BIOPSYCHOLOGY

Biological Rhythms: Circadian

www.alevelpsychologytutor.co.uk

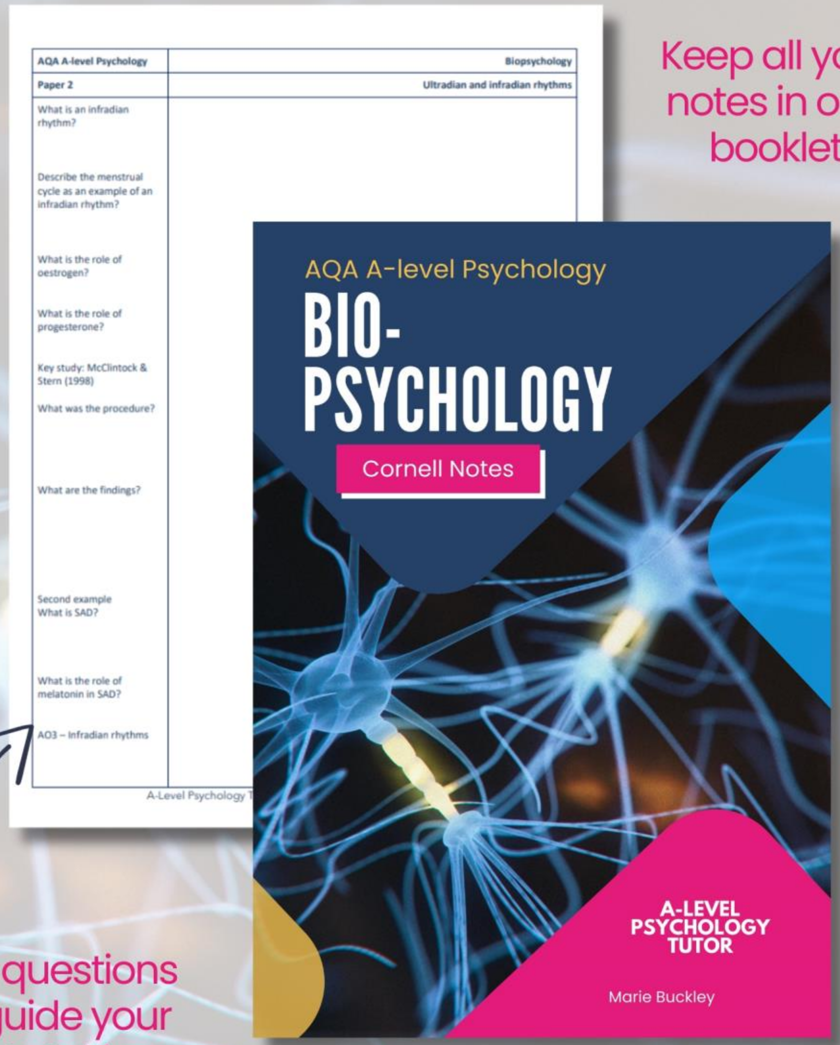
A-LEVEL PSYCHOLOGY TUTOR

Download the free Cornell Notes templates to take highly effective notes with this PowerPoint

www.alevelpsychologytutor.co.uk/shop

Biological Rhythms: Circadian

AO1 and AO3 kept separately to help structure your learning



Keep all your notes in one booklet

Key questions to guide your note taking

A-LEVEL PSYCHOLOGY TUTOR

4.2.2 Biopsychology

- The divisions of the nervous system: central and peripheral (somatic and autonomic).
- The structure and function of sensory, relay and motor neurons. The process of synaptic transmission, including reference to neurotransmitters, excitation and inhibition.
- The function of the endocrine system: glands and hormones.
- The fight or flight response including the role of adrenaline.
- Localisation of function in the brain and hemispheric lateralisation: motor, somatosensory, visual, auditory and language centres; Broca's and Wernicke's areas, split brain research. Plasticity and functional recovery of the brain after trauma.
- Ways of studying the brain: scanning techniques, including functional magnetic resonance imaging (fMRI); electroencephalogram (EEGs) and event-related potentials (ERPs); post-mortem examinations.
- Biological rhythms: circadian, infradian and ultradian and the difference between these rhythms. The effect of endogenous pacemakers and exogenous zeitgebers on the sleep/wake cycle.

