
Australasian
Society of
Lifestyle
Medicine

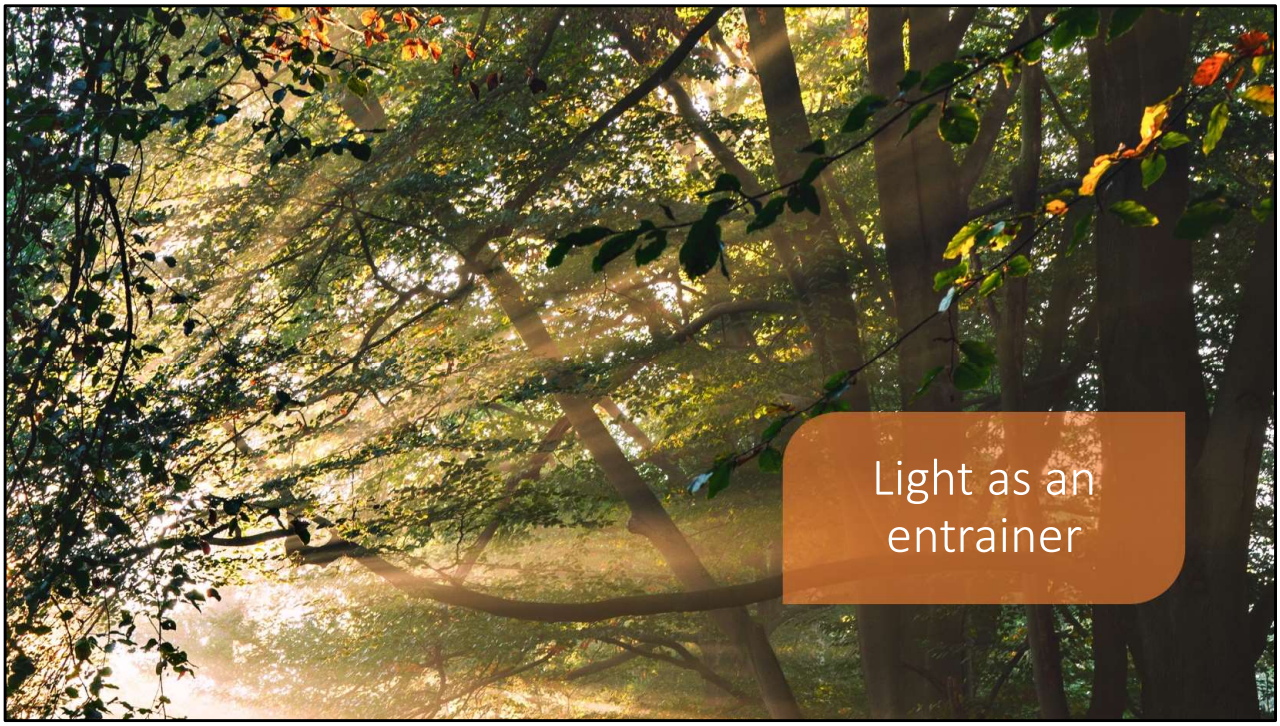
Sleep Physiology – Factors that influence sleep

