Neurofysiologi

BNEU 1 – Kapital 7

Noter fra læsning:

Centralnervesystemet (CNS) består af dele af nervesystemet, der er indkapslet i knoglen: hjernen og rygmarven. Hjernen ligger helt inden i kraniet. Et sidebillede af rottehjernen afslører tre dele, der er fælles for alle pattedyr: cerebrum, cerebellum og Brain stem hjernestammen (fig. 7.4a).

Cerebrum. Den største del af hjernen er cerebrum. Figur 7.4b viser rotte-cerebrum som det vises set fra oven. Bemærk at det tydeligt delt på midten i to cere-Bral halvkugler, adskilt af den dybe sagittale revne. Generelt modtager højre hjernehalvdel fornemmelser fra og styrer bevægelser, af den venstre side af kroppen. Tilsvarende er den venstre hjernehalvdel vedrører fornemmelser og bevægelser på højre side af kroppen.

Cerebellum. Det der ligger bag cerebrum er cerebellum (ordet er afledt af det latinske ord for "lille hjerne"). Mens cerebellum er faktisk vækshæmmede ved den store cerebrum, det faktisk indeholder så mange neuroner, som begge hjernehalvdele kombineres. Lillehjernen er primært bevægelse kontrol center, der har omfattende forbindelser med cerebrum og rygmarv. I modsætning til de cerebrale halvkugler, er den venstre side af vokshud-bellum vedrører bevægelser i venstre side af kroppen, og den højre side af lillehjernen vedrører bevægelser i højre side.

Brain Stem = Hjernestammen. Den resterende del af hjernen er hjernestammen, bedst observeres i en midsagittal visning af hjernen (figur 7.4c). Hjernestammen danner armen, hvorfra de cerebrale halvkugler og lillehjernen spire. Hjernestammen er en kompleks helhed af fibre og celler, der dels tjener til at relay information fra cerebrum til rygmarven og cerebellum, og omvendt. Imidlertid hjernestammen er også stedet, hvor de vitale funktioner **reguleres, såsom vejrtrækning, bevidsthed, og kontrol af kropstemperaturen**. For selv hjernestammen betragtes som den mest primitive del af den mammale hjerne, er også den vigtigste for liv. **Man kan overleve skader på cerebrum og cerebellum, men skader på hjernestammen betyder normalt hurtig død.**

Spinal Cord = Rygmarven. Rygmarven er indkapslet i den benede rygsøjlen og er fastgjort til hjernestammen. Rygmarven er vigtig kilde af information fra huden, leddene, og muskler i kroppen til hjernen, og omvendt**. En transektion af rygmarven resulterer i anæstesi (manglende følelse) i huden og lammelse af musklerne i dele af kroppen caudalt til snittet. Lammelse i dette tilfælde betyder ikke, at musklerne ikke kan fungere, men at de ikke kan styres af hjernen.**

Rygmarven kommunikerer med kroppen via spinale nerver, som indgår i det perifere nervesystem (beskrevet nedenfor). Spinal nerver forlader rygmarven gennem hak mellem hver ryghvirvel af rygsøjlen. Hver spinal nerve

One stain, still used today, was introduced by the German neurologist Franz Nissl in the late nineteenth century. Nissl showed that a class of basic dyes would stain the nuclei of all cells and also stain clumps of material surrounding the nuclei of neurons (Figure 2.1). These clumps are called *Nissl bodies*, and the stain is known as the **Nissl stain**. The Nissl stain is extremely useful for two reasons. First, it distinguishes neurons and glia from one another. Second, it enables histologists to study the arrangement, or **cytoarchitecture**, of neurons in different parts of the brain. (The prefix *cyto-* is from the Greek word for "cell.") The study of cytoarchitecture led to the realization that the brain consists of many specialized regions. We now know that each region performs a different function.

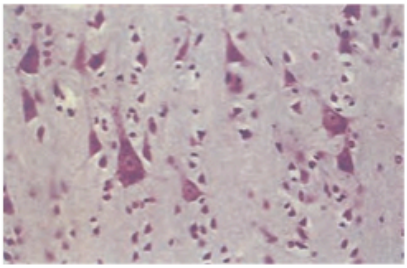


FIGURE 2.1
Nissl-stained neurons. A thin slice of brain tissue has been stained with cresyl violet, a Nissl stain. The clumps of deeply stained material around the cell nuclei are Nissl bodies. (Source: Hammersen, 1980, Fig. 493.)

