

Nervous system, integration: Overview, and peripheral nervous system:

Some review & misc. parts [Fig. 28.11B, p. 573]:

- white matter --> looks white due to the myelinated sheaths, which are quite fatty.
- gray matter --> consists mostly of nerve cell bodies, dendrites, and axons without fatty sheath.
- ventricles --> spaces in the CNS that contain cerebrospinal fluid. This moves nutrients, hormones and other substances around, and, particularly in the brain acts as a shock absorber.
- meninges [Fig., not in text]:
 - nervous tissue generally has the consistency of watery jello. It's very fragile.
 - meninges surround the nervous tissue and help maintain the structural integrity; they also allow for cerebrospinal fluid to circulate. Consists of:
 - an outer covering, the dura mater
 - a space in between made up of cerebrospinal fluid and the arachnoid membrane
 - an inner membrane lying right over the brain, the pia mater

The PNS, or Peripheral Nervous System:

consists of paired spinal nerves and paired cranial nerves [Fig. 28.11A].

- each set comes/goes to different structures. Except for a few cranial nerves (e.g. optic nerve), each set contains both sensory and motor components.
- mammals have 12 pairs of cranial nerves.
- reptiles have 10.
- in anatomy classes, the function of each pair of nerves is explained.

The PNS is divided into two broad groups [Fig. 28.12, p. 574. *NOTE: the fourth edition figure (28.12A) is NOT accurate*]:

- 1) Somatic - sensory and motor nerves, generally parts that you have voluntary control over and that sense the external environment.
- 2) autonomic - generally non-voluntary. Nerves that serve the internal

organs. Divided into three parts, but let's skip these details.

Note: the description of some of this is not accurate in the 4th edition.

Finally, how does all this work and fit together?

Example: reflex arc [Fig. 28.1B, p. 564,]:

sensory neuron --> CNS --> motor neuron

A reflex is a response that does not involve the brain.

But - you can feel the response. So the signal does eventually get to the brain.

Reflex arc. What happens to signal as it does go to the brain?

- there are two pathways that lead to the brain. Both cross over to the other side as follows [Fig., not in book]:

- sensory neuron --> thalamus --> sensory cortex [Fig. 28.15A, p. 577]

- thalamus — coordinates information coming from different parts of the body and sends it to the correct spot in the cortex.

- cortex - the outer layer of the cerebrum.

- cerebrum - higher functions take place here (more shortly)

- the nerve cell bodies are at the surface (i.e. on the cortex).

- sensory neuron --> cerebellum

- cerebellum is major area of motor coordination and motor “memory” (e.g., learning how to play the piano or ride a bike)

- sensory cortex

- receives information from different parts of the body. Each part of the body can be represented on the surface of the sensory cortex [Fig., not in book].

- amount of area on the sensory cortex is related to the # of receptors at each part of the body (e.g., fingers have many more receptors, and also a much higher representation on the sensory cortex).

2) Other pathways going into the brain [illustrate on board]:

- optic nerve leads (eventually) to the thalamus --> primary visual cortex

- taste receptors lead to brainstem (pons, medulla) --> thalamus --> parietal lobe.
- auditory nerve leads to the “superior olive” --> thalamus --> primary auditory cortex.

- “superior olive” helps determine direction of sound.

smell receptors --> cortex --> thalamus --> other parts of cortex [note the difference].

3) Summary: all these pathways eventually wind up in the cortex, which as mentioned, is the outer part of the cerebrum.

- Cerebrum [**Fig. 28.16, p. 578**]:

- highly folded structure: it is surface area rather than volume that appears to contribute to intelligence (remember - the surface is where nerve cell bodies sit).

- No other animal has as many ridges and grooves as man (corrected for size) (next in line: dolphins).

- processes and integrates information from all parts of the body.

- note that areas of the cortex can be mapped to different functions such as speech, pattern recognition, etc.

- the cortex, particularly the frontal part, is where “intelligence” resides.

- so, information is received, processed, and then if needed, the appropriate action is taken (sometimes no action is needed at all!). More below.

- nerve tracts cross both on the way up and on the way down. Thus the right hemisphere controls the left side and vice-versa.

- corpus callosum - communicates information between the two halves of the cerebrum [**Fig. 18.15B, p. 577**].