Unit: 3.3.2

Presenter: Dr Jenny Brockis

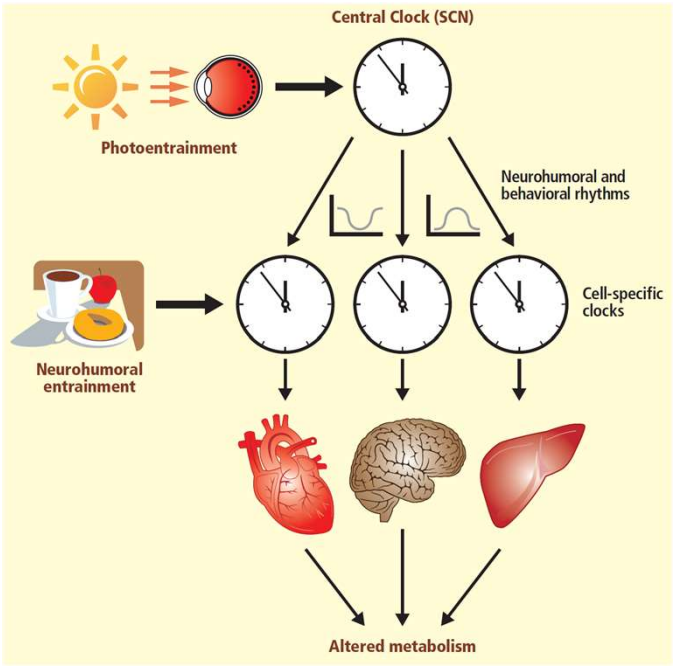
Version 1.0

The role of light exposure and hormonal factors on sleep



While the circadian rhythm is approximately 24 hours
In reality, it is usually a little bit more like 24 hours and 15 mins
There are various influencers or entrainers that influence or reset our circadian rhythm the principle one being light

One body, many clocks



(Adapted from Bray & Young, 2009; Spivey, 2010)

Increasing evidence links disruptions in the body's various circadian timekeepers to obesity and malfunctions in metabolism. It's generally accepted that light exposure can reset the main clock in the suprachiasmatic nucleus of the brain, and that cues from the main clock as well as from eating and activity can reset peripheral clocks that operate in almost all the body's cells.

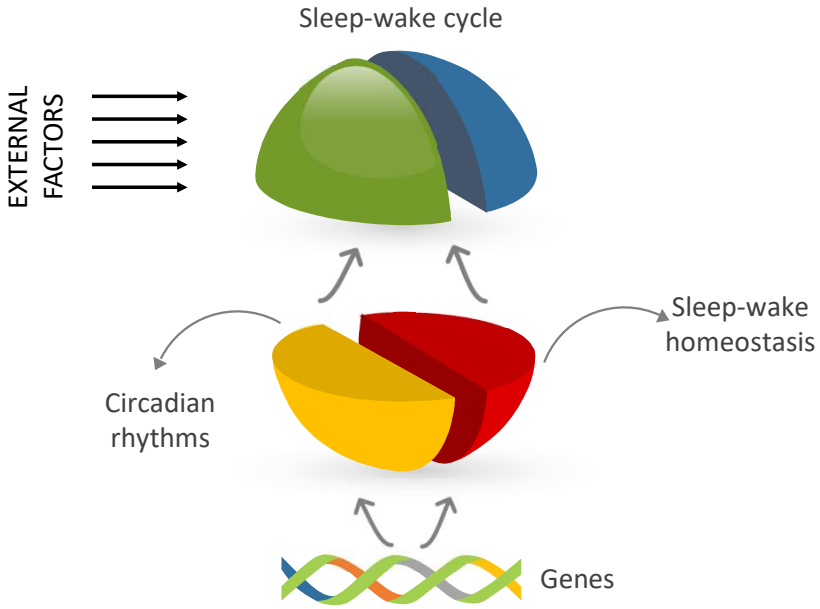
The drivers to sleep

Sleep is regulated by two systems

Sleep is regulated by two systems
1. Sleep/wake homeostasis
2. The circadian rhythm

The homeostatic sleep drive tracks how long you've been awake, becoming stronger the longer the period of wakefulness and regulates the intensity of sleep. When sleep deprived the drive to sleep becomes stronger leading to longer and deeper sleep

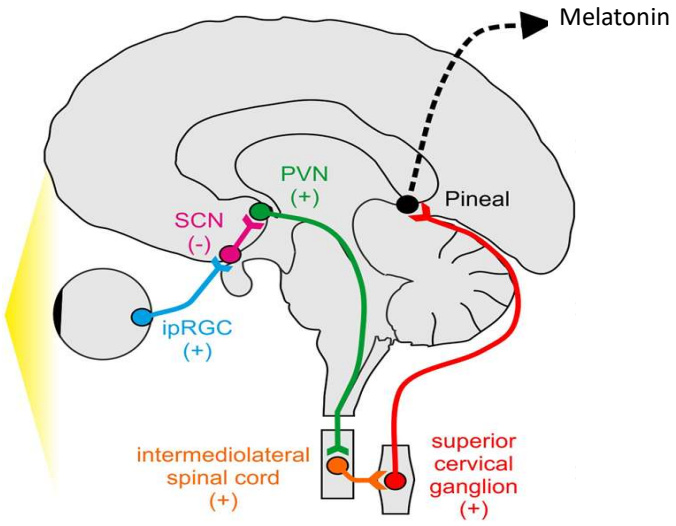
The two-process model of sleep regulation