What do they *all mean?*

Biological rhythms: cyclical patterns within biological systems

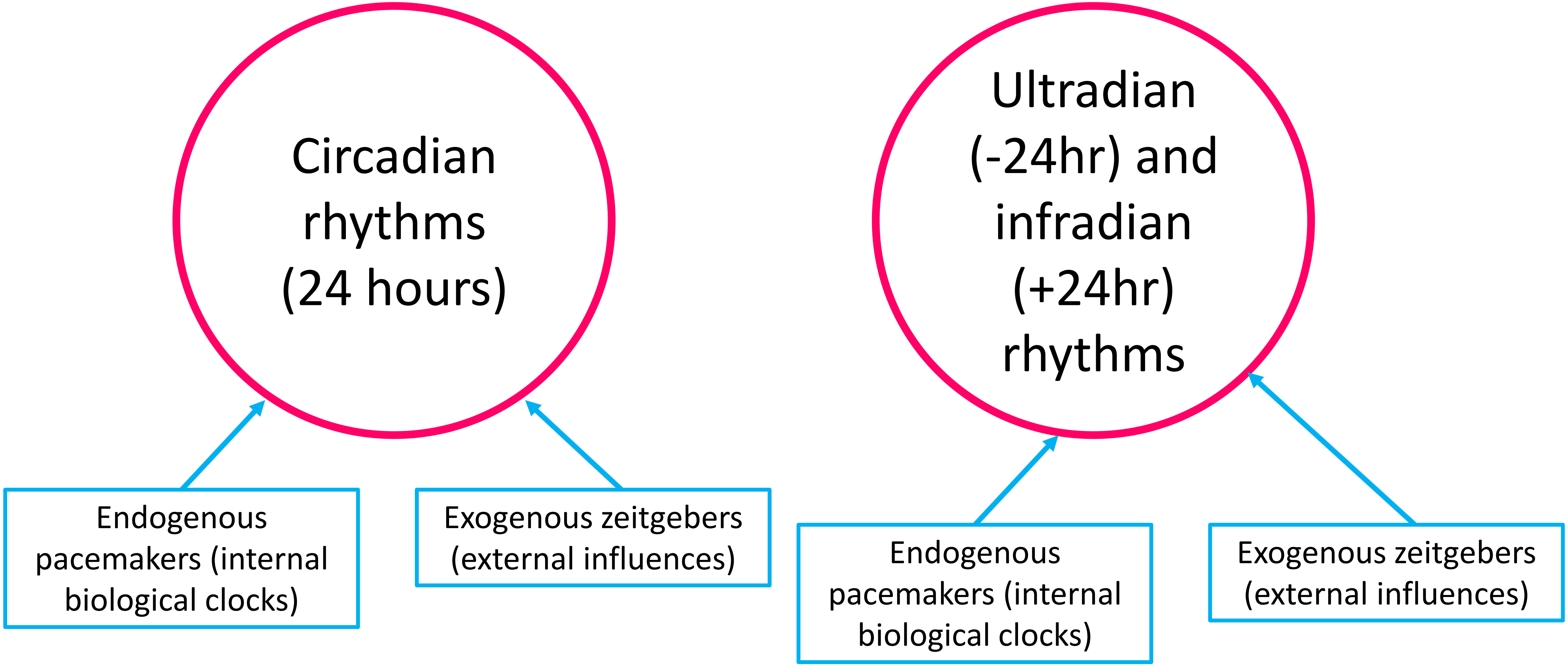
Circadian rhythms: Circa = around / Dian = day e.g. sleep wake cycle

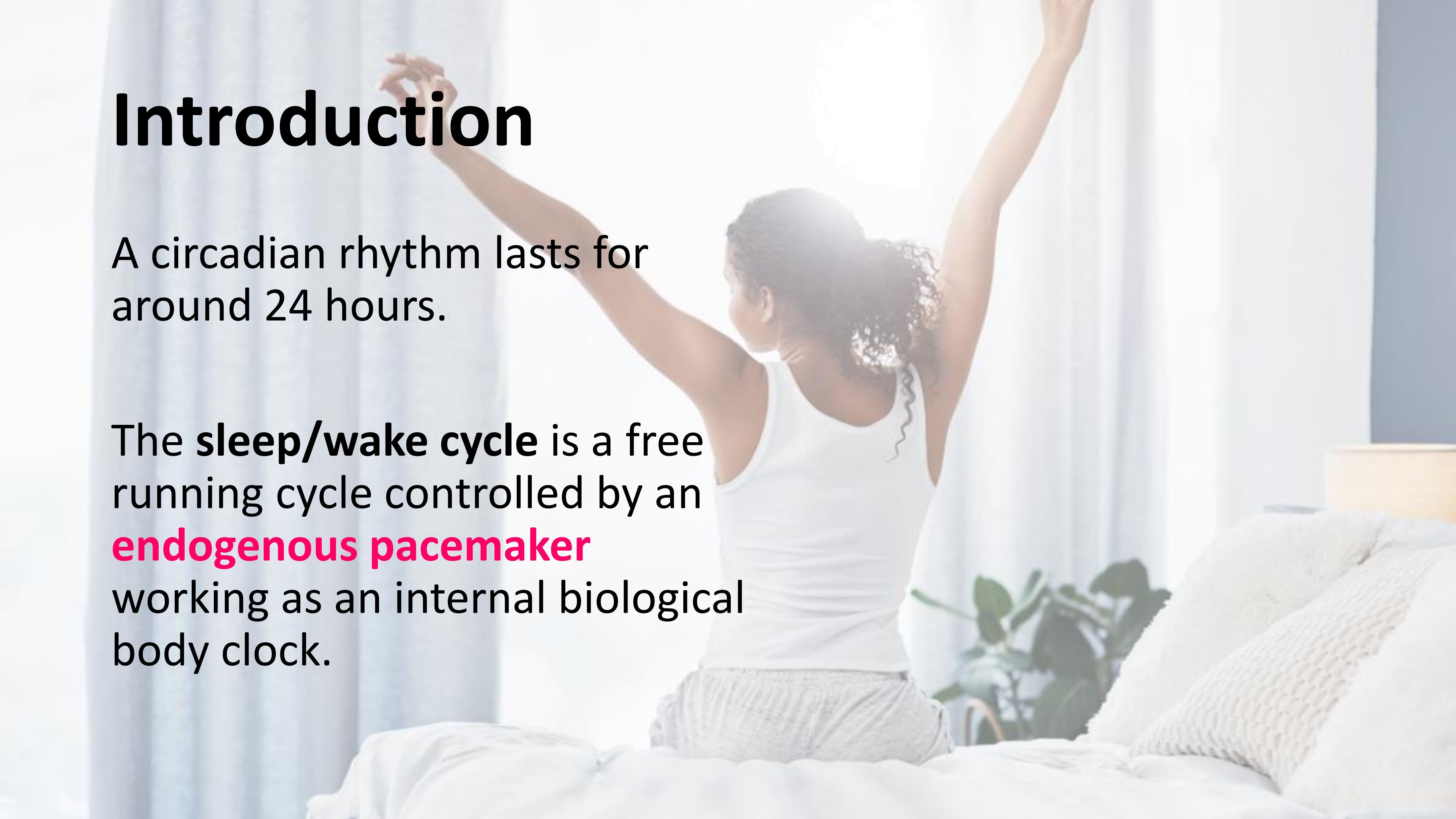
Infradian rhythms: Lasts longer than one day e.g. menstrual cycle

