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 μm) 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 μm); 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 μm); _____ 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 **E**xcitatory or **I**nhibitory:

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. _____ (acetylecholine)- 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 O_2, 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 relexes 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 [O_2]; 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 and Associated

- **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

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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 L_1–L_5; 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 divison

- 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