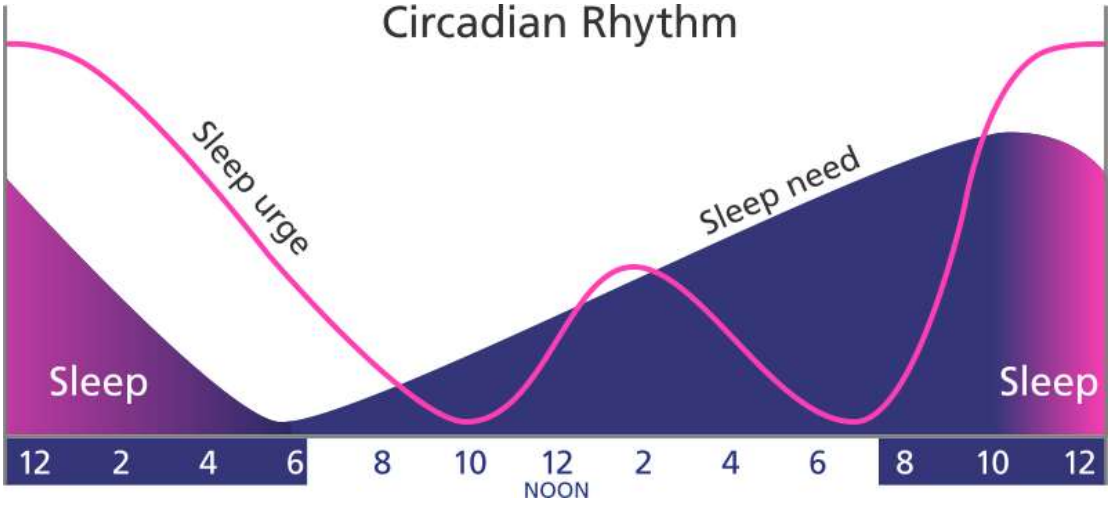
(Adapted from Thompson, n.d.)

Stress, social factors, drugs, temperature and food

The Suprachiasmatic Nucleus (SCN)



(Paul & Brown, 2019)



The drive to sleep is highest between 2 and 4 am and between 1 and 3 pm

(Sleep Council, n.d.)

The difference light makes

Type of lighting	Illuminance (Lux)
Bright sun	32,000 TO 13,000
Partly cloudy sunny day	20,480
Overcast day or shade	10,240
Studio light	1,000
Office with windows	640
Fluorescent light	320
Street lights	320
Dimly lit spaces	160
Home lighting	80
Twilight	3.4
Full moon	1

Lux: SI of illuminance = one lumen/m²
It is a measure of perceived brightness

A bright sunny day boosts attention, reaction time and mood

Home lighting of around 300-500 lux will influence how easily you fall asleep

Aim to keep to below 180 lux pre bedtime

(Tähkämö, Partonen, & Pesonen, 2019)

