

Understandings:

1. Explain how brain is formed from the neural tube.

- We know how neural tube is formed and what happens next is the formation of the brain. The anterior (upper) part of the neural tube develops into the brain. How does it recognize where the anterior and the posterior ends are? Well, it is thought that gravity plays a role. Note that the process where brain is developed from the neural tube is called cephalization. Encephalon in Latin means brain so the name is not out of the blue.

Why do we even have the brain in the first place? It is like an HQ where everything is processed, so having one big workplace is efficient rather than having several dispersed ones. Also in case you have not thought about it, major sensory organs (eyes, nose, ears, and tongue) are near the brain.

2. Outline specific roles different parts of brain have.

- There are certain parts of the brain we have to know.

If we start from bottom to top, it should be easier to remember these structures.

1. Medulla oblongata. This structure is a part of what we call the brain stem (other two structures in brain stem are midbrain and pons). The brain stem is the most primitive part of the brain so it also controls the very fundamental autonomic processes. What medulla specifically is said to regulate is gut muscles, breathing, heart muscle and even acidity/pressure in blood.

2. Right behind medulla we have cerebellum. Cerebellum literally means “little brain”. This little structure controls our movement coordination and also motor learning. “Practice makes perfect” is mainly thanks to cerebellum.

3. Hypothalamus. We have met this guy before and we usually associate this structure as “the thing that has to do with hormones”. I would like to make things clear between hypothalamus and pituitary gland. Hypothalamus is the boss. Hypothalamus is what detects the temperature and blood concentration in blood.

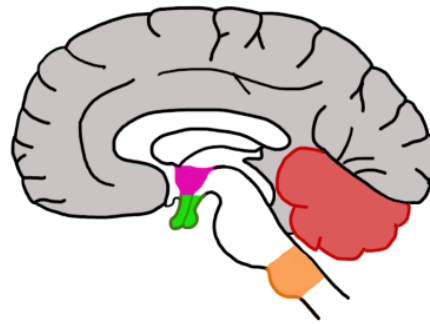
4. Pituitary gland. This is the chief executor. What we should note is that there is an anterior (front) part and posterior (back) part. Posterior pituitary is directly connected to the hypothalamus and this is where it receives hormones from hypothalamus, stores them and decides when to release. Note that posterior pituitary cannot synthesize hormones. Anterior pituitary on the other hand may do it and examples are LH and FSH. However, the secretion is still controlled by hypothalamus since hypothalamus is the boss.

5. Cerebral hemisphere. This is basically the left and right of the brain. It is different from cerebral cortex because cortex is only the thin grey matter in the outer layer.

cerebral hemisphere
acts as the integrating centre for high complex functions such as learning, memory and emotions.

hypothalamus
maintains homeostasis, coordinating the nervous and endocrine systems, secreting hormones of the posterior pituitary, and releasing factors regulating the anterior pituitary.

pituitary gland
the posterior lobe stores and releases hormones produced by the hypothalamus and the anterior lobe, and produces and secretes hormones regulating many body functions.