4) If some action (response) is taken or needed, then the motor cortex receives information from [point out structures on overhead]:

1) occipital lobe

2) temporal (hearing, memory, emotion)

3) parietal lobes (sensory, spatial)

--> all via the frontal association cortex, or lobe.

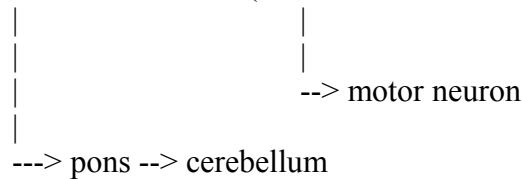
5) Motor cortex:

- maps parts of the body in a manner very similar to the sensory cortex [Fig., not in book].

- If an electrical current is applied here, the appropriate body part can be made to move.

- BUT, it's not just a simple connection from the motor cortex to the muscle:

motor cortex --> medulla (here connection crosses over to the other side)



[Aside: please don't confuse cerebrum with cerebellum. Cerebellum means "little brain" and is much smaller in man than the cerebrum]

6) Why go to the cerebellum?

- the cerebellum coordinates movement.

- information is processed, then taken BACK to the thalamus, then BACK to the motor cortex, and back down.

cerebellum (processing) --> thalamus --> motor cortex

- in this way the path has a loop in it, so movements can be refined as they take place

-also remember that sensory nerves often stop in cerebellum, so the cerebellum can coordinate the signal headed down with sensory information coming from the body.

7) A few other brain parts to be aware of [Fig. 28.15A, p. 577]:

- medulla - controls breathing, heart and blood vessel activity, other autonomous nervous system functions.

- pons - similar to the medulla, but, for example, can control breathing centers of medulla.

- hypothalamus

- gets signals (eventually from sensory pathways of the vagus nerve), and uses this to help regulate body functions by communicating with endocrine system.

- also is responsible for sensations associated with "pleasure".

8) Other systems associated with the brain **[Fig. 28.20, p. 581 & not in book]:**

-limbic system - associated with cerebrum, thalamus, hypothalamus. Part of frontal cortex (prefrontal) forms associations with this system to determine emotional content of “messages/information” circulating around the brain.

- reticular formation - an area in the midbrain (between the brain stem and the thalamus) that helps determine states of arousal (= alertness).

- by filtering information, the reticular formation can decrease alertness. This might be useful when trying to get to sleep.

9) Higher brain functions - some examples/comments **[Fig. 28.16, p. 578]:**

- as mentioned, various functions have been mapped to different parts of the cerebral cortex:

- speech - laterally, left side

- sensing object with the left hand - this winds up on the RIGHT side (remember that nerve tracts cross over).

- this information then travels through the corpus callosum.

- If this becomes severed, a person can't name the object, because information can't get from the right to the left (where the speech centers are).

- right brain/left brain - this is not as straight forward as it appears:

- Cultural differences have been found. In different cultures, some association areas, may be on the other side.

- it appears that the methods of learning/teaching are very important for these areas to develop.

- But in general, we have:

- left - analytical/mathematical

- right - spatial/music recognition

- Another example: reading

- symbols wind up in the visual cortex, then moved to a part of the brain where they are translated into the equivalent of “sounds”.

- from here they go to Wernicke's area (also on the cerebrum, left side), where they are finally comprehended.

- This complicated path is probably due to the fact that sound communication is much older than writing, so writing needs an extra step for interpretation.

- Finally, just a little bit about long and short term memory.

- again, this is a little more complicated, since there are also “immediate memories”.

- the texture of the wall behind you, or the car in front of you at a stop light.

- short term - memories that you can recall for a few minutes.

- The classic example is a phone number, that you remember long enough to dial.

- If you dial this number repeatedly, then eventually:

- long term memories - memories that you can recall months or even years later.

- As usual, this is not straight forward. For example, if you study, you’ll do fairly well on the final. BUT, a few weeks from now, you probably won’t remember a thing about anything on the final!

- the process of going from short to long term memory is not well understood, but repetition helps (like that phone number example).

- learning involves the hippocampus. If this is damaged or removed, person’s can no longer learn (but previous events are still recalled clearly!).