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1.Some ion channels are highly selective for one type of ion, but others let various kinds of ions pass through. Ion channels that mainly allow K to pass are called **potassium channels**, and ion channels that mainly allow NA  to pass are called **sodium channels**. The electrical potential difference across the cell membrane that exactly balances the concentration gradient(梯度) for an ion is known as the **equilibrium potential(平衡电位)**. 2.Because the system is in **equilibrium(平衡)**, the membrane potential will tend to stay at the **equilibrium potential**. For a cell where there is only one **permeant** ionic species (only one type of ion that can cross the membrane), the resting membrane potential will equal the equilibrium potential for that ion.3. In a resting neuron, both NA and K are permeant, or able to cross the membrane. 1)NA will try to drag the membrane potential toward its (positive) equilibrium potential.2) K will try to drag the membrane potential toward its (negative) equilibrium potential. 4. The   concentration gradients across the membrane of the cell (and thus, the resting membrane potential) are maintained by the activity of a protein called the  -  ATPase, often referred to as the [sodium-potassium pump](https://www.khanacademy.org/science/biology/membranes-and-transport/active-transport/v/sodium-potassium-pump-video).5. Why is a pump needed to maintain the concentration gradients? A：Like the ion channels that allow   and   to cross the cell membrane, the - pump is a membrane-spanning protein. it [actively transports](https://www.khanacademy.org/science/biology/membranes-and-transport/active-transport/a/active-transport)   and   against their electrochemical gradients(与梯度相反). ATP hydrolysis (the splitting of ATP into ADP and inorganic phosphate). For every molecule of ATP that's broke down, NA ions are moved from the inside to the outside of the cell, and K ions are moved from the outside to the inside.6. In a neuron, the resting membrane potential is closer to the potassium equilibrium potential than it is to the sodium equilibrium potential. That's because the resting membrane is much more permeable to K than to NA.

**Neuron action potentials**:1) dendrites: receive signals from neighboring neurons (like a radio antenna)2) axon: transmit signals over a distance (like telephone wires)3) axon terminal: transmit signals to other neuron dendrites or tissues (like a radio transmitter)4)myelin sheath: speeds up signal transmission along the axon.

**Action potential** During the resting state (before an action potential occurs) all the gated sodium and potassium channels are closed. These gated channels are different from the leakage channels, and only open once an action potential has been triggered. We say these channels are “voltage-gated” because they are open and closed depends on the voltage difference across the cell membrane. Voltage-gated sodium channels have two gates (gate m and gate h), while the potassium channel only has one (gate n).1)Gate m (the activation gate) is normally closed, and opens when the cell starts to get more positive.2)Gate h (the deactivation gate) is normally open, and swings shut when the cells gets too positive.3)Gate n is normally closed, but slowly opens when the cell is depolarized (very positive).

**Voltage-gated sodium channels exist in one of three states**:1) Deactivated (closed) - at rest, channels are deactivated. The m gate is closed, and does not let sodium ions through.2) Activated (open) - when a current passes through and changes the voltage difference across a membrane, the channel will activate and the m gate will open.3) Inactivated (closed) - as the neuron depolarizes, the h gate swings shut and blocks sodium ions from entering the cell. **Voltage-gated potassium channels** are either open or closed.