Ultradian rhythms: You have more than one day e.g. REM sleep

Endogenous pacemakers: Internal mechanisms that govern biological rhythms e.g. pineal gland

Exogenous zeitgebers: External mechanisms that govern biological rhythms e.g. light/ dark


Circadian rhythms (24 hours)
Endogenous pacemakers (internal biological clocks)
Exogenous zeitgebers (external influences)
Ultradian (-24hr) and infradian (+24hr) rhythms
Endogenous pacemakers (internal biological clocks)
Exogenous zeitgebers (external influences)



Introduction

A circadian rhythm lasts for around 24 hours.

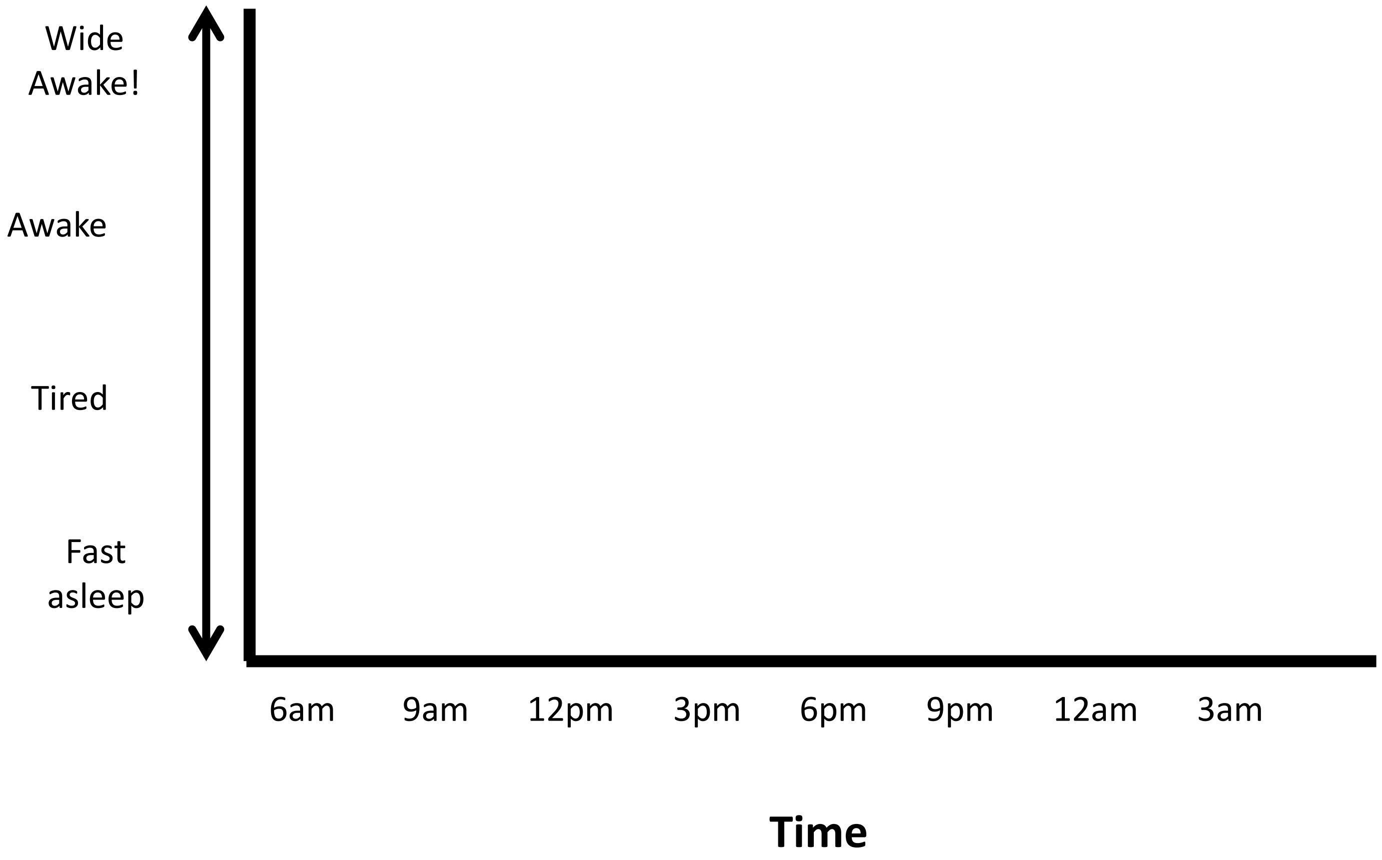
The **sleep/wake cycle** is a free running cycle controlled by an **endogenous pacemaker** working as an internal biological body clock.

