6.9 Biological Rhythms: Circadian, Infradian and Ultradian

AQA 7182 · about 60 minutes · Write-in edition

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions.

1 Define a circadian rhythm and give one example relevant to human behaviour, as studied in biological rhythms.

(Total for Question 1 is 1 mark)

2 Define an infradian rhythm in the context of human biology and give one example with its typical timescale.

(Total for Question 2 is 3 marks)

3 Define an ultradian rhythm and give one human example identified using sleep-stage research.

(Total for Question 3 is 2 marks)

4 A nurse works permanent night shifts and reports persistent sleepiness during the night shift and difficulty sleeping during the day. Identify two negative consequences of chronic night shift work on health or performance and briefly explain each consequence in terms of circadian disruption.

(Total for Question 4 is 4 marks)

5 Outline Siffre's cave study of circadian rhythms (context: isolation from natural light) and one key finding from that study.

(Total for Question 5 is 2 marks)

6 Outline Folkard et al.'s research into shift work and circadian disruption and one practical implication for workplaces.

(Total for Question 6 is 3 marks)

7 Outline Dement and Kleitman's (1957) study of sleep stages and one key finding about REM sleep as an ultradian rhythm. Include the method context and the conclusion about REM periodicity.

(Total for Question 7 is 3 marks)

8 Explain briefly how the suprachiasmatic nucleus (SCN) acts as an endogenous pacemaker in the sleep-wake cycle.

(Total for Question 8 is 2 marks)

9 Outline the role of melatonin, produced by the pineal gland, in the regulation of the sleep-wake cycle and one way light influences its secretion.

(Total for Question 9 is 3 marks)

10 A business executive travels from London to Sydney, crossing multiple time zones, and experiences difficulty sleeping at the destination for several days. Explain how both endogenous pacemakers and exogenous zeitgebers contribute to jet lag in this scenario, and suggest one practical strategy to reduce jet lag.

(Total for Question 10 is 4 marks)

11 Outline one strength and one limitation of using isolated cave studies, such as Siffre's, to investigate endogenous pacemakers in humans. Relate each point to the study context.

(Total for Question 11 is 4 marks)

12 Discuss the role of endogenous pacemakers and exogenous zeitgebers in the control of the human sleep-wake cycle. In your answer, refer to relevant research evidence and consider strengths and limitations of the evidence.

(Total for Question 12 is 12 marks)

13 Explain how exogenous zeitgebers such as light and social cues can entrain the sleep-wake cycle, giving one specific example of each type of cue.

(Total for Question 13 is 3 marks)

Mark scheme · 6.9 Biological Rhythms: Circadian, Infradian and Ultradian

Question 1

A circadian rhythm is a biological cycle of roughly 24 hours; example, the sleep-wake cycle or core body temperature cycle oe — **B1**

Answer: A circadian rhythm is a biological cycle of about 24 hours; example: the human sleep-wake cycle.

Question 2

defines infradian rhythm as a biological cycle longer than 24 hours oe — **M1**

gives an example, e.g. the human menstrual cycle, with a typical timescale of about 28 days oe — **A1**

alternative example allowed, e.g. seasonal affective disorder showing seasonal (annual) variation oe — **A1**

Answer: An infradian rhythm is a biological cycle longer than 24 hours; example: the menstrual cycle, typically about 28 days (or seasonal affective disorder with annual seasonal variation).

Question 3

ultradian rhythm: a biological cycle shorter than 24 hours oe — **B1**

example: roughly 90-minute cycles of REM and non-REM stages during sleep, as shown by sleep-stage research such as Dement and Kleitman oe — **B1**

Answer: An ultradian rhythm is a biological cycle shorter than 24 hours; example: the roughly 90-minute cycle of REM and non-REM sleep stages.

Question 4

identifies a consequence such as increased risk of accidents or reduced alertness during night shifts oe — **M1**

explains this in terms of circadian misalignment, e.g. being awake when the body is biologically primed for sleep reduces alertness and increases error risk oe — **A1**

identifies a second consequence such as long-term health risks, e.g. increased risk of cardiovascular problems or impaired metabolic regulation oe — **M1**

explains that chronic disruption of circadian rhythms can affect hormone timing, sleep quality and metabolic processes, increasing long-term health risk oe — **A1**

Answer: Consequences: (1) Increased risk of accidents and reduced night-time alertness because the nurse is active when the circadian drive for sleep is strong, impairing performance. (2) Long-term health risks, such as higher risk of cardiovascular and metabolic problems, because chronic circadian disruption alters hormone timing and sleep quality.

