Section 11.3: The Central Nervous System

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1. The three main regions of the brain that are shared by all primates are the forebrain, midbrain, and hindbrain. The most significant differences in the human brain occur in the forebrain, the region associated with reason, intellect, memory, language, and personality.

2. The main functions of the spinal cord are to relay signals between the PNS and the brain and to control reflexes.

3. A hockey player with damage to the cerebellum might have difficulty walking, maintaining balance, and initiating and stopping movement of his or her limbs. The player’s movements would be slow and uncoordinated. The cerebellum controls sensory input and interprets it. Outputs from the cerebellum to the cerebrum, brain stem, and spinal cord modify and fine-tune the movements to keep the body in balance and directed toward targeted positions in space.

4. The right side of the brain controls the left side of the body and the left side of the brain controls the right side of the body. Nerves carrying afferent and efferent signals cross from left to right within the spinal cord or brain stem. Thick axon bundles, forming a structure called the corpus callosum, connect the two cerebral hemispheres and coordinate their functions.

5. In most people, activity occurs in the left hemisphere when people perform verbal or mathematical tasks, and activity occurs in the right hemisphere when people perform intuitive, spatial, artistic, or musical tasks. When we say someone is left-brained, we mean that there is a tendency for their stronger abilities to be verbal and/or mathematical. Right-brained people tend to have more developed artistic and/or musical abilities.

6. Answers may vary. Reports should include the following information:

   • MEG works by measuring and recording the electromagnetic fields that your brain activity generates. That is, when different parts of your brain are communicating, they are sending signals (electrical impulses) back and forth. The electrical impulses generate tiny magnetic fields that can be detected by MEG. Therefore, MEG measures your brain activity from the outside of your head. For this reason, this technique is a non-invasive procedure.
   • MEG is used in neuroscience because it is a non-invasive way to measure brain activity and function. Neuroscientists and doctors have used MEG technology for many applications including helping surgeons find the site of a disease or trauma, helping researchers determine the functions of various parts of the brain, and in neurofeedback studies. It has also been used to classify patients with various diseases and disorders including multiple sclerosis, Alzheimer's disease, schizophrenia, Sjögren's syndrome, chronic alcoholism, and facial pain. MEG can be used to distinguish these patients from healthy control subjects, suggesting a future role of MEG in diagnostics.
   • The advantages of MEG are that it is non-invasive (that is, it does not require measurements from inside the head), it is a direct measurement of neural electrical activity (unlike fMRI, PET and SPECT, which are secondary measures of brain metabolism), it has a very high temporal resolution, and because the magnetic fields are produced only by neural activity, they are less likely to be distorted by surrounding tissues, as is the case with EEGs. The disadvantages of MEG are that it is relatively expensive, and that is has a relatively low spatial resolution.

7. No. A larger brain is necessary to control larger muscles in larger animals and is also necessary to process more sensory information from the skin in larger animals. This size of the brain is not related to intelligence.

8. In this case, the stroke caused a reduced blood flow in the frontal lobe, damaging Broca’s area.
9. The blood-brain barrier protects the brain and spinal cord from infection by viruses, bacteria, and toxic substances that may circulate in the blood. Tight junctions set up a blood–brain barrier that prevents most substances dissolved in the blood from entering the cerebrospinal fluid.

10. Some of the techniques used today to study brain functions include functional magnetic resonance imaging (fMRI), 3D ultrasound, and positron emission tomography (PET). These techniques allow researchers to identify the normal functions of specific brain regions in non-invasive ways. The instruments record a subject’s brain activity during various mental and physical tasks by detecting tiny increases in blood flow or metabolic activity in specific regions.

11. Answers may vary. Sample answer: I think that the brain stem had to evolve first. This is because the brain stem, which is comprised of the medulla, the midbrain and the pons, not only connects the forebrain to the spinal cord, but is also responsible for controlling involuntary behaviours, such as breathing, digestion, heart rate, and blood pressure. Control of these behaviours would have been necessary to maintain life during early evolution in a higher organism. Conversely, the cerebellum controls motor responses, balance, and fine motor control, which would not have been as instrumental in maintaining early life as breathing and digestion. Therefore, it is likely that the cerebellum evolved after the brain stem.

12. (a) Answers may vary. Sample answer: I think the brain makes a strong connection between sight and touch because it allows us to respond very rapidly and efficiently to our immediate environment. By connecting memories of different sensory inputs our brain has more information available and can react more efficiently.

(b) Answers may vary. Sample answer: This type of connection between sight and touch could benefit me by preventing me from touching a harmful object once I have seen it. For example, if I look at a hot stove, I will remember what it feels like to touch a hot element on a stove. Due to this memory and connection between the two senses, I do not have to touch the hot stove again to remember that it will burn me.