The sleep/wake cycle is **entrained** by **exogenous zeitgebers** (external influences) e.g. light

Entraining is the process of making something have the same pattern or rhythm as something else.

It is likely that humans (and other species) have evolved to have a 24 hour clock due to the earth taking 24 hours to rotate on its axis.

What is your pattern of sleep/wake?



What do you think would happen to our sleep/wake cycle if there was no daylight?

If we had no idea whether it was day or night would we still fall asleep and wake up at regular times?

Sleep-wake *cycle*

The **suprachiasmatic nucleus (SCN)** is a tiny bundle of nerve cells that is a major **endogenous pacemaker** in mammals that controls the sleep wake cycle (‘master clock’). The SCN is in the **hypothalamus** where the optic nerves from the eye cross over.

The SCN gets stimulated by light that penetrates the closed eye lids which then regulates the sleep wake cycle. Light is therefore an important **exogenous zeitgeber** in the sleep/wake cycle.

What does the SCN do?

The **SCN passes the information** on to the **pineal gland.**

During the night (when it is dark) the **pineal gland** increases the production of **melatonin** which induces sleep.

Sunlight in the morning stops the production of **melatonin.** This increases the production of **cortisol** which increases wakefulness.

SCN

↓

Sends messages to pineal gland

↓

Dark - night = increases melatonin

↓

Induces sleep

Sleep-wake cyle & homeostasis

Sleeping and wakefulness are also determined by **homoeostasis** which is the maintenance of constant internal environment.

When an individual has been **awake for a long time**, homeostasis tells the body that there is a **need for sleep** because of energy consumption.

This **homeostatic drive** for sleep increases throughout the day, reaching its maximum in the late evening, when most people fall asleep.

Another *example*

Body temperature is another example of a circadian rhythm.

Lowest (36°C) at 4:30am

Highest (38°C) at 6pm

Temperature also drops slightly between 2pm and 4pm which explains why many people feel sleepy in the early afternoon

When body temperature **begins to drop, sleep occurs**.

When body temperature **starts to rise** during the last few hours of sleep it promotes a **feeling of alertness** in the morning.

