Anatomy of the Nervous System

1. Relational and Anatomical Terms often used
2. Supporting structures: Skull, Meninges and Cerebrospinal fluid
3. Peripheral Nervous System:
   A. Autonomic nervous system
      a. Sympathetic nervous system
      b. Parasympathetic nervous system
      c. Enteric nervous system
   B. Somatic nervous system
      a. Cranial nerves
4. Central Nervous System:
   A. The Brain
   B. The Spinal Cord

Anatomical Terms for Direction
Support and Protection of the Brain

The Skull

Ventral Inside Surface

Dorsal Inside Surface
Meninges And Cerebrospinal Fluid

Cerebrospinal fluid (CSF): produced by the choroid plexus, it cushions the brain and spinal cord against impact.

Meningitis and Encephalitis

- Meningitis
  - Infection of the meninges (linings) of the brain, as well the CSF between them
- Encephalitis
  - Infection of the brain itself

Right hemisphere of a brain infected with meningitis – there is pus visible over the surface.
Cerebrospinal Fluid

• Produced by choroid plexus from blood plasma
• Clear, colorless, containing a high concentration of salts
• Involved in excreting wastes from the brain (excess neurotransmitter, etc.)
• Circulates around the brain in the subarachnoid space, fills ventricles and central canal of spinal cord (source for spinal tap)
• Cushions brain from shock and sudden changes in pressure

► A scanning-electron micrograph of the choroid plexus.
Cerebrospinal Fluid

• Excess CSF is continuously absorbed into dural sinuses (blood filled spaces which run through the dura mater and drain into the jugular veins of the neck)

• CSF is being continuously produced
• If too much CSF is produced, or if the normal drainage CSF is prevented in some way (ex. by a growth, or scarring of the meninges associated with bacterial meningitis) pressure begins to build up in the ventricles, which in turn push on the surrounding brain – this can produce hydrocephalus

Hydrocephalus (Greek: “water head”)

• Occurs in about 1:500 births
• Treated by inserting a tube (shunt) to drain CSF from the blocked ventricle into a vein
The Nervous System
The Peripheral Nervous System

1) **Somatic Nervous System**
   - Sensory systems and skeletal muscles involved in movement

2) **Autonomic Nervous System** (self-regulating)
   - Internal “motor” (efferent) system working all the time
     a. **Sympathetic Nervous System**
        - (arousing = alarm “fight or flight”)
     b. **Parasympathetic Nervous System**
        - (calming = “business as usual”)
     c. **Enteric Nervous System**
        - Alimentary canal (gut) effector system

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**SOMATIC NERVOUS SYSTEM**

- **Sensory**
  - Carries sensory signals from skin, skeletal muscles (proprioception), joints, bones, and other sensory systems to CNS = afferents to CNS

- **Motor**
  - Carries instructions from CNS to skeletal muscles = efferents from CNS

- **Cranial nerves**
  - Deal with smell, vision, equilibrium (balance), hearing, taste, etc
  - 12 pairs of cranial nerves: 1 & 2 purely sensory, others contain both sensory and motor fibers
  - Project from the brain
**Dermatome**
- Area of skin connected to a particular spinal nerve

**CRANIAL NERVES**

- I. Optic Vision
- II. Olfactory Smell
- III. Oculomotor
- IV. Trochlear
- V. Trigeminal
- VI. Abducens
- VII. Facial
- VIII. Vestibulocochlear

- IX. Glossopharyngeal
  - Taste, muscles of throat, pharynx, and larynx.

- X. Vagus
  - Internal organs

- XI. Accessory Spinal
  - Neck muscles

- XII. Hypoglossal
  - Tongue movement
Autonomic Nervous System

Damage to the Spinal Cord Can Have Profound Consequences

Christopher Reeve
Autonomic Nervous System

The Brain

The human brain is similar in organization to that of other mammals, but differs in size.
The Brain

- Brain size is not necessarily predictive about what the brain DOES or CAN DO
- The size of a particular brain region relative to the rest of the brain gives an indication of that region’s importance for the animal
  - Examples of proportionally large brain regions:
    - Gorillas and humans: visual centers
    - Dolphins and bats: echolocation regions
    - Racoons: somatosensation and digit representation
    - Rats: olfactory bulbs
Major Structures of the Adult Brain