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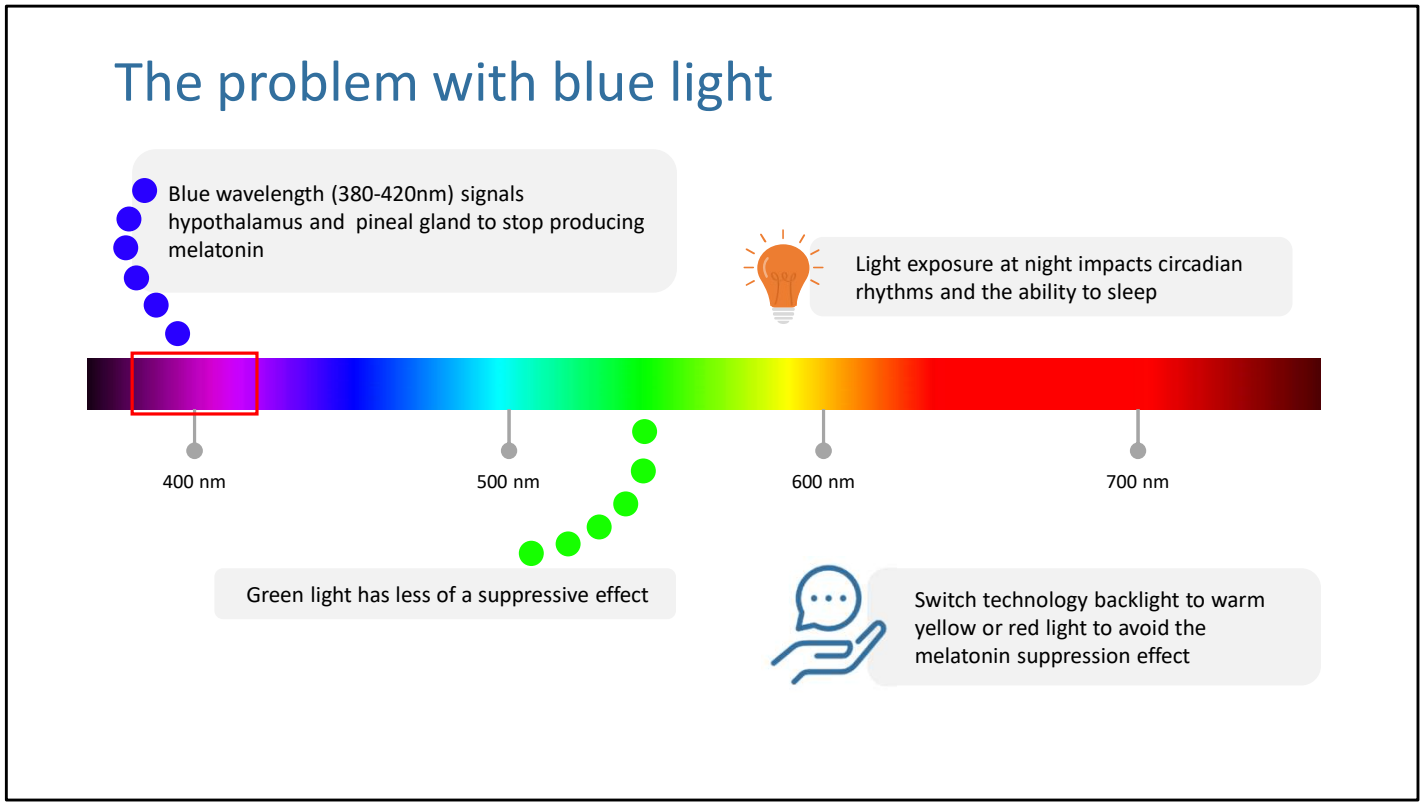
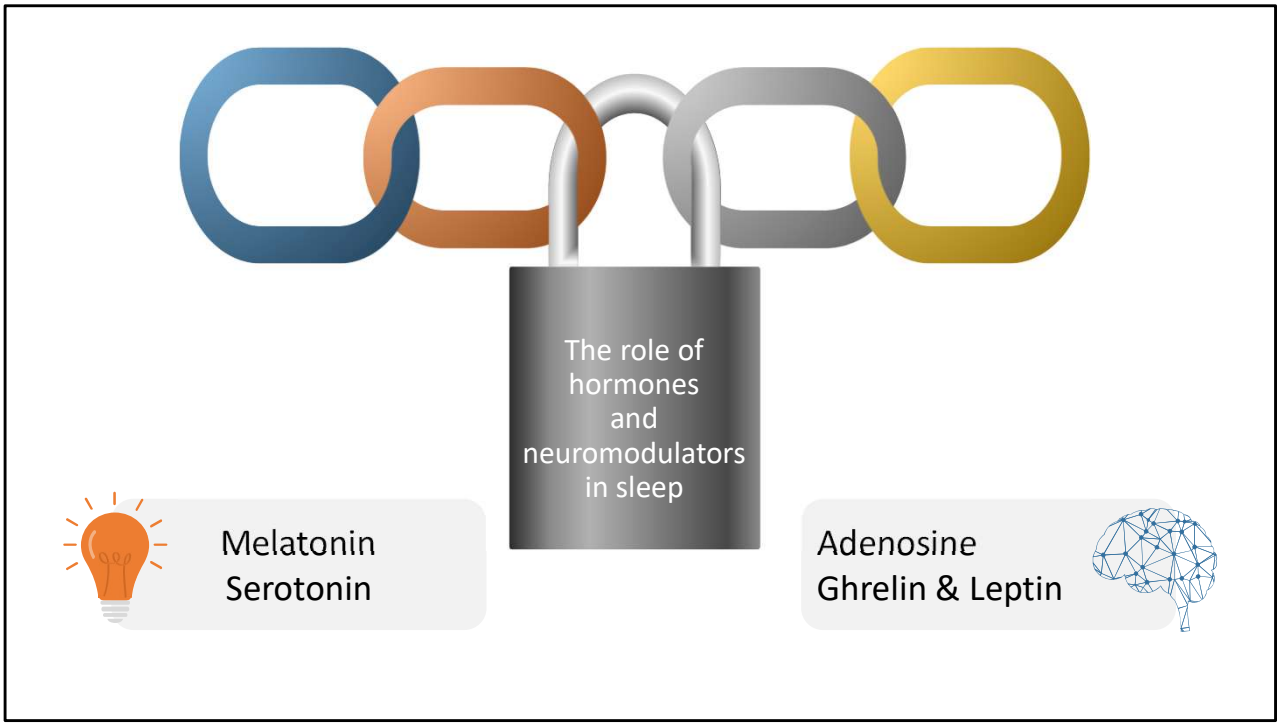