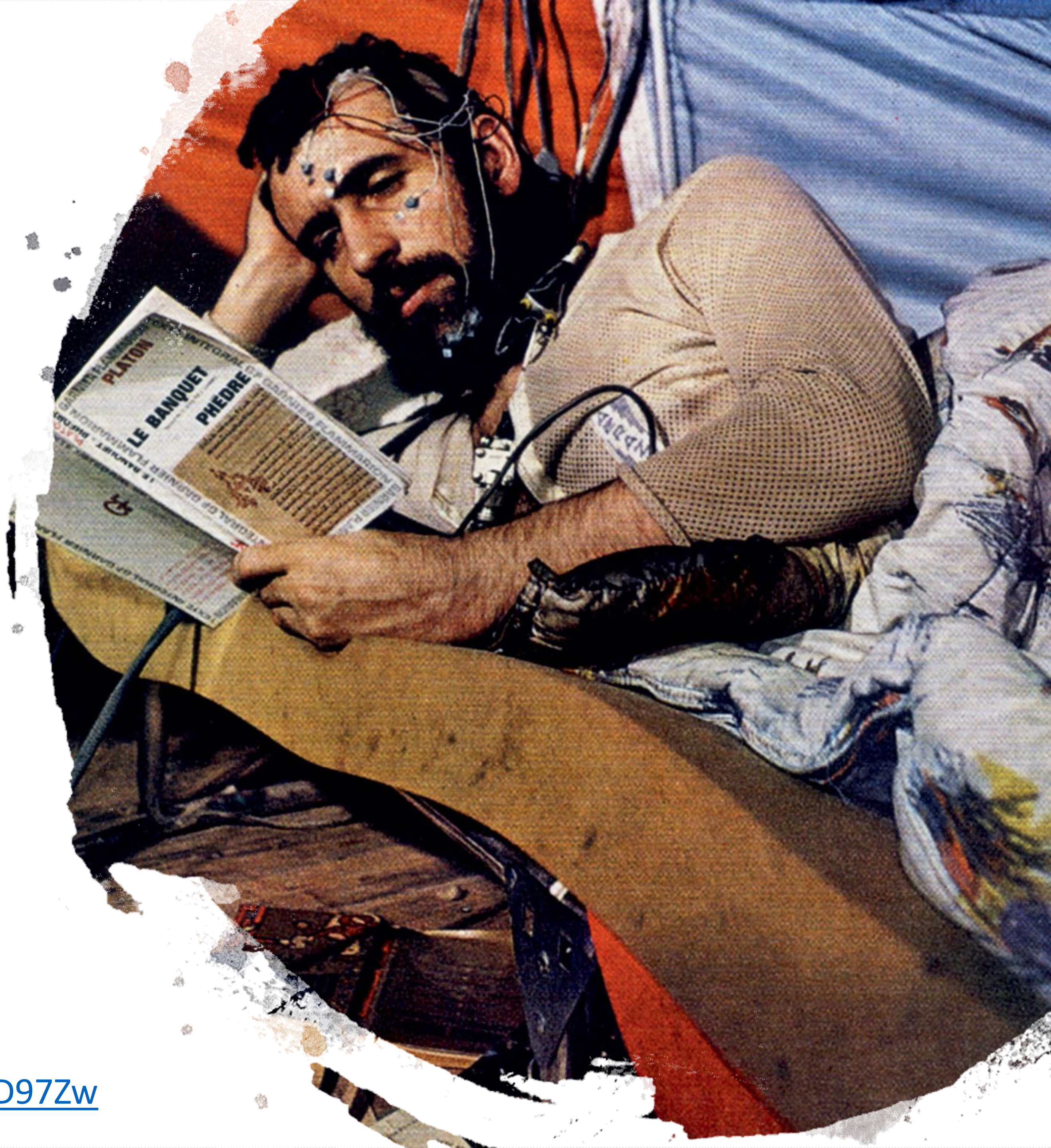
The Cave Study

Siffre spent 6 months in a cave deprived of natural light and sound, but with food and water. He wanted to investigate the effect of no environmental cues on his biological rhythms which is known as 'free-running' cycles.

Siffre (1975) found that the **absence of external cues** altered his circadian rhythm. When he returned from the underground stay, he believed the date to be a month earlier than it was because his sleep wake cycle had increased to around 25 hours.

This suggests that his sleep-wake cycle lengthened by the lack of exogenous zeitgebers. Although he did still have a regular biological rhythm.

Conclusion: Circadian rhythms are mainly controlled by EP’s rather than EZ’s – **but** EZs do have a significant influence.



https://www.youtube.com/watch?v=3fxshED97Zw

Other *research*

Siffre's cave study has been subject to criticism (he was the researcher and only participant and he took a lamp down with him). So, what have other researchers found…?

Aschoff and Wever (1976) convinced ppts to spend 4 weeks in WWII bunker deprived of light. All but 1 ppt displayed a circadian rhythm of 24-25 hours. The other extended to 29 hours. What does this suggest?

Folkard conducted a study of circadian rhythms similar to Siffre, in a cave. This time, they had a clock to enforce strict bed and waking times. What ppts did not know was researchers sped up the clock so their days were only 22 hours instead of 24. **Only 1 ppt was able to comfortably adjust to the new regime.** What does this suggest?

Summary

There is a **strong natural circadian rhythm** which is slightly longer than 24 hours but it can be *influenced* by exogenous zeitgebers such as meal times, social cues, daylight etc.

