



CIRCADIAN RHYTHMS AND SLEEP™



manufacturing  
Safety Alliance of BC

# Elite Sleep

**Safety Alliance of BC**  
**February 14<sup>th</sup>, 2023**

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# Elite Sleep Series

90 minutes

- Sleep Matters!
- Why can't I Sleep?
- Circadian Rhythms are the secret to Sleep Health!

Sleep Matters!

# Combating a Pandemic

**A:** Reproduction Rate ( $R_0$ ) =



**B:** Transmission rate ( $\beta$ )

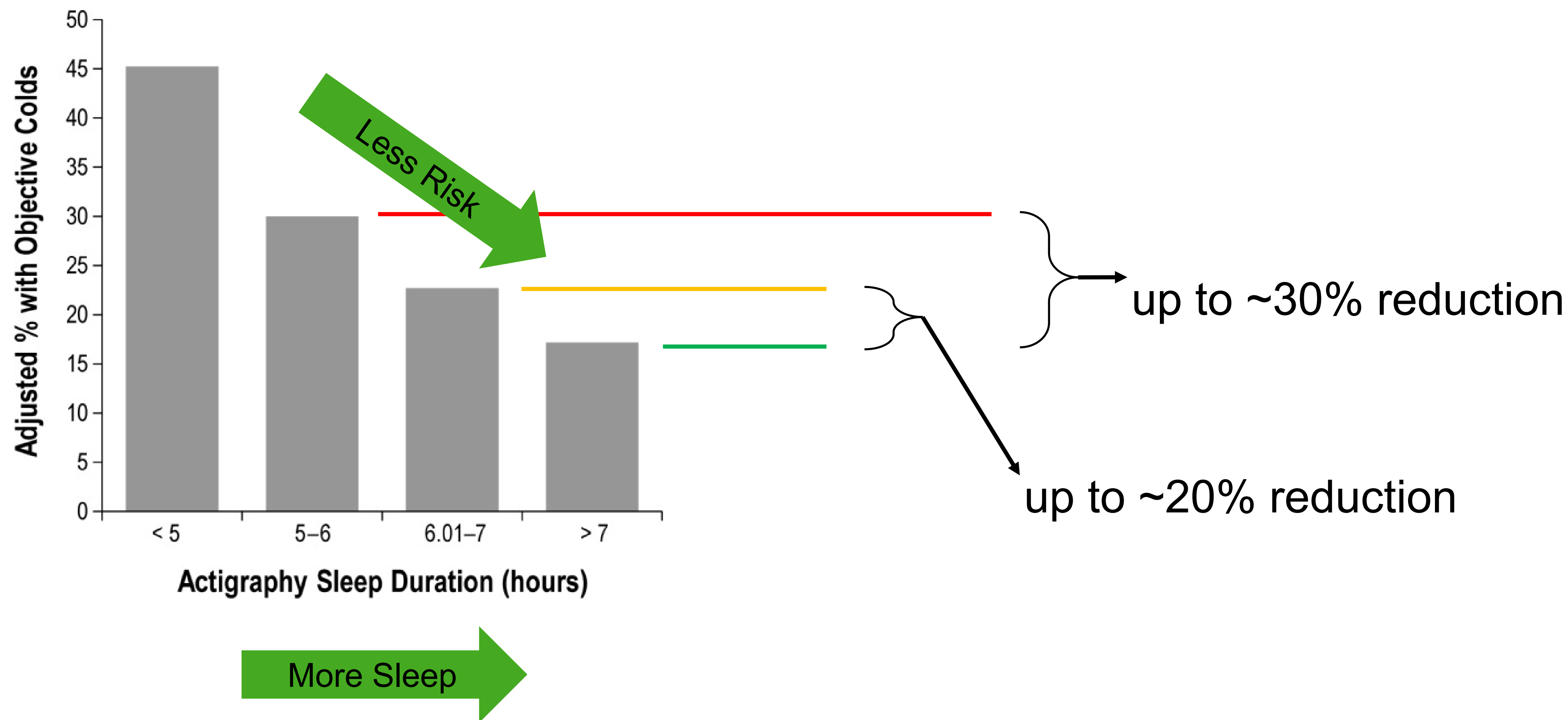
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**C:** Recovery Rate ( $\gamma$ )