Question 5

describes Siffre spending extended periods in underground caves isolated from external light cues oe — **M1**

reports a key finding, e.g. Siffre's free-running sleep-wake cycle lengthened to about 25 to 30 hours, showing endogenous control oe — **A1**

Answer: Siffre lived in caves isolated from daylight for extended periods; his free-running sleep-wake cycle lengthened to about 25 to 30 hours, indicating internal pacemakers operate without light cues.

Question 6

outlines Folkard et al.'s focus on how rotating shift patterns disrupt normal circadian rhythms and affect sleep and performance oe — **M1**

identifies a finding such as increased fatigue and reduced alertness among night-shift workers, leading to higher error rates oe — **A1**

gives a practical implication, e.g. suggesting that employers minimise quick rotations, schedule regular rest breaks, or provide controlled light exposure to reduce risk oe — **A1**

Answer: Folkard et al. studied how rotating shift work disrupts circadian rhythms, finding increased fatigue and reduced alertness on night shifts. Practical implication: employers should avoid rapid shift rotations and allow appropriate rest breaks or controlled light exposure to reduce errors.

Question 7

outlines that Dement and Kleitman used EEG, monitored eye movements and woke participants to report dreams, to study REM and non-REM sleep stages oe — **M1**

states a key finding: REM sleep tended to occur in roughly 90-minute cycles across the night, supporting the idea of an ultradian rhythm oe — **A1**

notes that participants' reports linked REM periods with vivid dreaming, supporting the behavioural significance of the REM stage oe — **A1**

Answer: Dement and Kleitman monitored EEG and eye movements and woke participants to obtain dream reports. They found REM recurred in approximately 90-minute cycles and REM periods were associated with vivid dreaming, supporting REM as part of an ultradian rhythm.

Question 8

identifies SCN in the hypothalamus as the primary endogenous pacemaker controlling circadian rhythms oe — **B1**

explains that the SCN receives light information from the retina and sends timing signals to regulate sleep-wake patterns and other rhythms oe — **B1**

Answer: The SCN, in the hypothalamus, functions as the main endogenous pacemaker for circadian rhythms; it receives light information from the retina and coordinates timing signals that regulate the sleep-wake cycle and related physiological rhythms.

Question 9

states that the pineal gland secretes melatonin and that melatonin promotes sleepiness/helps initiate sleep oe — **M1**

explains that melatonin secretion increases in darkness and decreases in response to light, so light exposure suppresses melatonin production oe — **A1**

links the mechanism to the SCN or retinal input as the route by which light controls melatonin timing oe — **A1**

Answer: The pineal gland secretes melatonin, which promotes sleepiness; melatonin secretion rises in darkness and is suppressed by light exposure, with light information reaching the gland via the SCN and retinal pathways.

Question 10

explains that the executive's endogenous pacemaker (SCN and melatonin rhythm) is still aligned to the original time zone, causing desynchrony with the new local time oe **M1**

explains that exogenous zeitgebers such as the new light-dark cycle and social schedule at the destination gradually shift the circadian rhythm, but this can take several days oe **A1**

suggests a practical strategy, e.g. timed bright-light exposure at the destination or taking melatonin at the appropriate local evening to accelerate re-entrainment oe **A1**

explains why the strategy helps, e.g. light suppresses melatonin and shifts the SCN, so timed exposure advances or delays the rhythm to match local time oe **A1**

Answer: Jet lag occurs because the executive's SCN-driven circadian rhythm and melatonin timing remain set to London time, while local light-dark cycles and social schedules in Sydney are different; the mismatch causes sleep disturbance until exogenous zeitgebers reset the clock. Practical strategy: use timed bright-light exposure or take melatonin in the local evening to shift the rhythm, because light and melatonin influence the SCN and speed re-entrainment.