1.**A triggering event occurs that depolarizes the cell body**. This signal comes from other cells connecting to the neuron, and it causes positively charged ions to flow into the cell body. Positive ions still flow into the cell to depolarize it, but these ions pass through channels that open when a specific chemical, known as a neurotransmitter, binds to the channel and tells it to open. Neurotransmitters are released by cells near the dendrites, often as the result of their own action potential! These incoming ions bring the membrane potential closer to 0, which is known as depolarization. An object is polar if there is some difference between more negative and more positive areas. As positive ions flow into the negative cell, that difference, and thus the cell’s polarity, decrease. If the cell body gets positive enough that it can trigger the voltage-gated sodium channels found in the axon, then the action potential will be sent.**2. Depolarization** - makes the cell less polar (membrane potential gets smaller as ions quickly begin to equalize the concentration gradients) . Voltage-gated sodium channels at the part of the axon closest to the cell body activate, thanks to the recently depolarized cell body. This lets positively charged sodium ions flow into the negatively charged axon and depolarize the surrounding axon. We can think of the channels opening like dominoes falling down - once one channel opens and lets positive ions in, it sets the stage for the channels down the axon to do the same thing. Though this stage is known as depolarization, the neuron actually swings past equilibrium and becomes positively charged as the action potential passes through!**3. Repolarization** - brings the cell back to resting potential. The inactivation gates of the sodium channels close, stopping the inward rush of positive ions. At the same time, the potassium channels open. There is much more potassium inside the cell than out, so when these channels open, more potassium exits than comes in. This means the cell loses positively charged ions, and returns back toward its resting state.**4. Hyperpolarization** - makes the cell more negative than its typical resting membrane potential. As the action potential passes through, potassium channels stay open a little bit longer, and continue to let positive ions exit the neuron. This means that the cell temporarily hyperpolarizes or gets even more negative than its resting state. As the potassium channels close, the sodium-potassium pump works to reestablish the resting state.

**bioelectric potentials** electrocardiogram心 (ECG) electroencephalogram脑 (EEG) electromyogram 肌(EMG) .

**Three types of muscle** 1) skeletal 2) cardiac(心) 3) smooth（平滑），肌肉功能：1)contractility 2) extensibility 3) excitability.

**Motor unit** 1) The smallest functional unit to describe the neural control of the muscular contraction process**.**2)The motor neuron, situated in the spinal cord, has a long axon which goes to the muscle.3) Each axon splits up into a number of branches each of which ends on a motor endplate on a muscle fibre.4) Ensemble of a motor neuron and the muscle fibres it innervates is called the motor unit. **Motor Unit Action Potential**1) Typically, each motor-neuron innervates several hundred muscle fibers (innervation ratio)2)Motor Unit Action Potential (MUAP) = summed electrical activity of all muscle fibers activated within the motor unit3)Muscle force increased through higher recruitment and increased rate coding.

**Inserted**: 1) Fine-wire (Intramuscular) 2) Needle 3) Implanted  **Surface:** Extramacular. **Advantages of Inserted**: Extremely sensitive/Record the activity of a single motor unit/Access to deep musculature/Little cross-talk concern/ **Disadvantages**: Requires medical personnel, certification/Repositioning nearly impossible/Detection area may not be representative of entire muscle/ **Advantages of surface:** Advantages: Quick, easy to apply/No medical supervision, nor required certification/Minimal discomfort/Easy to reposition/Disposable. **Disadvantages**: Generally used only for superficial muscles/Cross-talk concerns/No standard electrode placement/May affect movement patterns of subject

**The surface EMG electrodes should be placed :** between the motor unit and the tendinous insertion of the muscle, **/**along the longitudinal midline of the muscle**/**Electrode alignment with the direction of muscle fibres to increase probability of detecting same signal.

When the electrodes are arranged in this way, the detecting surfaces intersect most of the same muscle fibres, and as a result, an improved superimposed signal is observed.

图示

描述已自动生成The quality of the detected sEMG signal determines the usefulness of the information extracted from the sEMG signal. /It is of high importance to maximise the quality of the acquired signal. /The quality of the acquired signal depends on:1) Sensor location (upon the middle of muscle belly). 2) Tissue characteristics 3) Cross-talk from other muscles.3) Noise contamination

**Time Domain**: Rectification/Smoothing/Filtering/Amplitude Normalization. **Frequency Domain**: FFT Analysis/Frequency spectrum/Mean frequency/Median frequency **Time-Frequency Analysis :**Short-time Fourier Transform/Wavelet Transform

**Time Domain: Rectification**(整流) : Only positive values are analysed/Half-wave rectification/all negative data is discarded/ positive data is kept.**Full-wave rectification**:the absolute value of each data point is used/Full-wave is preferred.

**Smoothing** (平滑): Outline the mean trend of signal development: cutting away steep amplitude spikes/Receiving a amplitude envelop/Moving average /Root mean square

**(WBSN) Definition**: Body Sensor Network (BSN): a number of heterogeneous sensors placed on different parts of the body (and in the environment where the person is moving). ♦ Similar (or alternatives): WBSN, WBAN, WPAN

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