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脑 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** – 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

- **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

<table>
<thead>
<tr>
<th>Principles of Electrophysiology: Types of Ion Channels</th>
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<tr>
<td>_________ - Ions follow conc. gradient</td>
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<tr>
<td>_________ - Open in response to specific chemical binding</td>
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<tr>
<td>_________ - Open or close due to changes in voltage across PM</td>
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<td>_________ - Open or close due to mech. stim. (stretch, press., vibration)</td>
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<td>RMP =</td>
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<td>Cell is polarized (positive on outside, negative on inside of PM)</td>
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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:**

- ________ – $\text{Na}^+$ channels open, $\text{Na}^+$ flow into cell; membrane potential becomes more positive
- ________ – $\text{K}^+$ ion channels open; $\text{K}^+$ flow out of cell; cell becomes more negative, returning to RMP
- ________ – cell becomes more negative than normal RMP due to efflux of $\text{K}^+$ plus influx of $\text{Cl}^-$

**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 Synapsis**

- 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

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**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
- **Cerebral ventricles** – 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

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**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**

- located inferior to occipital lobe

- arbor vitae

**The 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

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**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 -

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**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 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 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

-
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

- 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

*dua**l 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 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