Unit 02 L32 Neurons

2020年1月26日　　下午 6:28

- What are Neurons and how they work?
- Cortex and Neurons
- Neuron
    - Camillo Golgi (1900) discovered a method of staining nervous tissue called black reaction which resulted in a stark black deposit on the soma as well as on the axon and all dendrites, providing an exceedingly clear and well-contrasted picture of neuron against a yellow background.
    - The human brain has about 100 billion very tiny neurons.
    - Each neurons is connected to about 10000 others.
    - Each neuron only connects directly to a very small portion of other neurons <=> as if you could only communicate directly with 3 other people in Canada.
- Some Interesting Facts
    - The brain is metabolically very active. It consumes 25% of the body energy, while it only takes up about 1% of body weight.
    - Almost the full set of neurons is in place before birth.
    - Unlike most body cells, neurons in the brain are only able to divide to make new cells during fetal development and for a few months after birth. After that, no new brain cells are formed, although existing ones may increase in size until the age of about eighteen years. They are designed to last a lifetime.
    - During childhood, and particularly during adolescence, a process known as "synaptic pruning" occurs. Although the brain continues to grow and develop, the overall number of neurons and synapses are reduced by up to 50%, removing unnecessary neuronal structures and allowing them to be replaced by more complex and efficient structures, more suited to the demands of adulthood.
- Electronic Potential in Neurons
    - The Neurons have potassium and sodium ions which cause electric flow inside our brain
    - The thinouter membrane of the neuron is made of proteins, which have channels that may allow the passage of ions.
    - By maintaining an uneven match of positive and negative ions, the neuron has an electric potential across the outer membrane.
    - **Resting Potential**: Refers to the difference between the voltage inside and outside the neuron at a stable non-firing state. The resting potential of the average neuron is around -60 millivolts, indicating more –vecharge inside the cell body than outside it.
    - Incoming signals have the effect of locally altering the potential at the dentrites where the signal arrives.
    - If the incoming signal, and thus the locally altered potential is

maintained, it will very quickly change the potential of the whole cell body. This is because the positive and negative ions attract each other, and will move to develop a uniform concentration.
    - This transfer of potential is called slow potential. It actually takes place very quickly, but it is "slow" relative to other forms of conducting electric potential.
- Varying Effects of Signals
    - Even though the axon sends the same signals to all of its recipient neurons, the effect on the potential can be quite different for each of the recipients. The effect can be amplified or de-amplified, and can be negated, depending on the nature of the individual synapses through which the signal travels.
- Thresholds for Transmission
    - The effect of the potential at the axon base would have little or no influence on the potential at the site of "contact" without the mechanism of **ion pumps**.
    - If the potential at a point along the axon rises beyond a threshold, ion pumps at that point will operate, and cause a sudden large local increase in potential called an **action potential**.
- Measure of Activation
    - The higher the activation, the faster the neuron will attain its threshold potential.
    - The spacing in between action potentials is a direct measure of the activation of the neuron at the time.
    - The frequency of action potentials encodes the activation of the neuron. Because of the resting period between action potentials, the max firing rate is about 200/sec.
- Transmission through Synapse
    - The same signal transmitted to all of recipient neurons, can cause different effects on the recipient neurons depending on type and ions at the synapses.
    - When an action potential arrives at the end of the axon, it causes the release of many tiny neurotransmitters. The neurotransmitters drift across the gap to the dendrite.
- The Power of Dopamine
    - Dopamine
        - Dopamine is a hormone and neurotransmitter
        - Acts to reinforce happiness
        - Several important diseases of the nervous system are associated with dysfunctions of the dopamine system. E.g. Parkinson's disease
        - Attention Deficit Hyperactivity Disorder (ADHD) and restless legs syndrome (RLS) are also believed to be associated with decreased dopamine activity
        - Balanced food, exercise, and rest are good
    - Alcohol and other drugs
        - Reduces dopamine

        - Inhibits the inhibitory signals
- Interdisciplinary Crossroads
    - Questions that cognitive scientists try to answer are:
        - What causes how much loss of memory?
        - How a brain wave of a patient differs from that of a normal person?
        - What kind of brain signals are generated for certain types of motor actions?
        - Analyze brain images and signals to see what brain parts react and how, when we hear alarming news or see shocking pictures?
        - Create neural models of seizures