1 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

2 Anatomical Terms
   for Direction

3 Support and Protection of the Brain

4 The Skull

5 Meninges And Cerebrospinal Fluid

6 Meningitis and Encephalitis
   • Meningitis
     − Infection of the meninges (linings) of the brain, as well the CSF between them
   • Encephalitis
     − Infection of the brain itself

7 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

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9 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)
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
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
     - (waking up “fight or flight”)
     b. Parasympathetic Nervous System
     - (calming = “business as usual”)
     c. Enteric Nervous System
     - Alimentary canal (gut) effector system

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

Autonomic Nervous System

Damage to the Spinal Cord Can Have Profound Consequences
Autonomic Nervous System

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

22  Major Structures of the Adult Brain
23  Development of the Human Brain
25  5 Major Divisions of the Adult Brain
26  The Hindbrain: Myelencephalon & Metencephalon
    • Reticular Formation
      - Involved in sleep, attention, movement, maintenance of muscle tone, various cardiovascular 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 (e.g. playing a musical instrument)

27  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?

28  Alterations in the Pons: A Link to Autism?
    • Several nuclei in the posterior pons are smaller than normal in individuals with autism
29  Midbrain: Mesencephalon
    • Superior Colliculus
      - visual function
    • Inferior Colliculus
      - auditory function
    • Substantia nigra
      - Contains dopaminergic neurons that communicate with the caudate nucleus and putamen in the basal ganglia
      - Parkinson’s disease

30  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

31 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

32 Forebrain: Telencephalon
• Cerebral cortex
  – Youngest part of nervous system
  – Interprets sensory input
  – Initiates voluntary movement
  – Mediates complex cognitive processes

33 Forebrain: Telencephalon
• Cerebral cortex
  – Frontal Lobes
  – Parietal Lobes
  – Temporal Lobes
  – Occipital Lobes

34 Forebrain: Telencephalon

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36

  – Frontal Lobes
  – Parietal Lobes
  – Temporal Lobes
  – Occipital Lobes

37 Primary Motor Cortex

38 Primary Sensory Cortex

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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

- 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