Electromagnetism in Human Physiology

Electromagnetism · Answer Key · 18 Questions

1. What is the primary physical principle that allows Magnetic Resonance Imaging (MRI) to detect hydrogen nuclei in human tissue?

A) The photoelectric effect
B) Nuclear magnetic resonance
C) Quantum entanglement of electrons
D) Thermal ionization of water molecules

2. In cardiac electrophysiology, what is the specific magnitude range for the electrical potential generated by the depolarization of the myocardium during a typical ECG?

A) 10-20 microvolts
B) 1-2 millivolts
C) 50-100 millivolts
D) 1-2 volts

3. Which ionic movement is responsible for the 'resting membrane potential' of approximately -70mV in human neurons?

A) Efflux of sodium ions
B) Influx of calcium ions
C) Efflux of potassium ions
D) Active transport of chloride ions

4. Magnetoencephalography (MEG) measures the extremely weak magnetic fields generated by neuronal activity; what is the approximate order of magnitude of these fields in Tesla?

A) 10^-5 T
B) 10^-10 T
C) 10^-14 T
D) 10^-20 T

5. What is the frequency range of the electromagnetic spectrum typically used in Transcranial Magnetic Stimulation (TMS) to induce local neural depolarization?

A) 10-30 kHz
B) 1-5 MHz
C) 20-50 Hz
D) 100-300 GHz

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6. During a nerve impulse, the propagation of the action potential along an axon is facilitated by 'saltatory conduction' at which specific structures?

A) Synaptic vesicles
B) Nodes of Ranvier
C) Dendritic spines
D) Axon hillocks

7. Which form of electromagnetic radiation is most commonly associated with the DNA-damaging potential of ionising radiation in human cells?

A) Microwave
B) Infrared
C) Gamma rays
D) Radio waves

8. What is the primary role of the Faraday cage effect in the context of electroencephalography (EEG) recordings?

A) To amplify neural signals
B) To shield against 50/60 Hz power line interference
C) To accelerate neuronal firing
D) To cool the scalp during testing

9. The Nernst equation is fundamental in physiology for calculating:

A) The equilibrium potential of an ion across a semi-permeable membrane
B) The total magnetic field of the heart
C) The refractive index of the eye
D) The thermal conductivity of human skin

10. What happens to the electrical impedance of human skin when it is significantly hydrated or damaged, such as in an abrasion?

A) It increases significantly
B) It remains constant
C) It decreases significantly
D) It becomes purely inductive

11. In medical physics, which factor primarily determines the 'Specific Absorption Rate' (SAR) when a human is exposed to non-ionizing electromagnetic radiation?

A) Magnetic susceptibility of the brain
B) Dielectric properties and mass density of tissue
C) The speed of blood flow
D) The rate of neural synaptic transmission

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12. The Hodgkin-Huxley model describes the kinetics of which specific channels during the generation of an action potential?

A) Voltage-gated sodium and potassium channels
B) Ligand-gated chloride channels
C) Mechanosensitive water channels
D) Passive glucose transporters

13. What is the biological effect of exposure to extremely low-frequency (ELF) electromagnetic fields on the human body, according to current scientific consensus?

A) Spontaneous DNA replication
B) Induction of microscopic electrical currents in body tissue
C) Permanent alteration of the blood-brain barrier
D) Immediate thermal ablation of skin cells

14. The electrical conduction velocity of a myelinated nerve fiber is primarily limited by:

A) The speed of light
B) The internal axial resistance and membrane capacitance
C) The ambient temperature of the body
D) The concentration of atmospheric oxygen

15. Which physiological process is the direct result of the electromagnetic properties of the sinoatrial node?

A) Release of neurotransmitters
B) Cardiac pacemaker function
C) Regulation of blood pH
D) Conversion of light to nerve signals

16. In electromyography (EMG), the captured signal represents the summation of:

A) Action potentials from muscle fibers within the electrode's pickup area
B) The magnetic flux of the spinal cord
C) The kinetic energy of blood flow
D) Reflected infrared radiation from the skin

17. What is the relationship between the wavelength of non-ionizing radiation and its ability to penetrate human tissue?

A) Longer wavelengths generally provide deeper penetration
B) Shorter wavelengths are less attenuated by tissues
C) Wavelength has no effect on penetration
D) Higher frequency always equals deeper penetration

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18. Which human organ exhibits the strongest natural magnetic field, largely due to the alignment of ferromagnetic magnetite crystals?

A) The Liver

B) The Human Brain

C) The Heart

D) The Kidneys