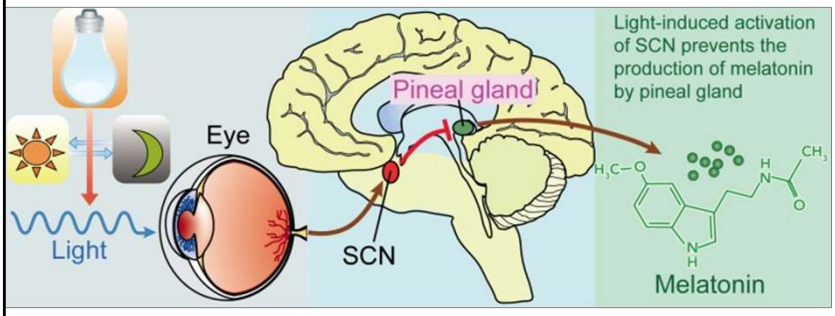
Light exposure at night impacts circadian rhythms and the ability to sleep
Blue wavelength 380-420nm stimulates the ganglion cells in the retina, tricking the body into thinking its daytime – send signals to hypothalamus and causes pineal gland to stop producing melatonin

Harvard research showed how exposure to 6.5 hours of blue light compared to green, suppressed melatonin production twice as long and shifted the circadian rhythm twice at much.

Advised to switch technology backlight to warm yellow or red light to avoid the melatonin suppression effect


The role of hormones and neuromodulators in sleep
Melatonin
Serotonin
Adenosine
Ghrelin & Leptin

Melatonin



Peak at 3-4 am
- Acts as signal of darkness
- Marker for circadian rhythms

Aids falling asleep and maintaining sleep

Seasonal rhythm

Production decline with age

(Ma et al., 2016; You and your hormones, 2018)

- SCN – suprachiasmatic nuclei

- Produced by pineal gland in response to darkness, peaking at 3-4 am – acts as a signal of darkness and a marker for circadian rhythms
- Cues night-time behaviour aids falling asleep and maintaining sleep
    - induces heat loss, reduces brain activity, delays cortisol production, which increases blood pressure and blood sugar in preparation for sleep
- SCN regulates its release, leads to opening of 'sleep-gate'
- Has a seasonal rhythm, higher levels in autumn and winter
- Lower in spring and summer
- Production declines with age

Serotonin and sleep

Serotonin – positive effect on mood.
Predominantly produced in the gut.
Role in wakefulness, triggering sleep, and REM sleep.

