26. Biological Clocks (page 34)

1. (a) In the hypothalamus
   (b) Light and dark.

2. (a) and (b) any two of:
   - Predicting and preparing for important events in the environment, such as hibernation in anticipation of a predictable reduction in food over winter. The adaptive value is in ensuring survival over a period that may be physiologically challenging.
   - Synchronising events such as migration or reproduction with others of the same species. The adaptive value is in ensuring all members of a population are doing the same thing at once in terms of their strategy for mating, reaching breeding or overwintering grounds (maximising survival and reproduction).
   - Synchronising circadian and annual rhythms to maximise their effectiveness, e.g. basking in the morning in reptiles to raise body temperature for activity.
   - Time compensation in navigation and orientation in animals that need to navigate efficiently between home and sources of food. The adaptive value is in conserving energy and improved survival of individuals and the group.
   - Biological clocks also help to regulate internal rhythms such as hormone levels and sleep-wake cycles. These are adaptive because they ensure the animal remains in synch with its environment and physiological changes and behaviours occur at an appropriate time.

27. Biological Clocks and the Environment (page 35)

1. (a) A zeitgeber resets the internal biological clock.
   (b) A common zeitgeber is the light-dark cycle.

2. (a) Entrainment is the process of resetting the internal clock to the environmental cue, such as the light-dark cycle.
   (b) Entrainment enables the organism to stay in synch with the environmental changes that are important to its survival, e.g. times of feeding/foraging and sleeping during the light-dark cycle. It prevents behaviours drifting away from the time that they should occur.

3. (a) Person A
   (b) Person A has travelled a greater distance east in the same time so their biological clock will be more out-of-synch with the environmental cues.

28. Biological Rhythms (page 36)

1. (a) The endogenous component of a biological rhythm resides within the animal itself (its internal biological clock) and will continue in the absence of external cues. The exogenous component of the rhythm is the environmental cue that synchronises the rhythm, e.g. the light-dark cycle.
   (b) The internal biological clock (the endogenous component of the rhythm) maintains the basic rhythm of activity, but the exogenous component (the environmental cue or zeitgeber) entrains that rhythm so that the endogenous rhythm does not drift from the environmental rhythm (e.g. light-dark cycle) that it approximates.

2. Note: Alternatives to each term, e.g. circadian (daily) have been added to the table. Many examples are possible.
   (a) **Circadian**: Rhythm approximates the cycle of a solar day (period = 24 h).
   Example: Weta are nocturnal and forage at night, when they are less vulnerable to predators.
   (b) **Circatidal**: Rhythm approximates the cycle of a tidal cycle (period = 12.35 hours).
   Example: Tunnelling mud crab becomes active at low tide, when it moves around and feeds, sifting through the mud for food. Low tide exposes enables it to sort through the bacteria and diatoms in the sand without these being washed away (returns to burrow to wet its gills). Note some other intertidal crabs, such as the common rock crab are more active when the tide is in.
   (c) **Circalunar**: Rhythm approximates the cycle of a lunar month (period = 29.5 days).
   Example: Inanga spawn during spring tides at full and new moons. During these spring tides they can lay their eggs up high on the riverbank where they will be protected from predators.
   (d) **Circannual**: Rhythm approximates the cycle of a solar year (period = 365.25 days).
   Example: NZ long-tailed bats hibernate for 4-5 months of the year during autumn and winter. This has a survival advantage because food is scarce during these periods.

3. (a) Drop in earth temperature.
   (b) Sunrise and sunset (the light: dark cycle).
   (c) Sunrise and sunset (the light: dark cycle).
   (d) Change in day length.

4. A scientist could remove the animal to an area in which there was an absence of exogenous cues, e.g. constant dark, and record the animal's activity over an extended period, e.g. 7 days. If the rhythm continued (even with a drift) it would show if there was an endogenous component to the rhythm. It it disappeared, the rhythm would be entirely exogenous (rare).

29. Circadian Rhythms in NZ Birds (page 38)

1. (a) Diurnal (b) Nocturnal (c) Crepuscular

2. Kokako displays a daily rhythm with a diurnal habit.

3. Kiwi displays a daily rhythm with a nocturnal habit.

4. The method of exploiting the chosen food resource seems a major factor. Kokako feed on insects, berries, and leaves. Being able to see would play an important role in locating and identifying these.

5. (a) Feeding at night allows the kiwi to exploit a food source which is not available to diurnal birds (competition for food resources is reduced).
   (b) A keen sense of smell and hearing allows them to find food in the dark.

30. Human Biological Rhythms (page 39)

1. (a) White blood cell count:
   Daily: 10-11 pm
   Monthly: At the end of the menstrual cycle
   Annually: May/June
   (b) Body temperature:
   Daily: 5-6 pm
   Monthly: Last quarter of menstrual cycle
   Annually: December

2. More natural deaths occur between midnight and noon, when body temperature is lower. Fewer deaths occur at the time of greatest body temperature.

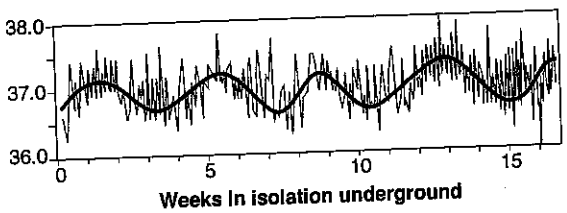
3. (a) 1-2 pm
   (b) Peak brain activity and memory responses occur at this time.

4. (a) 5 pm
   (b) Insulin causes cellular uptake of glucose from the blood into the cells. The main meal for the day is eaten in the early evening. Insulin peaks then so that the glucose released into the blood after eating can be utilised.

5. After midnight (worst during the morning).

6. Beard growth peaks during the coldest time of the year.

7. (a) Daily fluctuations in body temperature.
   (b) Line of best fit:



   (c) Menstrual cycle (monthly rhythm).
   (d) To exclude as many environmental cues as possible (e.g. day night cycle) so that she would not reset her biological rhythms.

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