Question 11

strength: identifies a strength such as the ability to observe free-running rhythms without external zeitgebers oe **M1**

explains why this matters in context, e.g. removing light and social cues allows researchers to infer the role of endogenous pacemakers directly oe **A1**

limitation: identifies a limitation such as small, unrepresentative samples and artificial conditions oe **M1**

explains why this matters in context, e.g. a single volunteer in a long cave residency may not generalise to wider populations and results may be influenced by the unusual setting oe **A1**

Answer: Strength: cave studies allow observation of free-running rhythms without external zeitgebers, so endogenous pacemaker effects can be isolated. Limitation: such studies use small, unusual samples and artificial conditions, limiting generalisability and possibly introducing effects specific to the extreme setting.

Question 12

Level 4 Knowledge of endogenous pacemakers and exogenous zeitgebers is accurate and detailed. Discussion is thorough and well balanced, integrating relevant research evidence and considering strengths and limitations. The answer shows clear evaluation of the relative contribution of internal and external mechanisms and is well structured using appropriate terminology. **10-12**

Level 3 Knowledge is generally accurate with some detail. Discussion includes relevant evidence and some evaluation, but may be less thorough or slightly unbalanced. Points are mostly linked and the answer is generally clear with appropriate terminology. **7-9**

Level 2 Knowledge is partial or simplistic. Discussion includes some evidence but evaluation is limited or descriptive. Reasoning about the relative roles of pacemakers and zeitgebers may be unclear or underdeveloped. Structure and terminology may be inconsistent. **4-6**

Level 1 Limited knowledge with little relevant evidence. Discussion is brief, largely descriptive, or confused. Evaluation is minimal or absent and specialist terminology is largely missing. **1-3**

Level 0 No creditable content. **0**

Indicative content:

- AO1: Endogenous pacemakers include the SCN in the hypothalamus which generates circadian rhythms and regulates timing signals including sleep-wake cycles; the pineal gland secretes melatonin downstream of the SCN to promote sleep.
- AO1: Exogenous zeitgebers are external cues such as light, social schedules and meal times that entrain the internal clock, with light acting via retinal input to the SCN to adjust timing.
- AO1: Key studies: Siffre's cave studies show free-running rhythms lengthening without light cues, supporting endogenous control; Dement and Kleitman show ultradian REM cycles identified via sleep monitoring; shift-work research such as Folkard's indicates that external schedules can disrupt rhythms and impair performance.
- AO3: Strength of endogenous-pacemaker evidence is that isolation studies provide strong causal evidence the human body has an internal clock that can run without external cues, allowing inference about SCN function.
- AO3: Limitation of isolation studies is small, unrepresentative samples and artificial settings, reducing generalisability and possibly introducing confounding factors like stress, which matters because the degree and period of free-running rhythms vary between individuals.
- AO3: Strength of zeitgeber evidence is applied and practical: light therapy and timed schedules can shift rhythms and treat problems like jet lag or seasonal affective disorder, showing external cues have real-world effects.
- AO3: Challenge and interaction: evidence shows endogenous and exogenous mechanisms interact; for example, the SCN is endogenous but depends on light for entrainment, and some studies show social cues can entrain rhythms when light cues are limited, so neither explanation alone fully accounts for real-world timing.
- AO3: Methodological issues include reliance on correlational field studies for some zeitgeber effects, and difficulty in isolating single zeitgebers in natural settings, which limits causal claims about specific external cues.
- AO3: Conclude by weighing evidence: both endogenous pacemakers and exogenous zeitgebers are essential, with pacemakers generating rhythms and zeitgebers synchronising them; evaluation should note the interactive and context-dependent nature of control and limits of existing evidence.

Question 13

explains that exogenous zeitgebers are external cues that synchronise internal biological clocks to the environment oe	**M1**
gives a specific light example, e.g. natural daylight or timed bright-light exposure shifting sleep timing/entraining the SCN oe	**A1**
gives a specific social cue example, e.g. meal times or work schedules acting as social zeitgebers that influence sleep-wake timing oe	**A1**

Answer: Exogenous zeitgebers are external cues that synchronise internal clocks. Light, such as daytime sunlight or controlled bright-light therapy, entrains the SCN and shifts sleep timing. Social cues, such as regular meal times or imposed work schedules, act as social zeitgebers that help set sleep-wake timing.