What is the difference between “gray matter” and “white matter”?

Gray & White Matter

- Brain areas with lots of neuron cell bodies/dendrites look darker ("gray matter") and function like information processors – receiving & combining input
- Areas with lots of myelinated axons appear lighter ("white matter") and function like cables connecting regions
- A group of neuron cell bodies = “nucleus” (in CNS) or “ganglion” (in PNS)
- A group of axons = “tract” or “pathway” (in CNS) or “nerve” (in PNS)

Cortex is Gray Matter

Cortex (the outer layer) is gray matter. Beneath cortex is dense white matter – all the axons carrying messages to and away from cortex.
Cross Section of Cord

Afferent (Sensory)

Dorsal

Dorsal root (afferent axons)

Dorsal root ganglion

Grey matter

Subcortical white matter

Spinal cord

Sensory root (afferent axons)

Efferent (Motor)

Directional Terms

Dorsal or posterior

Rostral or anterior

Ventral or anterior

Caudal or posterior

Directional Terms

Horizontal or frontal

5 Chunks of Brain

Teiencephalon - outer part of forebrain
Cerebral hemispheres

Diencephalon - inner part of forebrain
Thalamus & Hypothalamus

Mesencephalon - midbrain

Metencephalon - upper part of hindbrain
Pons & Cerebellum

Myelencephalon - lower part of hindbrain
Medulla oblongata

5 Vesicles that will develop into the 5 chunks of the adult brain are visible very early in the Embryonic Brain

Brain stem & Cerebellum

Our authors use the term brain stem to refer to the last 3 divisions (midbrain, pons, medulla) but you may find other sources that include the diencephalon (hypothalamus & thalamus) in their definition of the stalk-like brain stem

These evolutionarily ancient regions are sometimes called our reptilian brain
The Brain is Like a Tootsie Pop

The Limbic System is part of the ‘middle layer’ – wraps around the brainstem core.

Limbic System

- Fornix
- Thalamus
- Hypothalamus
- Amygdala
- Mamillary body
- Hippocampus

Basal Ganglia

Also part of the ‘middle layer’

Protection of the CNS

Bones, Meninges & Cerebrospinal Fluid (CSF) do a good job under normal everyday conditions.

Looking Into the Bottom of the Skull

- Anterior Fossa
- Middle Fossa
- Posterior Fossa
The Meninges

- 3 layers of connective tissue enclosing brain & spinal cord
- Starting from the outside, the layers are:
  - dura mater
  - arachnoid mater
  - pia mater
- Meninges mnemonic (from the inside → out) = PAD (the meninges PAD the outside of the brain)

Dura Mater (“tough mother”)

- Actually has 2 layers which run close together in most locations
  - outer layer is anchored to skull bone in certain places
  - inner layer forms folds that partition skull cavity into compartments
    - one between R & L hemispheres: falx cerebri
    - one between occipital lobe & cerebellum: tentorium cerebelli
- spaces between layers at those folds form “dural venous sinuses” for blood leaving brain

Falx is Latin for “sickle”

A sickle

Falx cerebri – sickle shaped membrane of the cerebrum between R and L hemispheres

Falx cerebri model

Cross-Section of Tentorium cerebelli between hemispheres & cerebellum (the “tent” over the cerebellum)
Arachnoid Mater (“spiderlike”)

- Thinner layer loosely enclosing CNS
- Space beneath arachnoid is filled with cerebrospinal fluid (CSF)
- Spider-like filaments cross this “subarachnoid space” to the inner most layer of meninges, the pia mater
The spidery filaments spanning the subarachnoid space between arachnoid and pia.

Pia Mater ("tender matter")
- Very thin layer that tightly follows brain surface
- Contains lots of small capillaries supplying blood to the CNS

Meninges also cover the spinal cord

Clinical Applications
- Dural partitions (Falx cerebri & tentorium cerebelli) play a significant role in brain damage related to head injuries as well as that resulting from increased intracranial pressure. Although partitions normally hold the brain in place, they become a firm barrier soft brain tissue rams up against in extreme movements or sudden stops.
- Meningioma - "brain tumors" arising from the meninges ("oma" ending means tumor)
- Meningitis – infection/inflammation of the meninges (we’ll come back to this shortly) ("itis" ending means infection/inflammation)

Bacterial Meningitis
- Most common acute CNS infection
- Medical Emergency - progression to permanent brain injury or death (10%) can occur in hours
- Symptoms: headache, fever, stiff neck, confusion, irritability, photophobia, nausea, vomiting, possible seizures, altered mental state, rash – but some will not show these signs
- Several common bacteria – if they gain access to the CNS – can cause it (Haemophilus influenzae B (Hib)*, Streptococcus pneumoniae, Neisseria meningitidis (the cause of the meningococcal meningitis in the news), & others

*Weak stomach warning
The Glass Test – “rash” doesn’t disappear when pressed on

Bacterial Meningitis continued

- Infection may get to CNS 1) via blood, 2) spread from nearby ear or sinus infections, or 3) through congenital or acquired defects in protective coverings of CNS
- Bacteria release toxins damaging capillaries & causing dangerous cerebral edema (swelling) and increased intracranial pressure. Can also trigger hydrocephalus, increasing the rapid rise in pressure. Antibiotics do not decrease edema but corticosteroids help.
- Causes lasting deficits in 20-30% (impaired hearing, vision or movement, retardation, epilepsy, hydrocephalus) of survivors, especially in neonatal cases or if treatment is delayed.
- [http://www.pbs.org/wgbh/nova/meningitis/](http://www.pbs.org/wgbh/nova/meningitis/)
- (click on news minute on right)

Tests

- CT scan can show swollen meninges
- Lumbar puncture (spinal tap) to identify infection
- Kernig’s sign
- Brudzinki’s sign

- Now vaccines for 2 varieties available: Hib and Meningococcal (Menomune and Menactra for Neisseria strains A,C,Y)) No vaccine for for the strain B. Menomune lasts 3-5 yrs, Menactra up to 10 years.

Viral Meningitis Less Serious

- Initial symptoms similar but mental status and brain usually unaffected. Excellent prognosis.
- More serious risks if a virus affects the brain itself (“viral encephalitis”).
- Sometimes drug reactions can cause a similar syndrome (ibuprofen, naproxen, trimethoprim, carbamazepine)
- Fungal infection of meninges can occur in those with compromised immune systems (like in AIDS)