Lecture 5 (Oct 12th): ANATOMY and FUNCTION OF THE NERVOUS SYSTEM

Lecture Outline

Finish up from last lecture

Explain the importance of Step 6 and Agonist Drugs

1) Basic Divisions (CNS vs. PNS, Somatic vs. Autonomic) and Directional Terms

2) The Brain (Hindbrain/ Midbrain/ Forebrain)

3) Cerebral Cortex & Functions of the 4 LOBES

4) The Spinal Cord (Nerves Below the Head)

5) Cranial Nerves (Nerves In the Cranium, i.e., Head), if there is time, or teach yourself!
Recreational (Medicinal?) Drugs (not always clear if they are Agonists or Antagonists)

Alcohol: works on many systems: Glutamate, GABA, DA, endorphin

Hallucinogenic "Psychodelic" Drugs (LSD, psilocybin, mescaline)
  Serotonin system. Agonist??
  creates hallucinations, dream-like state
  Raphe nuclei in brainstem (sleep and dreams)
  Used medicinally for PTSD, terminal death, etc

Other Serotonin-Related (Agonist?) Drugs (but it’s complicated!)
  PROZAC (depression) -> prevents re-absorption
  St. John’s Wort for Depression (more natural?)
  - social phobias, schizo, bulimia, autism

Opiates (Heroin, Morphine, Methadone)
  endorphin receptor AGONISTS
  used as pain-killers (more later in course)
  produce euphoria
Marijuana (THC and other cannabinoids, from Cannabis plant) acts on cannabinoid receptors (numerous in the brain especially in HIPPOCAMPUS). Agonist or Antagonist? dissolve in body FATS intensified sensory experience, time slows down used clinically for pain, nausea, glaucoma, migraines brings awareness to the “present moment”

“Overdosing”: shutting down the medullary respiratory center (involuntary breathing, more next lecture)

Barbiturates and Opiates -> Yes
Marijuana -> NO
Hallucinogens -> probably not

Ondine’s Curse
1) It is hard to learn *neuroanatomy* of the NS! Lots of divisions and names. We are going to go over it today because:

   a) to understand how the brain functions, you have to appreciate the different areas, connections between areas

   b) we will be talking about these different areas during the rest of the course (I’ll mention as we go along), so today’s lecture will give a feel for where these areas are located

   c) today’s lecture serves as a lesson in how to “categorize” things, which is a big part of any discipline, i.e., learn things in an organized fashion!

2) Need to read the chapter to reinforce, I am going to only show figures today. Draw yourself maps/divisions.

3) For the purposes of this course, you’ll mostly be expected to know the *main functions* of areas. This is not a neuroanatomy course!

4) Still, you will be tested on the neuroanatomy. But you are only expected to remember the names of areas that I mention today.
Basic Subdivisions of the Vertebrate Nervous System

1) CNS vs. PNS
   Central Nervous System (CNS): spinal cord & brain
   Peripheral Nervous System (PNS): the rest

2) Somatic vs. Autonomic
   A) Somatic: “voluntary” system
      * Sensory Organs -> Brain
         Sensory Organs: eyes (vision), ears (audition & vestibular), body surface (somatosensation), tongue (taste), nostrils (smell)
      * Brain -> Muscles (“Motor” System)
         Which muscle type?
B) **Autonomic:** “involuntary” system. Regulates functions of internal organs, e.g., heart, intestines, smooth muscle  
(more in last 3\textsuperscript{rd} of course)

i) **sympathetic:** expends energy (“fight or flight”, need in emergency)  
- increase heart rate, BP and breathing rate  
  (gets glucose and oxygen to muscles and brain)  
- decreases digestion, decrease mucus flow  
- signals originate in the **hypothalamus**

ii) **parasympathetic:** conserves energy (“rest and digest”, homeostatus)  
- decrease heart rate, BP and breathing rate  
- increase digestion, increase mucous flow  
- signals originate in  
  * **vagus nerve** (Cranial Nerve 10), originates in Medulla  
    -> heart, digestive system, lungs and diaphragm  
  * **oculomotor nerve** (Cranial Nerve 3) -> constricts the pupil  
  * **pelvic nerve** (Sacral region of spinal cord) -> empty bladder/rectum, erection
Autonomic Nervous System:
Sympathetic (Red) and Parasympathetic (Blue)
Directional Terms

Coronal plane

Sagittal plane

Horizontal plane

Anterior

Dorsal (for brain)

Left

Posterior

Ventral (for brain)

Ventral (for brainstem and spinal cord)

Medial

Dorsal (for brainstem and spinal cord)

Lateral
THE BRAIN STEM

Pineal gland
Midbrain
Thalamus
Superior colliculus
Inferior colliculus
Tectum
Tegmentum
Pons
Medulla

Posterolateral view of brainstem
HINDBRAIN

Medulla (right above Spinal Cord, looks like enlarged Spinal Cord, except in the skull).

