Nervous system

- Central - brain and spinal cord
- Peripheral - spinal nerves, motor and sensory nerves

Neuroglia

- Most CNS cells are glial cells
- They provide structure and maintain interneurons in the CNS
- Are capable of dividing, even in adulthood

- Astrocytes:
  - hold neurons together
  - establish a blood-brain barrier w/capillaries
  - repair brain injuries

- Oligodendrocytes form myelin sheaths around axons
- Ependymal cells line the internal cavities of the CNS.
Meninges

- Spinal and cranial meninges
  - fish - one layer
  - tetrapods 2 or 3 (mammals)

Cranial meninges

- Dura mater
- Arachnoid mater
- Subarachnoid space of brain
- Brain

Neurocoel and ventricles

- CNS develops from DHNC neural tube
- of embryo has neurocoel

Cerebral spinal fluid

- provides almost neutral balance for brain (it "floats")
- cushions and nourishes brain

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- cushions and nourishes brain
Cerebral spinal fluid
- CSF produced by choroid plexus in ventricles

Blood brain barrier
- Exists at choroid plexus and capillaries in brain
- Capillaries have tight junctions

Normal capillary
- Lipid-soluble substances
- Water-lined pore

BBB capillary
- Lipid-soluble substances
- Tight junction
- Carrier-mediated transport

Cerebral spinal fluid
- CSF produced in ventricles and resorbed in venus sinus

Brain development
- Forebrain
- Midbrain
- Hindbrain
- Neural tube
- Primary brain vesicles
- Olfaction
- Visual, auditory
- Inner ear, lat. line
Brain development

Basic plan for vertebrate brains

Brain shape changes

Comparing vertebrate brains
- Cerebrum and cerebellum vary among vertebrates – the brainstem is conserved throughout phylogeny.
**Brain stem and cerebellum**
- Brain stem - Controls basic functions: breathing, heart rate, digestion, etc.
- Cerebellum maintains balance, enhances muscle tone, and coordinates skilled muscle activity

**General trends for comparison**
- Cerebrum gets larger in later verts - increased sensory input
- Cerebellum - largest in birds, mammals, some fish. Receives lateral line input.

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**Optic lobe (tectum) increases as vision is utilized more - except mammals**
Spinal cord and spinal nerves

Gray matter vs. white matter

Brain regions

Going up the brain:

- Myelencephalon - primarily medulla oblongata - grades into the spinal cord.

Spinal cord arrangement of neurons is maintained into medulla

Dorsal nerves vs. Ventral nerves

Arrangement of gray matter by function in spinal cord
Cranial nerves

Nerves 5, 7, 9, 10 - “Dorsal nerves”
5 – Trigeminal - Mandibular arch
7 – Facial - Hyoid arch
9 – Glossopharyngeal – Pharynx, tongue
10 – Vagus – Pharynx, tongue, viscera

Branchiomeric nerves

Somites

Nerves 5, 7, 9, 10 - “Dorsal nerves”
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Metencephalon -
- Cerebellum and pons

Mesencephalon -
- Optic lobe -
- Auditory lobe - (amniotes) impulses from the cochlea
Optic lobe - functions as an integrating center in fish (similar to cerebrum in amniotes). Receives: visual, auditory, somatosensory, electroreception.

Diencephalon
- Thalamus, epithalamus, hypothalamus, optic chiasma, and pituitary.

Diencephalon - Pineal & parietal eye
- Photoreceptor in many fishes, amphibians, and reptiles - close to skin.
**Diencephalon - Pineal & parietal eye**
- Tetrapods – pineal secretes melatonin
  - indicator of day length for daily or seasonal synchronization
- Stimulated by light at eye & internal clock

**Telencephalon**
- Cerebrum and rhinencephalon
  - Rhinencephalon = olfactory bulbs, tracts, and lobes.
  - prominent in fish

**Telencephalon**
- Cerebrum: control motor movements; receive sensory info., “higher” functions.
- Flexibility in circuitry. Not as “hard wired”
Gray matter regions

- "Subpallium" = striatum and septum

Telencephalon

Striatum

- inhibits muscle tone
- selects and maintains purposeful muscle activity while inhibiting useless movement

Striatum

In tetrapods striatum includes portions of amygdala

Amygdala is associated with fear, arousal, emotional memory, basic drives.
- Pallium in mammals - cortex extends over striatum & midbrain
  
  Medial pallium

  Dorsal pallium

  Lateral pallium

- Pallium
  
  Medial pallium – a major part of limbic system. hippocampus in mammals.

  Dorsal pallium – In amniotes, integrates visual, auditory, somatosensory input. Small in fish, larger in amniotes.

  Lateral pallium – olfactory center. In fish, lateral p. integrates olfaction & motor responses

- Hippocampus
  
  Short-term memory is converted to long-term memory by passing through the hippocampus

- Telencephalon
  
  Comparing cortex of mammals, humans have greatly increased association areas