Development of the Human Brain

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5 Major Divisions of the Adult Brain

The Hindbrain: Myelencephalon & Metencephalon

- Reticular Formation
  - Involved in sleep, attention, movement, maintenance of muscle tone, various cardiac and respiratory reflexes

- Pons and Medulla
  - Many ascending and descending tracts (autism link?)
  - Help control respiration and heart rhythms, blood pressure, coughing, sneezing, swallowing and vomiting

- Cerebellum
  - Important for fine motor control and cognitive process that require precise timing (ex. playing a musical instrument)
The Hindbrain: Myelencephalon & Metencephalon

- Damage to the Pons
  - may result in double vision and partial paralysis of the body
- Damage to the Medulla
  - may cause death
  - may create loss of pain and temperature sensation and make swallowing difficult
- Damage to the Cerebellum
  - may influence body movements and hinder walking
  - may make sitting upright impossible
  - may cause cognitive problems?

Alterations in the Pons: A Link to Autism?

- Several nuclei in the posterior pons are smaller than normal in individuals with autism
Midbrain: Mesencephalon

• Superior Colliculus
  – visual function
• Inferior Colliculus
  – auditory function
• Substania nigra
  – Contains dopaminergic neurons that communicate with the caudate nucleus and putamen in the basal ganglia
  – Parkinson’s disease

Forebrain: Diencephalon

• Thalamus (at the top of the brainstem)
  – Processes and relays most sensory information (ex. sight, sound, feelings over the body)
• Hypothalamus
  – Involved in almost all complex behavior: feeding, sexual behavior, sleeping, temperature regulation, fighting, emotional behavior
• Pituitary Gland
  – Releases hormones
Forebrain: Diencephalon

- Damage to the Thalamus
  - Damage to this area may result in reduced or boosted sensitivity to heat, cold, pain and pressure
- Damage to the Hypothalamus
  - may result in a variety of effects ranging from problems regulating body temperature to emotional disturbances
  - diabetes insipidus, a condition characterized by extreme thirst and the excretion of large amounts of urine
Forebrain: Telencephalon

• **Cerebral cortex**
  - Youngest part of nervous system
  - Interprets sensory input
  - Initiates voluntary movement
  - Mediates complex cognitive processes

  *Fissures*: furrows in the cortex
  *Sulci (sulcus)*: small furrows in the cortex
  *Gyri (gyrus)*: ridges between furrows

Forebrain: Telencephalon

• **Cerebral cortex**
  - Frontal Lobes
    • Control planning and emotion
  - Parietal Lobes
    • Control body senses and taste
  - Temporal Lobes
    • Control learning, memory, hearing, associations and language
  - Occipital Lobes
    • Control vision
Frontal Lobes
- Damage may alter a person’s ability to execute plans and may make them inconsiderate or passive.
- It also may hurt movement.

Parietal Lobes
- Damage may interfere with the recognition of touch and pain.
- It also may jumble knowledge of where the body is in space.

Temporal Lobes
- Damage may result in an inability to recognize faces, even those of close family members.
- It also can result in dramatic hallucinations and loss of memory.

Occipital Lobes
- Damage can harm eyesight, possibly even causing blindness.
Functionally Related Structures: The Limbic System

- Involved in emotions, memory and social responsiveness
  - Medial Prefrontal Cortex
    - social behavior and “working” memory
  - Hippocampus
    - learning and memory, stress
  - Amygdala
    - aggressiveness, fear, anxiety and other emotions
Functionally Related Structures: The Limbic System

- Medial Prefrontal Cortex
  - damage may impair social behavior and planning (ex. Phineas Gage)

- Hippocampus
  - damage to this area may result in memory impairment (ex. Patient HM)

- Amygdala
  - damage may result in inappropriate or peculiar episodes of rage and sexual behavior

Phineas Gage
Functionally Related Structures: The Basal Ganglia

Plays a major role in voluntary motor responses

Striatum
- Caudate (“tail-like”)
- Putamen
  - receives dopaminergic axons from substantia nigra in the midbrain
  - this pathway degenerates in Parkinson’s Disease – characterized by rigidity, tremors, limited voluntary movement

Globus Pallidus

The Basal Ganglia

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