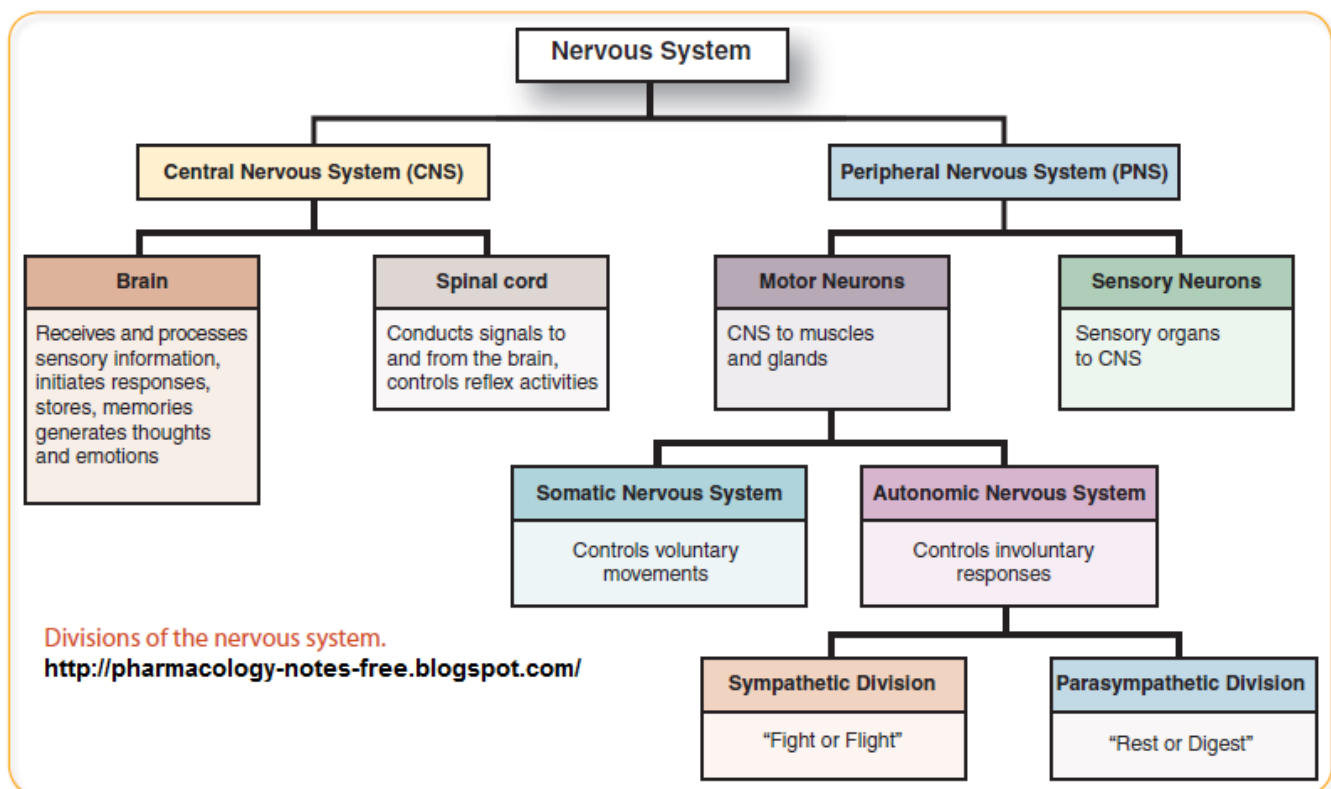


cerebellum
coordinates unconscious functions, such as movement and balance.

medulla oblongata
controls automatic and homeostatic activities, such as swallowing, digestion and vomiting, and breathing and heart activity.

3. Explain the autonomic nervous system.

- This was briefly mentioned as an extra note in chapter 6, but we can just review it.



Look at how things are classified. The first step is logical. Any neuron that stretches outside the CNS (brain and spinal cord) is a peripheral nervous system. Within, we already know that there are motor and sensory neurons. Within motor neurons, we can do things voluntarily (somatic) or involuntarily (autonomic). Within autonomic nervous system we have two divisions that do contrasting jobs. Sympathetic controls response during threat. Parasympathetic controls response during rest (remember the “r”). I reckon “para” in this case means “against” something as in parasol (against sun) and parachute (against shock).

Extra notes

- This is a short comparison of sympathetic and parasympathetic response.

Sympathetic	Parasympathetic
Both are divisions of the autonomic nervous system	
Response during threat	Response during rest
Adrenaline that accelerates heart rate	Acetylcholine that slows down heart rate
Causes pupil dilation	Causes pupil constriction
Inhibits activity of stomach, pancreas, intestines, glands and blood flow	Stimulates activity of stomach, pancreas, intestines, glands and blood flow
Inhibits emptying bladder	Promotes emptying bladder

4. State what the cerebral cortex is.

- As mentioned, this is the outer layer or the “bark” of the cerebral hemisphere. Only mammals have this and humans have the most developed cortex.