Cellular components of the Nervous System

Two cell types:

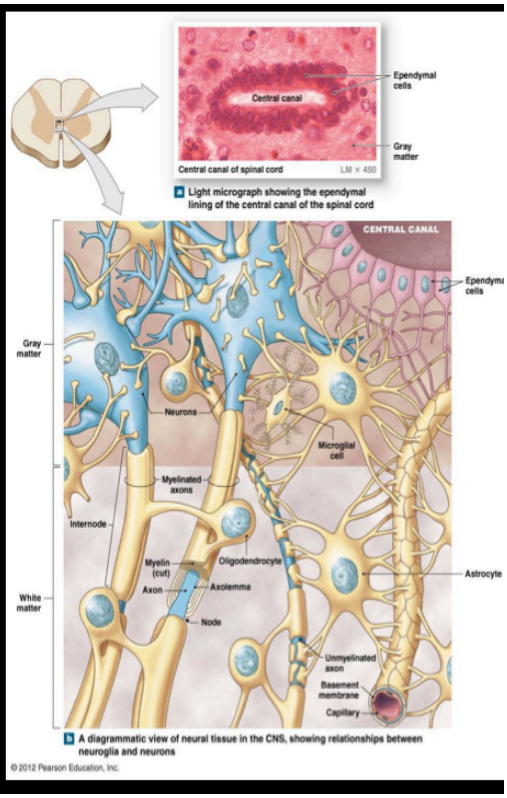
Neurons

- Functional, signal conducting cells

Neuroglia

- Outnumber neurons by 10 times!
- Supporting cells
- Nutrition

- Gray Matter: cell bodies
- White Matter: axons



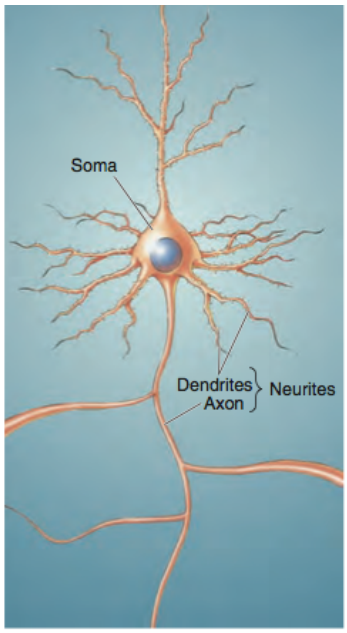
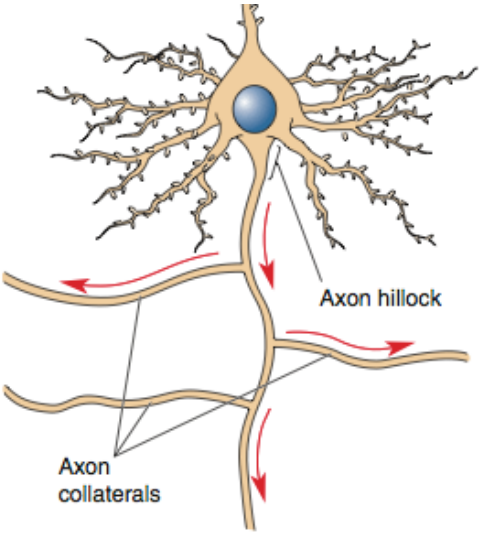


FIGURE 2.4
The basic parts of a neuron.

The axon begins with a region called the **axon hillock**, which tapers to form the initial segment of the axon proper (Figure 2.14).



Two noteworthy features distinguish the axon from the soma:

1. No rough ER extends into the axon, and there are few, if any, free ri- bosomes.

2. The protein composition of the axon membrane is fundamentally different from that of the soma membrane.

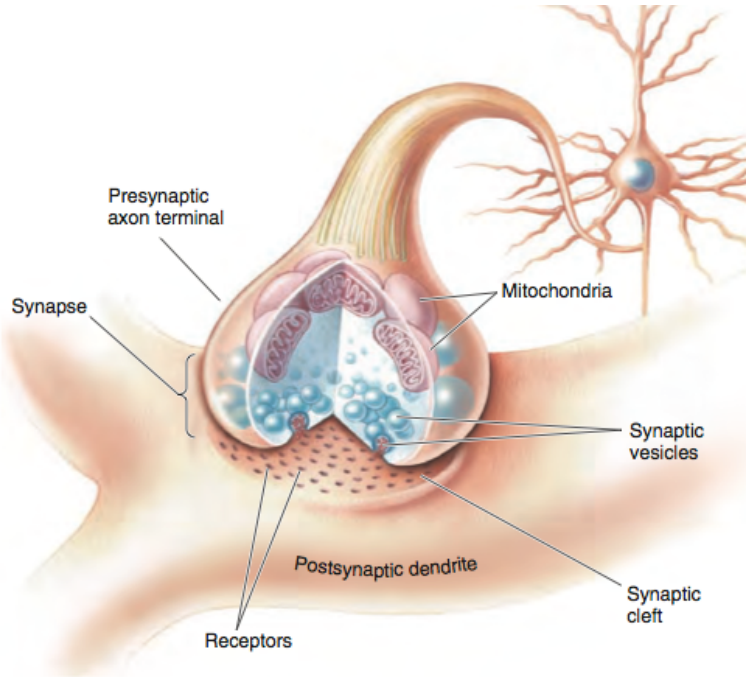
*These structural differences translate into functional distinctions. Because there are no ribosomes, there is no protein synthesis in the axon. This means that all proteins in the axon must originate in the soma**. And it is the different proteins in the axonal membrane that enable it to serve as the "telegraph wire" that sends information over great distances.***

