

Electromagnetism in Human Physiology

Electromagnetism · Practice Test · 20 Questions

1. What is the primary ionic mechanism responsible for the resting membrane potential of a neuron, typically measured at approximately -70 mV?

- A) Sodium-potassium pump activity
- B) Calcium ion influx
- C) Chloride ion sequestration
- D) Potassium ion efflux through leak channels

2. In Magnetoencephalography (MEG), which physical principle is utilized to detect the extremely weak magnetic fields produced by electrical activity in the brain?

- A) Superconducting Quantum Interference Devices (SQUIDs)
- B) Hall effect sensors
- C) Faraday cage resonance
- D) Piezoelectric transducers

3. During a standard Electrocardiogram (ECG), the P-wave corresponds to which specific electromagnetic event in the heart?

- A) Ventricular repolarization
- B) Atrial depolarization
- C) Ventricular depolarization
- D) Atrioventricular node conduction delay

4. What is the specific physical property of deoxyhemoglobin that allows it to be distinguished from oxyhemoglobin in functional Magnetic Resonance Imaging (fMRI)?

- A) Diamagnetism
- B) Paramagnetism
- C) Ferromagnetism
- D) Superconductivity

5. The Hodgkin-Huxley model describes the mathematical relationship between the membrane potential and which specific biophysical property?

- A) Thermal conductivity
- B) Ion channel conductance
- C) Fluid viscosity
- D) Molecular binding affinity

6. Which ion is primarily responsible for the 'plateau phase' of a cardiac action potential, preventing tetanic contraction?

- A) Potassium
- B) Magnesium
- C) Calcium
- D) Phosphate

7. What is the range of the magnetic field strength typically generated by the human heart, detectable by high-sensitivity sensors?

- A) 1-5 microtesla
- B) 10-50 picotesla
- C) 100-500 millitesla
- D) 1-5 nanotesla

8. In Electromyography (EMG), the motor unit action potential (MUAP) represents the summation of electrical activity from which structures?

- A) All muscle fibers innervated by a single motor neuron
- B) The entire muscle belly
- C) The neuromuscular junction only
- D) The sensory afferent nerve fibers

9. Which type of radiation is utilized in Positron Emission Tomography (PET) to detect metabolic activity, relying on the annihilation of positrons and electrons?

- A) Alpha particles
- B) 511 keV gamma photons
- C) Beta-minus radiation
- D) X-rays

10. What role does the myelin sheath play in the electromagnetic propagation of a nerve impulse?

- A) Increases membrane resistance and decreases capacitance
- B) Decreases membrane resistance and increases capacitance
- C) Acts as a ferromagnetic insulator
- D) Converts electrical energy to chemical energy

11. In the context of the Nernst equation, what does the variable 'z' represent in the calculation of the equilibrium potential for a specific ion?

- A) Ion concentration
- B) Temperature in Kelvin
- C) The valence of the ion
- D) The gas constant

12. The 'QRS complex' in an ECG is electromagnetically generated by which cardiac process?

- A) Atrial repolarization
- B) Ventricular depolarization
- C) Sinoatrial node firing
- D) Ventricular repolarization

13. What physical phenomenon makes the human body partially transparent to high-frequency radio waves in MRI?

- A) The spin of hydrogen nuclei in water
- B) The ionization of oxygen
- C) The diamagnetic properties of carbon
- D) The high electrical resistance of bone

14. In bioelectricity, what is the 'space constant' (λ) defined as in cable theory regarding nerve fibers?

- A) The distance at which a graded potential decays to 37% of its original value
- B) The velocity of the action potential
- C) The thickness of the axon membrane
- D) The frequency of the ion channel oscillation

15. Which structure in the inner ear transduces mechanical vibrations into electromagnetic signals via hair cell depolarization?

- A) Organ of Corti
- B) Semicircular canals
- C) Stapes
- D) Eustachian tube

16. Transcranial Magnetic Stimulation (TMS) induces electrical currents in the brain by utilizing which physical principle?

- A) Coulomb's Law
- B) Electromagnetic induction (Faraday's Law)
- C) The Doppler effect
- D) The Bernoulli principle

17. At the chemical synapse, the conversion of an electrical signal to a chemical signal and back to an electrical signal occurs primarily through which mechanism?

- A) Direct electron tunneling
- B) Ligand-gated ion channels
- C) Quantum tunneling
- D) Active transport of protons

18. What is the primary electromagnetic effect observed during the repolarization phase of an action potential?

- A) Sodium influx
- B) Potassium efflux
- C) Calcium sequestration
- D) Magnesium uptake

19. Which medical imaging modality uses the gyromagnetic ratio of the hydrogen nucleus?

- A) CT scanning
- B) PET scanning
- C) Magnetic Resonance Imaging
- D) Ultrasound

20. In the human eye, the 'ERG' (Electroretinogram) measures the electrical response of which layer to light stimulation?

- A) The lens
- B) The cornea
- C) The retina
- D) The iris