5. Explain how the human cerebral cortex has become enlarged.

- As humans became better and more precise in dexterity and intelligence, there has been a demand in brain power since highly sophisticated (vagueness alert) functions would require more neurons and networks (that alliteration though). But also an overly developed cranium would hinder fast movement and facilitated coordination. I mean, imagine walking around with a dinosaur egg on top of your head. It's not easy. Thus the solution was a lot of folding of the cerebral hemispheres and naturally cerebral cortex.

More folding (NOT brain size) generally tends to mean a higher intelligence in relation to the body size. This is because there is an excess of brain matter that needs to fit in a small cranium.

6. Explain the functions of cerebral hemispheres.

- Cerebral cortex on the cerebral hemisphere is what we usually relate with intelligence. This involves the so called “higher order functions” such as reasoning, contemplating existence, contemplating future and other abstract entities.

7. Explain the cross-processing nature of the cerebral hemispheres.

- This is a famous fact. Our left half of the body is processed by our right hemisphere while our right half of the body is processed by our left hemisphere. A more fancy term of this is decussation, in case you wanted to know. Of course, this is not ENTIRELY true because the processing of left and right hemisphere is not a clear-cut division. Almost always, the process occurs in both hemispheres, but it is a matter of how much.

Vision: It is not actually the “right eye” and “left eye” that is classified. It is rather the “right vision” from both eyes that gets processed in left hemisphere and the “left vision” from both eyes that get processed in the right hemisphere.

Touch: Our primary motor cortex is the responsible section. In this case, the full distinction seems to be true. Touch from right hand has its primary motor cortex located in left, and vice versa.

Hearing: This is similar to primary motor cortex. For hearing, primary auditory cortex is also at the opposite side (my book says the right ear is processed on right side, which is a bit peculiar).

Extra notes

- But I think what we are all interested in is why on earth does this decussation nature exist? Let's think because I don't think there is a definite answer to this (maybe future Nobel Prize winner if answered). Decussation is not only present in humans, but rather in all vertebrates. So this suggests that decussation is not evolved for intelligence. Here are three reasons I find to be most reasonable (may very well be other better reasons). First reason is integration. If one side is only processed on one side of the brain, there is no need for corpus callosum (the bridge between two hemispheres) and we would get two split visions. So by crossing, we can integrate the information into one and make the most of the surroundings to avoid predator or to hunt prey. Second reason is security. It is said that the right arm is better at protecting the left side of the brain and vice versa. Third reason is specifically for optics. The pupil flips our view (bottom to top, and left to right). So we send signal to opposite hemisphere in order to react fast to the inversed image. Confusing I know, but it is still a theory.

8. Explain the control of motor neurons by cerebral hemispheres.

- We have already mentioned that primary motor cortex is in the opposite side of its effector neurons. And not surprisingly, there is a specific area on the primary motor cortex that is responsible for a certain part of our body (ears, feet, nose, thumb, etc.). What often gets represented by this is the Homunculus, a figure that exaggerates the sensitive/important/occupant parts in our body.

But you probably knew this already. Let me tell something interesting you may not have heard. What I am about to tell you is a real-life example that suggests divisions in the primary motor cortex. A man (#confidentiality) had lost an arm and said that he had a phantom limb. A phantom limb is an imaginary sensation of an amputated arm (not so new so far). What a scientist (credit to Ramachandran) noticed was that when touching parts of the patients face, the patient felt a sensation in the phantom limb! For instance, cheek was the thumb, under nose was the index, under mouth was pinky, etc. Why did this happen? Well, location of hands in primary motor cortex is close to the location of the face. Thus, neurons responsible for the "hands" have migrated/formed connections with a nearby neuron. In this case the face section. Cool!