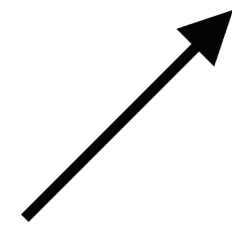


# Healthy Sleep Reduces Risk of Infection

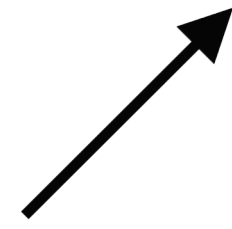


# Healthy Sleep Increases Recovery Rate

Neutrophil



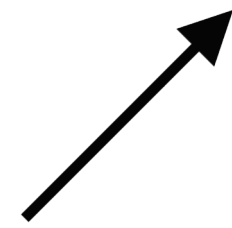
NK



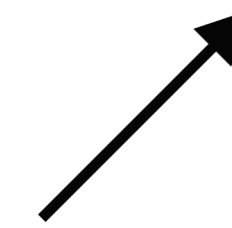
Th1 & Th2



Antibodies



**Recovery Rate**





# Conclusion

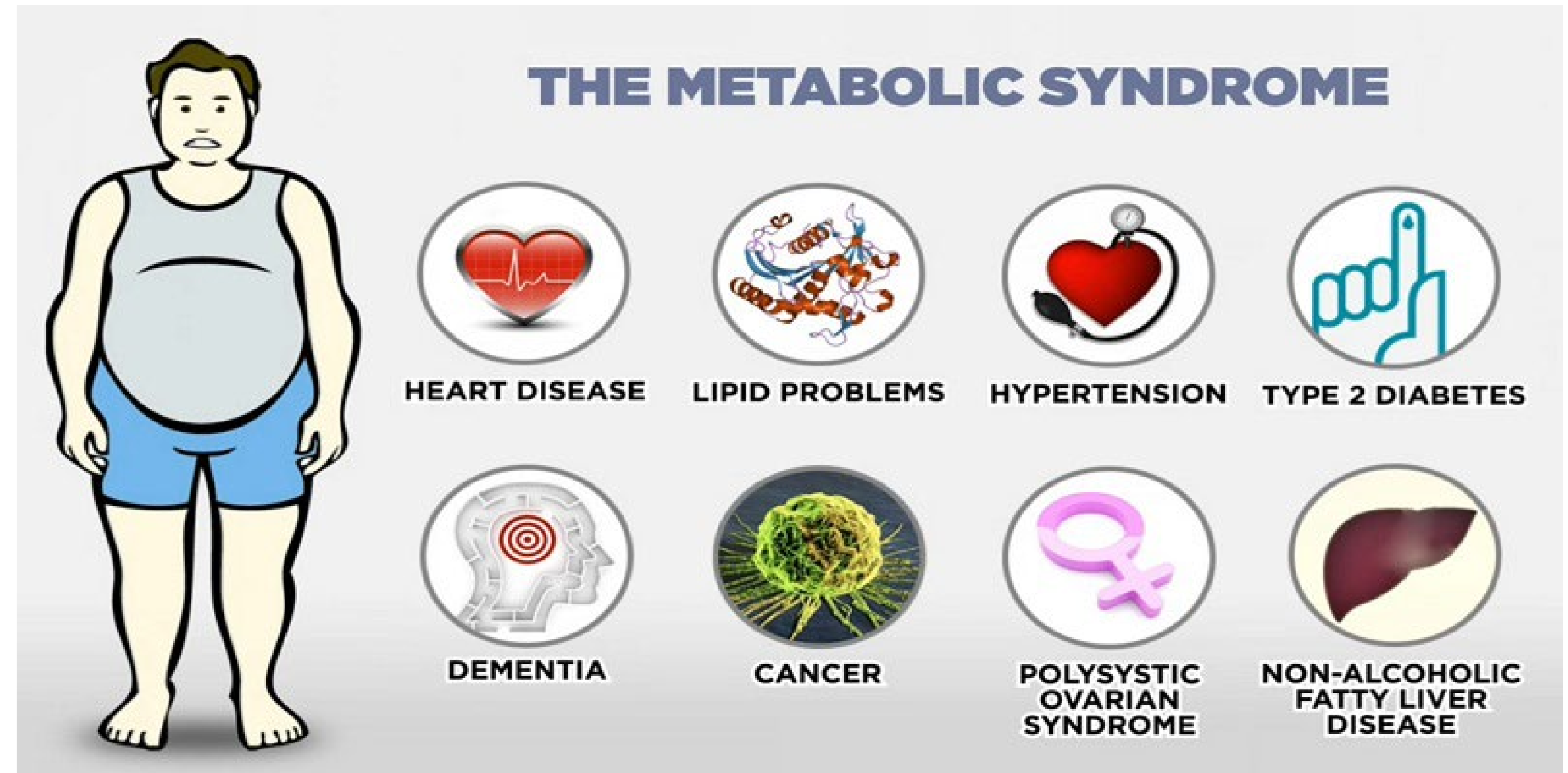
- We need to promote Healthy Sleep to combat COVID-19!



