Human Physiology in Aerospace Environments

Aerospace Engineering · Answer Key · 18 Questions

1. Which specific physiological adaptation occurs during the early phase of cephalad fluid shift in microgravity?

A) Increased production of erythropoietin
B) Decreased total blood volume via diuresis
C) Hypertrophy of the cardiac ventricles
D) Increased secretion of aldosterone

2. What is the primary mechanism of Space Adaptation Syndrome (SAS) as understood in vestibular neurophysiology?

A) Irritation of the semicircular canals by high G-loads
B) Mismatch between visual, proprioceptive, and vestibular inputs
C) Decompression of the endolymphatic sac
D) Degeneration of the otolith organs

3. Which bone density measurement technique is the gold standard for monitoring astronauts for spaceflight-induced osteopenia?

A) Quantitative Computed Tomography (QCT)
B) Single-photon absorptiometry
C) Dual-energy X-ray absorptiometry (DEXA)
D) Ultrasonic bone densitometry

4. What is the pathophysiological cause of Spaceflight Associated Neuro-ocular Syndrome (SANS)?

A) Direct radiation damage to the retina
B) Increased intracranial pressure altering optic nerve morphology
C) Hypobaric hypoxia in the orbital cavity
D) Retinal detachment due to rapid depressurization

5. During atmospheric reentry, which physiological effect is most dangerous to the pilot's cerebral perfusion?

A) G-induced Loss of Consciousness (G-LOC) due to blood pooling in the lower extremities
B) Hyperventilation causing respiratory acidosis
C) Increased intracranial pressure from high-G loads
D) Tachycardia induced by cabin vibration

6. What is the primary radiation-induced health risk associated with high-LET (Linear Energy Transfer) galactic cosmic radiation?

A) Short-term skin erythema
B) Acute onset of leukemia
C) Stochastic induction of solid cancers
D) Rapid onset of CNS neurosis

7. Which hormone secretion is significantly suppressed in astronauts during long-duration spaceflight, contributing to muscle atrophy?

A) Growth hormone
B) Thyroid-stimulating hormone
C) Cortisol
D) Adrenocorticotropic hormone

8. What is the clinical definition of the 'Armstrong Limit' regarding human physiological survival?

A) The altitude where cabin pressure is insufficient to prevent fire
B) The altitude where the boiling point of water equals human body temperature
C) The maximum G-force a human can sustain without internal hemorrhage
D) The minimum O2 partial pressure for alveolar gas exchange

9. What is the compensatory mechanism known as the 'baroreflex' role during the transition from microgravity to 1G?

A) Immediate vasoconstriction in the peripheral vasculature
B) Inhibition of the sympathetic nervous system
C) Increased secretion of antidiuretic hormone
D) Rapid upregulation of RBC production

10. Which ocular pathology is most frequently correlated with the chronic exposure to microgravity and fluid shifts?

A) Development of cataracts
B) Choroidal folds and optic disc edema
C) Macular degeneration
D) Secondary glaucoma

11. In the context of EVA suits, what is the 'pre-breathe' protocol designed to prevent?

A) Decompression sickness due to nitrogen bubble formation
B) Oxygen toxicity from high O2 concentration
C) Nitrogen narcosis
D) Carbon dioxide buildup in the helmet

12. What is the primary effect of long-term exposure to microgravity on the human cardiovascular system?

A) Increased myocardial mass
B) Cardiac atrophy and reduced stroke volume
C) Chronic hypertension
D) Coronary artery calcification

13. Which physiological system undergoes the most rapid decrement in mass during the first 14 days of microgravity exposure?

A) Cortical bone density
B) Skeletal muscle, particularly anti-gravity extensors
C) Visceral adipose tissue
D) Dermal collagen structure

14. What is the significance of the 'otolith organs' in human aerospace orientation?

A) Detecting angular acceleration of the head
B) Transducing linear acceleration and gravity
C) Maintaining equilibrium through chemical sensors
D) Regulating blood flow to the inner ear

15. Why does the heart rate variability (HRV) change during spaceflight?

A) Increased vagal tone from high altitude
B) Autonomic nervous system dysregulation in microgravity
C) Excessive consumption of electrolytes
D) Increased demand for oxygen by peripheral muscles

16. What is the primary physiological challenge of the 'head-down tilt' bed rest study used to simulate spaceflight?

A) Increased intracranial pressure and fluid redistribution
B) Chronic depletion of glycogen stores
C) Increased production of red blood cells
D) Reduced activity of the thyroid gland

17. Which mineral metabolism is most disrupted in astronauts, leading to an increased risk of renal calculi (kidney stones)?

A) Iron and Zinc
B) Calcium and Phosphate
C) Magnesium and Potassium
D) Sodium and Chloride

18. What is the impact of microgravity on the human immune system's T-cell response?

A) Hyper-activation of T-cell pathways

B) Suppression of T-cell activation and proliferation

C) Increased production of cytokines

D) Reduction in white blood cell mortality