13.3: The Spinal Nerves

Structure of Spinal Nerves and Spinal Nerve Plexuses

Cervical Plexus

-

Brachial Plexus

-

-

- Musculocutaneous n.

- Median n.

-

Lumbar Plexus

- Obturator n.

-

Sacral Plexus

-

A Hiccup Cure That Really Works

- **Hiccups** –spasms of diaphragm that cause a forceful inhalation of air
- **Phrenic nerve remedy:**
 - Place fingers ~ 1 cm lateral to vertebral column level of C3-C5
 - Apply firm pressure to muscles of neck that overlie phrenic nerve until hiccups stop, in about 5–10 seconds

Lumbar Plexus

- Left and right **lumbar plexuses** are derived from anterior rami of L₁–L₅; anterior to vertebrae; embedded deep within psoas muscle; branches innervate pelvic structures and lower extremity after splitting into 2 divisions

Module 13.4: Role of PNS in Sensation

Classification of Sensory Receptors

- Based on location of stimuli they detect:

_____ – detect stimuli originating from outside body (thermoreceptors, chemoreceptors, photoreceptors)

_____ – detect stimuli originating from within body itself (chemoreceptors)

_____ - depolarize in response to anything that mechanically deforms tissue (vibration, light touch, stretch, and pressure)

- **Merkel cell fibers**

Found in epidermal ridges of especially fingertips

Detect discriminative touch stimuli (object form and texture)

- **Tactile corpuscles** (_____corpuscles)

Dermal papillae

- **Ruffini endings**

- **Lamellated corpuscles** (_____corpuscles)

Module 13.6: Reflex Arcs: Integration of Sensory and Motor Function

Reflex Arcs

- **Reflexes** – pre-programmed, automatic responses to stimuli; _____ arc; usually protective negative feedback loops

Reflexes begin with a sensory stimulus and finish with a rapid motor response

Neural integration between sensory stimulus and motor response occurs in CNS, at spinal cord or brainstem

Types of Reflexes

- Reflexes can be classified by at least two criteria:

Number of synapses that occur between neurons involved in arc

Type of organ in which reflex takes place, either visceral or somatic

- Simplest reflex arcs (_____ **reflexes**) involve only a single synapse within spinal cord between a sensory and motor neuron; more complicated types of reflex arcs (_____ **reflexes**) involve multiple synapses

- **Simple stretch reflex**

Body's reflexive response to stretching of muscle to shorten it back to within its "set" optimal length

- **Flexion (withdrawal) reflex:**

Amyotrophic Lateral Sclerosis

_____ - degeneration of cell bodies of motor neurons in anterior horn of SC, upper motor neurons in cerebral cortex; cause of degeneration is unknown at present; many factors likely play a role

- Most common early feature of disease is muscle weakness, particularly in distal muscles of limbs and hands; over time weakness spreads to other muscle groups; upper motor neuron symptoms also develop
- Death usually in ~5 years of disease's onset
- Although intensive research efforts are ongoing, at this time there is no cure or treatment that prevents disease progression

Chapter 14: The Autonomic Nervous System and Homeostasis

ANS = involuntary arm of **PNS**

-
- two divisions:
 - _____ (**SNS**)
 - _____ (**PSN**)
- maintain **homeostasis**

Module 14.1: Overview of the Autonomic Nervous System

Comparison of Somatic and Autonomic Nervous Systems

- Motor divisions of PNS:
 - _____ **division** → **skeletal muscle** (conscious control)
 - _____ **motor division** → **smooth** muscle, **cardiac** muscle, and glands (involuntary)
- - ANS motor neurons require a two-neuron circuit:
 1. **Preganglionic neuron** –
 2. **Postganglionic neuron** –

Divisions of the ANS

Main structural and functional differences between **SNS** and **PSN**:

- _____ **nervous system** – preganglionic axons are usually short and postganglionic axons are usually long
- _____ **nervous system** – preganglionic parasympathetic axons are long while postganglionic axons are short

Sympathetic nervous (SNS)

- **thoracolumbar division**
- **Sympathetic ganglia** located near SC
- “_____” division of ANS; prepares body for emergency situations

Parasympathetic nervous system

- **Craniosacral division**
- **Cranial nerves** → head and neck, thoracic viscera, and most abdominal viscera
- “_____” division; role in digestion and maintain body’s homeostasis at rest
- Postganglionic neurons located near target organ; requires only a short axon to connect

Module 14.2: The Sympathetic Nervous System

Effects of SNS on Target Cells

Effects of **SNS** on target cells:

- directed at ensuring survival and maintenance of homeostasis during time of physical or emotional stress
- Cardiac muscle cells → Increase _____ and force of contraction
- _____ of blood vessels → digestive, urinary, & integumentary
- Dilation of _____
- _____ to skeletal & cardiac muscle
- Constriction of sphincters → urinary & digestive
- Relaxation of smooth muscle of digestive tract
- Dilation of _____
- _____ sweating

Module 14.3: The Parasympathetic Nervous System

Gross and Microscopic Anatomy PSN

“_____” division of ANS

- Role in maintenance functions - digestion and urine formation
- Craniosacral division

- PSN cranial nerves – oculomotor (CN III), facial (CN VII), glossopharyngeal (CN IX), and vagus (CN X) nerves

Effects of PSN on Target Cells

- Cardiac muscle cells - _____ HR & BP
 - _____
 - SMC contraction along digestive tract – increased _____
 - _____ of digestive and urinary sphincters → promotes urination and defecation
- Engorgement of penis or clitoris
- _____ salivation, lacrimation, and digestive enz.

Module 14.4: PNS Maintenance of Homeostasis

Interactions of Autonomic Divisions

- Sympathetic and parasympathetic divisions work together to keep many of body's functions within their normal homeostatic ranges

dual innervation

Dual innervation allows **SNS** to become dominant and trigger effects that maintain homeostasis during physically demanding periods

PSN division regulates same organs, preserving homeostasis between periods of increased physical activity

Postural Orthostatic Tachycardia Syndrome (POTS)

- Increase in heart rate (known as **tachycardia**) when an individual moves from lying or sitting down to standing up; VD → BP drop due to drop due to gravity

Symptoms (from low blood pressure)

- include dizziness and lightheadedness
- fatigue and thirst
- shortness of breath, chest pain, cold extremities, and muscle weakness

Cause: excessive SNS activity

Treatment: dietary modifications such as increasing water and salt intake