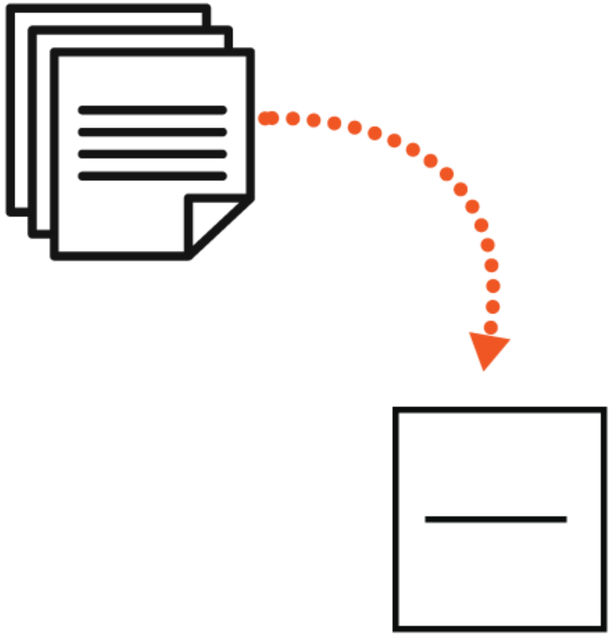
Desynchronisation

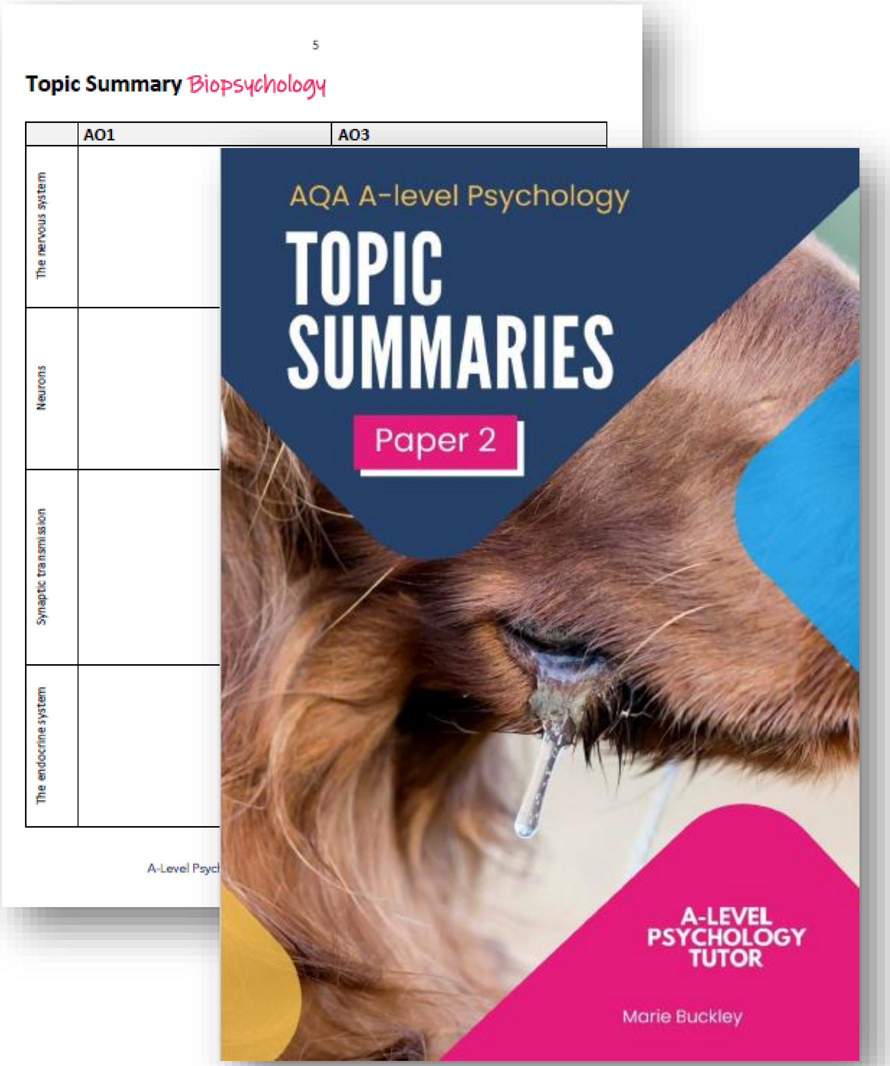
Jet lag is caused by traveling across several time zones within several hours. The internal **clock** (SCN) is not synchronised with the daytime-night time **rhythm** at the place of arrival. **Jet lag** can cause insomnia, fatigue, irritability, and poor concentration.

Shiftwork also causes **desynchronisation** in **circadian rhythm** which in turn leads to negative health effects.

Topic Summary

Complete the key terms in the AO1





AO3 Methodological issues

A limitation of Siffre's cave study into the sleep wake cycle is the **methodological issues** presented in the study.

There was a lack of control as Siffre used an artificial light when in the cave. This could have confounded the results as other research has shown circadian rhythms can be adjusted as a result of dim lighting. Also, he was also the researcher and the only ppt which means experimenter bias could have been present.

Both of these factors reduce the **internal validity** meaning it is hard to establish cause-and-effect.

Despite this other research has found similar results to Siffre demonstrating the results have good reliability, although direct replication was not possible due to lack of controls.

Mutant hamsters

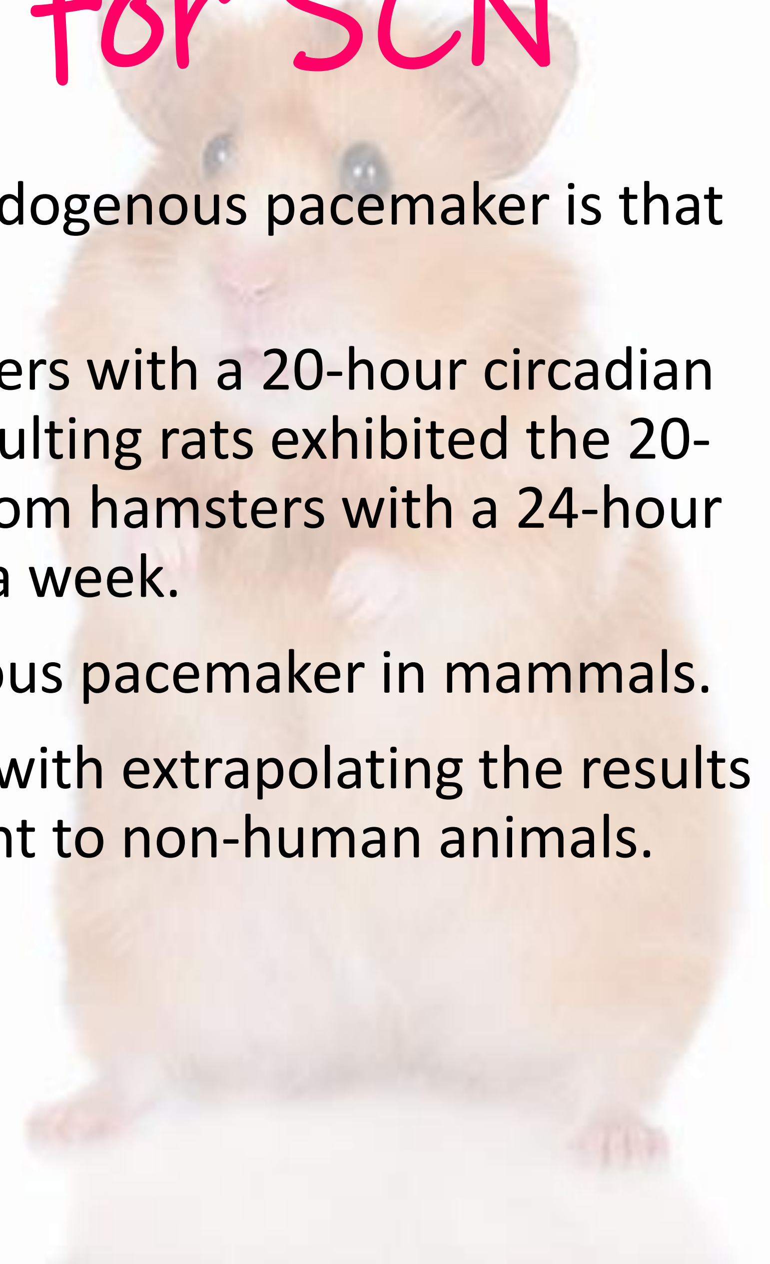
Mutant hamster with a
20-hour circadian cycle