Low levels can cause sleep disruption and insomnia

Synthesised in pineal gland raphe neurons adds to sleep pressure

(Oikonomou et al., 2019)

Serotonin – known for its positive effect on mood and predominantly produced in the gut also plays an important role in sleep – specifically in wakefulness, triggering sleep and REM sleep

- Synthesised in pineal gland via Raphe neurons to make melatonin

Is at its lowest in REM sleep
Low levels can cause sleep disruption and insomnia
Stress being a common cause

Adenosine

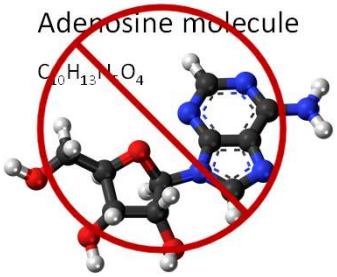
$C_8H_{10}N_4O_2$

Caffeine molecule

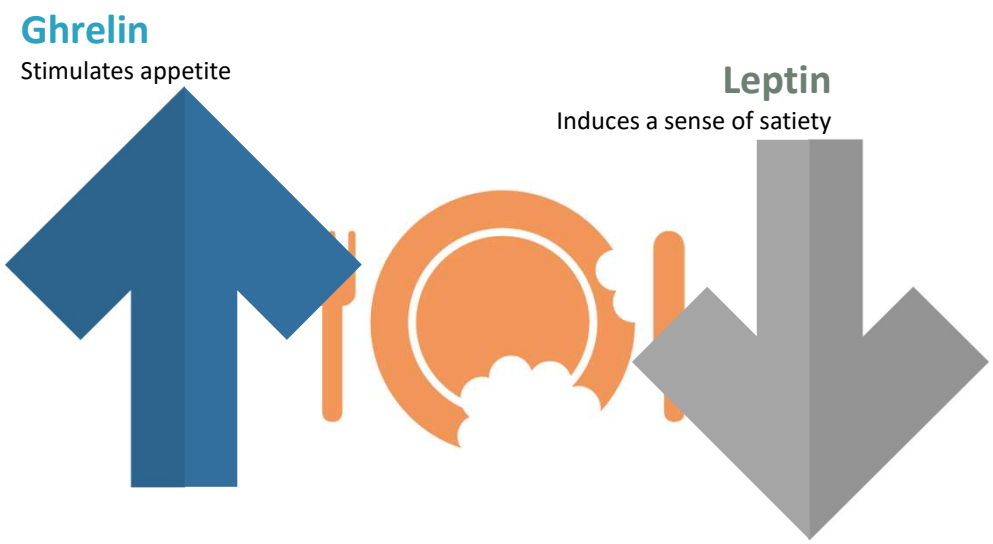
Half-life:
6-8 hours

Adenosine molecule

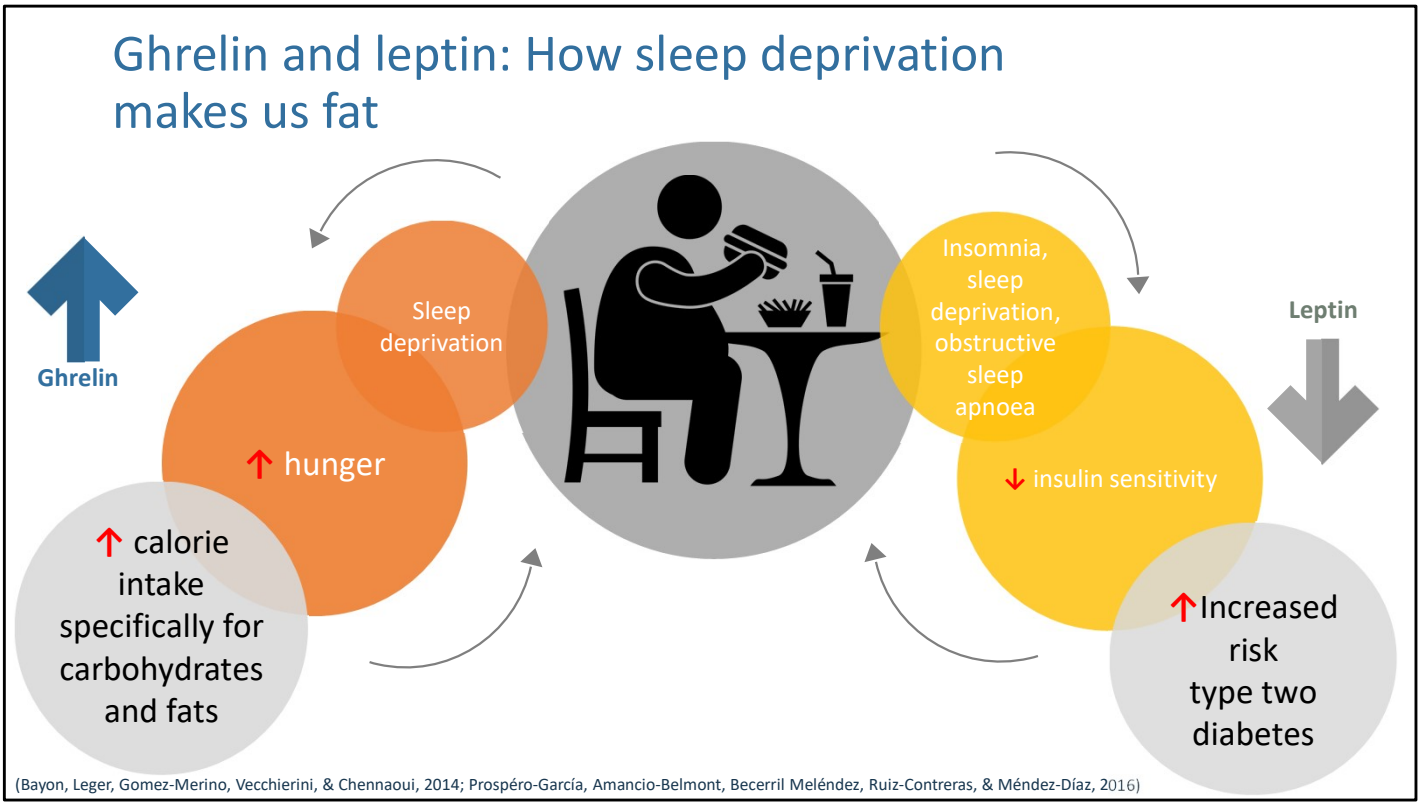
$C_{10}H_{13}N_5O_4$



Ghrelin and leptin



Ghrelin produced by stomach small amt also small intestine pancreas and brain
Stimulates appetite increase food intake and promotes fat storage
Basically tells your brain when to eat when to stop burning calories and when to store energy as fat
Levels DECREASE in normal sleep When sleep deprived have more – we think we're hungry and eat more while not burning calories because thinks it needs to store them
Believed to be an evolutionary response to long winters nights when less food available



Ghrelin stimulates appetite
Leptin induces sense of satiety
Sleep deprivation causes ghrelin levels to spike, while leptin levels fall leading to hunger, and the associated rise in endocannabinoids leads to an increase in calorie intake (approx. 300 cals per day) specifically for carbohydrates and fats
Insomnia, sleep deprivation and obstructive sleep apnoea shown to lead to decreased insulin sensitivity and potential increased risk of type two diabetes.
Studies in men have shown how this is in part doe to an imbalance between testosterone and cortisol

Leptin produced primarily in adipocytes of white adipose tissue
Informs brain when fuel stored in fat and liver is becoming depleted
Lower leptin levels activates leptin receptors in brain plus pituitary and adrenals which secrete corticosterone that regulates energy stress response and food intake
Is reduced during starvation and dieting and sleep deprivation – can result in feeling constantly hungry and a general slow down of metabolism


Light is the primary entrainer for sleep

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