Axons may extend from less than a millimeter to over a meter long. Axons often branch, and these branches are called **axon collaterals**. Occasionally, an axon collateral will return to communicate with the same cell that gave rise to the axon or with the dendrites of neighboring cells. These axon branches are called *recurrent collaterals*.

This variation in axon size is important. As will be explained in Chapter 4, the speed of the electrical signal that sweeps down the axon—the *nerve impulse*—varies depending on axonal diameter. The thicker the axon, the faster the impulse travels.

The axon terminal

The terminal is a site where the axon comes in contact with other neurons (or other cells) and passes information on to them. This point of contact is called the **synapse**, a word derived from the Greek, meaning "to fasten together." Sometimes axons have many branches at their ends, and each branch forms a synapse on dendrites or cell bodies in the same region. These branches are collectively called the **terminal arbor**



In either case, when a neuron makes synaptic contact with another cell, it is said to innervate that cell, or to

ACTION POTENTIALS, AXONS, AND DENDRITES

Only membrane that contains these specialized protein molecules is capable of generating action potentials, and this type of excitable membrane is usually found only in axons. Therefore, the part of the neuron where an axon originates from the soma, the axon hillock, is often also called the **spike-initiation zone**. In a typical neuron in the brain or spinal cord, the depolarization of the dendrites and soma caused by synaptic input from other neurons leads to the generation of action potentials if the membrane of the *axon hillock* is depolarized beyond threshold (Figure 4.14a). In most sensory neurons, however, the spike-initiation zone occurs near the *sensory nerve endings,* where the depolarization caused by sensory stimulation leads to the generation of action potentials that propagate up the sensory nerves (Figure 4.14b).

CONCLUDING REMARKS

Let's return briefly to the example in Chapter 3 of stepping on a thumb- tack. The breaking of the skin caused by the tack stretches the sensory nerve endings of the foot. Special ion channels that are sensitive to the stretching of the membrane open and allow positively charged sodium ions to enter the nerve endings. This influx of positive charge depolarizes the membrane of the spike-initiation zone to threshold, and the action potential is generated. The positive charge that enters during the rising phase of the action potential spreads down the axon and depolarizes the membrane ahead to threshold. In this way, the action potential is continuously regenerated as it sweeps like a wave up the sensory axon. We now come to the step where this information is distributed and integrated by other neurons in the central nervous system. This transfer of information from one neuron to another is called *synaptic transmission*, the subject of the next two chapters.

It should come as no surprise that synaptic transmission, like the action potential, depends on specialized proteins in the neuronal membrane. Thus, a picture begins to emerge of the brain as a complicated mesh of interacting neuronal membranes. Consider that a typical neuron with all its neurites has a membrane surface area of about 250,000 μm^2. The surface area of the 100 billion neurons that make up the human brain comes to 25,000 m^2—roughly the size of four soccer fields. This expanse of membrane, with its myriad specialized protein molecules, constitutes the fabric of our minds.

Nerveimpulser

Når neuroner kommunikerer med hinanden og med andre dele af organismen, det være sig muskler, kirtler, sanser eller organer, sker det ved hjælp af nerveimpulser. Disse er altid digitale, det vil sige enten sendes et signal eller også gøres der ikke. Når vi fx kan mærke at et hår bliver bøjet, er det fordi at en sansecelle ved hårsækken "trigger" et impuls til at starte. For at det kan blive sat i gang, skal der nemlig en påvirkning af en vis størrelse til, den såkaldte tærskelværdi skal overskrides. Det som muliggør forplantningen af signalet videre gennem dendritten, er den elektriske forskel som er mellem inder- og ydersiden af cellemembranen. Forskellen er der på grund af forholdet mellem positive Na^+- og K^+-ioner inde i og udenfor cellen. Forsøg med neuroner fra blæksprutter[1] viser at koncentrationerne er som vist i tabel 1.

Tabel 1	Intracellulær koncentration i	Extracellulær koncentration i

[1] Grunden til at man bruger blæksprutteneuroner skyldes at disse er meget store og derfor nemmere at undersøge.