Hamster with a regular
24-hour circadian cycle

The importance of the **SCN** as an **endogenous pacemaker** has been identified in animal studies.

What is the issue with animal research?

AO3 *Animal evidence for SCN*



A strength of the theory that the SCN is the main endogenous pacemaker is that there is supportive evidence in animal studies.

Ralph (1990) transplanted the SCN cells from hamsters with a 20-hour circadian cycle into rat foetuses with regular rhythms. The resulting rats exhibited the 20-hour cycle. When the rats then received SCN cells from hamsters with a 24-hour cycle, they transitioned to the 24-hour cycle within a week.

This shows how powerful the SCN is as an endogenous pacemaker in mammals.

However, as it was an animal study there are issues with extrapolating the results to humans as human brains are qualitatively different to non-human animals.

AO3 Individual differences

A limitation of the explanation of circadian rhythms is that it does not take account of **individual differences.**

Duffy et al. (2001) found that ‘morning people’ prefer to rise and go to bed early (about 6 am and 10 pm) whereas ‘evening people’ prefer to wake and go to bed later (about 10 am and 1 am).

This demonstrates that there may be **innate individual differences** in circadian rhythms.

This suggesting that researchers should focus on these differences during investigations and not purely take a **nomothetic approach** when studying sleep-wake cycles.

AO3 Application to real life

A **strength** of the research into circadian rhythms is that it has given society a better understanding of the negative effects that can occur as a result of disruption to the sleep-wake cycle for example.

Boivin *et al* (1996) studied the sleep/wake cycles of ppts who worked night shifts. It was found that there was a reduced period of concentration around 6 in the morning (a circadian trough) meaning mistakes and accidents are more likely.

Such research has **practical applications** for health and safety policies in the workplace as well as economic implications in terms of how best to manage worker productivity.

Therefore, research into circadian rhythms strengthens our understanding of the implications of the sleep-wake cycle.

AO3 Role of temperature

A limitation of the theory that light is the main exogenous zeitgeber for the sleep-wake cycle is that temperature may be more important in determining circadian rhythms.

Buhr et al. (2010) found that fluctuations in temperature set the timing of cells in the body and caused tissues and organs to become active or inactive. Buhr claimed that information about light levels is transformed into neural messages that set the body’s temperature.

Body temperature fluctuates on a 24-hour circadian rhythm and even small changes in it can send a powerful signal to our body clocks.

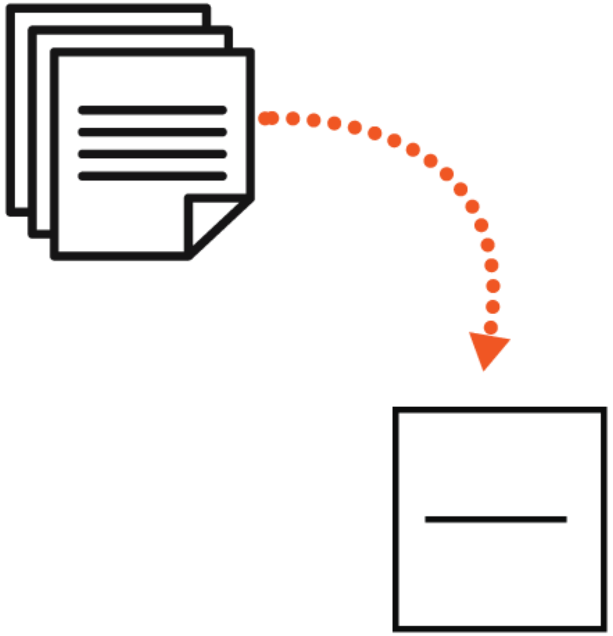
This shows that circadian rhythms are controlled and affected by several different factors and suggests that a more holistic approach to research might be preferable.