9. State that brain metabolism requires large energy inputs.

- Why do we need so much energy? (It is about 10%-20% of body's metabolism).

1. Maintenance of potential.

2. Synthesis of neurotransmitters.

Applications and skills:

1. Explain the visual cortex, Broca's area, nucleus accumbens as areas of the brain with specific functions.

- All these areas sit in/on the cerebrum.

Visual cortex: Stimuli from light are processed (after being converted to neural signals).

Areas where visual processing seems intense have been named as V1, V2, etc. This sits on the occipital lobe.

Broca's area: An area in the left hemisphere, in frontal lobe that controls speech. Recognized object cannot be expressed into words. Wernicke's area is another speech related area that deals with language comprehension.

Nucleus accumbens: This area senses reward and even addiction. One could think that this area is where dopamine is having most effect on. This sits near hypothalamus.

2. Elaborate the activities coordinated by the medulla.

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Peristalsis is controlled by medulla. This helps us to swallow and process food in one direction.

Breathing is controlled by medulla. It works together with chemoreceptors for pH to sense when oxygen is needed.

Heartbeat is controlled by medulla. Blood pH and pressure are the signals.

3. Explain how the use of the pupil reflex evaluates brain damage.

- Iris should be controlled automatically when exposed to different light intensities to protect the retina. If iris does not respond, medulla oblongata is probably damaged.

What may be good to know is that sympathetic (response to threat) contracts radial muscles to dilate the pupil while parasympathetic (response to rest) contracts circular muscles to constrict the pupil.

How do we remember which contracts which? Let me tell you how I remember it (my reasoning is not a factual truth). Since we are diurnal animals, we live in exposure to light. Thus parasympathetic is at work since it is at our natural habitat "at rest", and therefore contracts circular muscles (imagine a muscle in circle that contracts. It will constrict the

pupil). Conversely, when it is night we are not active and therefore vulnerable. Thus sympathetic is at work since darkness is associated with “threat”, therefore contracts radial muscles to get clearer vision (imagine muscles as the radius that contracts. It will stretch the pupil outwards and dilute it).

4. Discuss the use of animal experiments, autopsy, lesions and fMRI to identify the role of different brain parts.

- How do we study the brain?

1. Animal experiments. These were more prevalent in the past because no proper ethical consensus until like early 19th century. There is still a great debate going on regarding this. I won't take any sides.

2. Autopsy. This is a fancy term for dissection after death. A huge draw-back of this is that what we study is...dead. So we don't actually see the interactions that are going on.

3. Lesions. When areas are damaged, people's behaviour may change. Lesions are a great way to study, but problem is that one would have to wait for a lesion to occur. It is not like you can deliberately make a lesion. That would be an abusive act.

4. fMRI. This tracks the movement in blood supply by using a fancy machine.

5. Electrode. I might as well mention this too although the book does not mention it. This is a way to study activity of the brain like the fMRI by measuring electrical activity. A patient gets to wear a helmet with about 100 electrodes. An advantage is that patient can move unlike in fMRI so it is a great way to investigate brain during sleep. A disadvantage is that the resolution is not so strong...100 electrodes is not precise (but still something).

5. Be able to identify of parts of the brain in a photograph, diagram or scan of the brain.

- Structures you have to find are:

1. Skull
2. Cerebral hemisphere
3. Pituitary
4. Pineal gland. This sits right behind the thalamus (not hypothalamus).
5. Hypothalamus
6. Cerebellum
7. Medulla oblongata
8. Spinal cord and vertebra.

6. Be able to analyse correlations between body size and brain size in different animals.

- Ok.

TOK:

1. In medicine the concept of death is defined in terms of brain function, but sometimes conflicts can occur when the medical criteria for death differ from the family's criteria for death. To what extent should the views of the family members be given priority when making decisions in medical ethics? What criteria should be used to make ethical decisions?