Involved in regulation of body maintenance ->
Heart rate, breathing, vomiting, salivation, coughing
medullary respiratory center (last lecture)
raphe nucleus (in MEDULLA and PONS) involved in sleep and dreaming (last lecture)

Pons: above the medulla

Many “somatic system” neurons pass through the pons:
Sensory neurons -> Spinal Cord -> Brain
Motor neurons -> Spinal Cord -> Muscles

Cerebellum: many folds, involved in movement control, coordination, posture
(but note: there is a separate “motor cortex” in the FOREBRAIN)
MIDBRAIN

Superior Colliculus

Inferior Colliculus
e.g., Superior and Inferior Colliculus: routes for low-level (probably subconscious) sensory information.

Inferior Colliculus: Auditory
Superior Colliculus: Vision, Auditory, Visual+Auditory
FOREBRAIN:

(1) Cerebral Cortex (i.e., “grey matter”, has 6 layers)
(2) Subcortical Structures

- Cerebral Cortex
- Thalamus
- Hypothalamus
- Pituitary Gland
(1) Cerebral Cortex
(2) Subcortical Structures
e.g., Thalamus

- Relay Station between sensory organs & cortex (separate nuclei for different senses, e.g., lateral geniculate nucleus)

**Hypothalamus:** (ventral to thalamus)
Involved in:

- a) Autonomic (Sympathetic) System
- b) Feeding, drinking, sexual behaviors. *Damage leads to abnormal behaviors*
- c) Secretion of hormones ->
  - Pituitary Gland -> Other Glands in the Body
    (e.g., adrenal gland, ovaries/testes)
FOUR LOBES of Cerebral Cortex: Occipital, Parietal, Temporal, Frontal

**Occipital Lobe:** visual cortex
- damage to results in “cortical blindness”

**Parietal Lobes:**

*Postcentral gyrus:* primary somatosensory cortex (touch), receives from contralateral parts of the body skin

Parietal cortex also performs some VISUAL functions:

- Object *Location*

* Damage to parietal cortex leads to:
  1) impairment in identifying objects by touch
  2) hemi-neglect, don’t recognize body as your own
Temporal Lobes:
* auditory information
* left hemisphere -&gt; language comprehension
* temporal cortex also performs some VISUAL functions:
  Object Recognition, e.g., faces

Damage to temporal cortex leads to:
1) aphasia (left hemisphere)
2) prosopagnosia
Frontal Lobes: contains motor cortex and prefrontal cortex

A) Motor Cortex (**Precentral Gyrus**) governs fine and gross movements

B) Prefrontal cortex. Most recent addition in evolution
Involved in: “Executive Functioning”, including…

- Planning and a Sense of Time
- Problem Solving
- Predicting Outcomes
- Advanced Reasoning
- Internal Representations
- Emotional Control
- Response Inhibition
Communication between brain and PNS below the neck.

*(mostly focus here on somatic system, but also for the autonomic system)*

**Spinal Column** = Spinal Cord + Backbone (i.e., vertebrae)

4 sections: 
cervical (8), thoracic (12), lumbar (5), sacral (5), and coccyx

**C3, C4, C5:** diaphragm movement
Voluntary: somatic system
Involuntary: **autonomic system** (specifically, the vagus nerve of the parasym system)

Christopher Reeve -> C1, C2
3 WAYS to STOP BREATHING

1) Lesion at or above C3

2) Damage to Medullary Respiratory Center in Medulla, while you are unconscious (last lecture)

3) Drugs that are antagonists of the Ach system at the neural-muscular junction in the diaphragm (last lecture)
12 CRANIAL NERVES (CN) (i.e., in the cranium or “skull”)

Communication between brain (CNS) and *senses and muscles* (PNS) *in head*

Except CN #10, the “vagus nerve”, which goes *below* the head (heart, digestive system, lungs, diaphragm)

**VAGUS NERVE IS A BIG DEAL THESE DAYS!!**
(even yoga teachers are talking about)
SOMATIC SYSTEM NERVES

A) SENSORY (input) ONLY:
e.g., 1 = olfaction (smell from nose)
2 = optic (from eyes)
8 = audition and vestibular input

B) MOTOR (output)
e.g., 4 = Trochlear Nerve (rotates eyeballs)

C) MOTOR and SENSORY:
e.g., 5 ("Trigeminal") = movement (e.g., chewing) and sensation on face

AUTONOMIC SYSTEM NERVES
10 = "Vagus", part of Parasympathetic system projects to (and receives from) many organs (e.g., heart, gut and diaphragm)