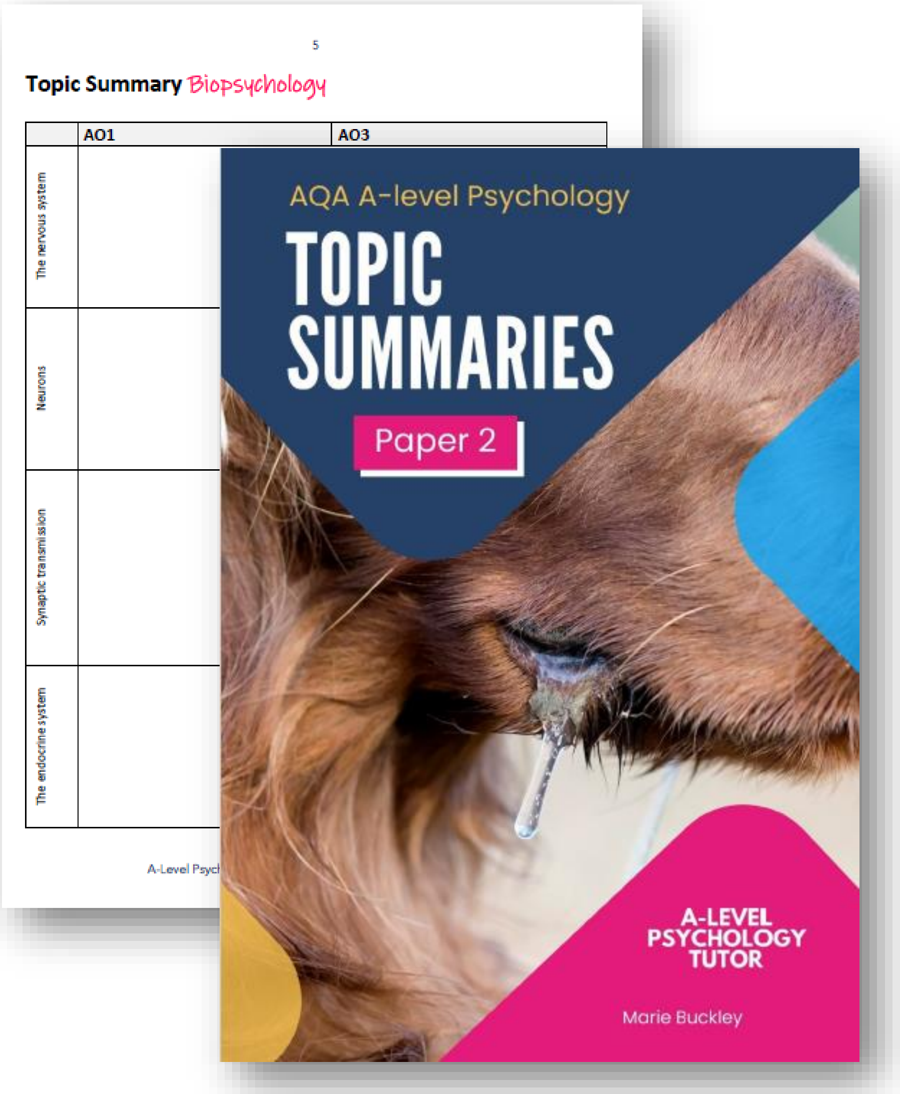
AO3 Importance of EPs

Another piece of evidence in support of the importance of EP is in the sleeping habits of Innuit Indians who live in the Arctic Circle. They inhabit an environment that has **hardly any darkness in summer and hardly any light in winter.** If the sleep-waking cycle was primarily controlled by EZs they would tend to sleep a huge amount in winter and hardly at all in summer. However, this is not the case - **they maintain a fairly regular pattern of sleeping and waking all year around.**

Topic Summary

Complete the key terms in the AO1

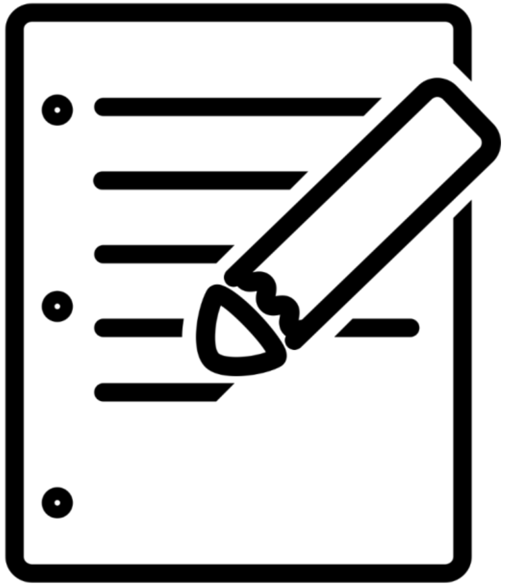




Complete the + and – in AO3

Essay Plan

Outline and evaluate circadian rhythms. (16 marks)



AO1

AO3

Complete the **AO1** using full sentences and the **AO3** using either full PEELs or as shortened flow diagrams.

Essay Planning booklet

Revision Notes

Create a revision summary of this topic onto **one side of A4** or you may choose to make flash cards instead.

Why do we sleep? Beyond the spec

There is not one universally agreed theory but 3 main arguments:

- **Homeostasis** – it has a restorative function (but we do not conserve much more energy than being relaxed – about 100 cals!)
- **Adaptive** – keep us safe from predators when it is dangerous at night due to poor vision
- **Maintaining the brain and its plasticity** – appears to be important in memory consolidation and learning


GENES AFFECTING
Share
Add to list
Like
Recommend
Russell Foster | TEDGlobal 2013
Why do we sleep?
21:35

AQA A-level Psychology

OTHER RESOURCES

- Cornell Notes booklets
- Topic Summaries
- Essay Planning booklets
- A* Evaluation booklets
- Revision Activity booklets
- Revision Notes
- Doodle Notes
- Topic Essays

Designed to help you get the grade you deserve