# Health Hazards

## Metabolic Syndrome

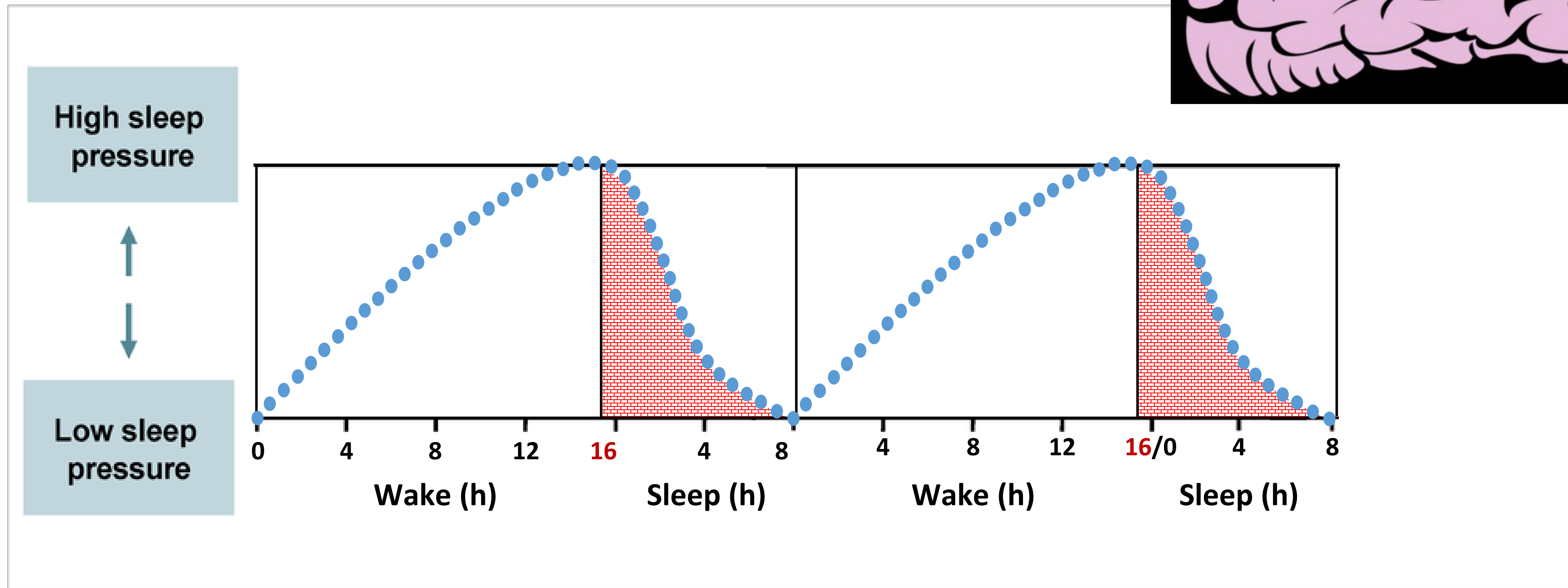
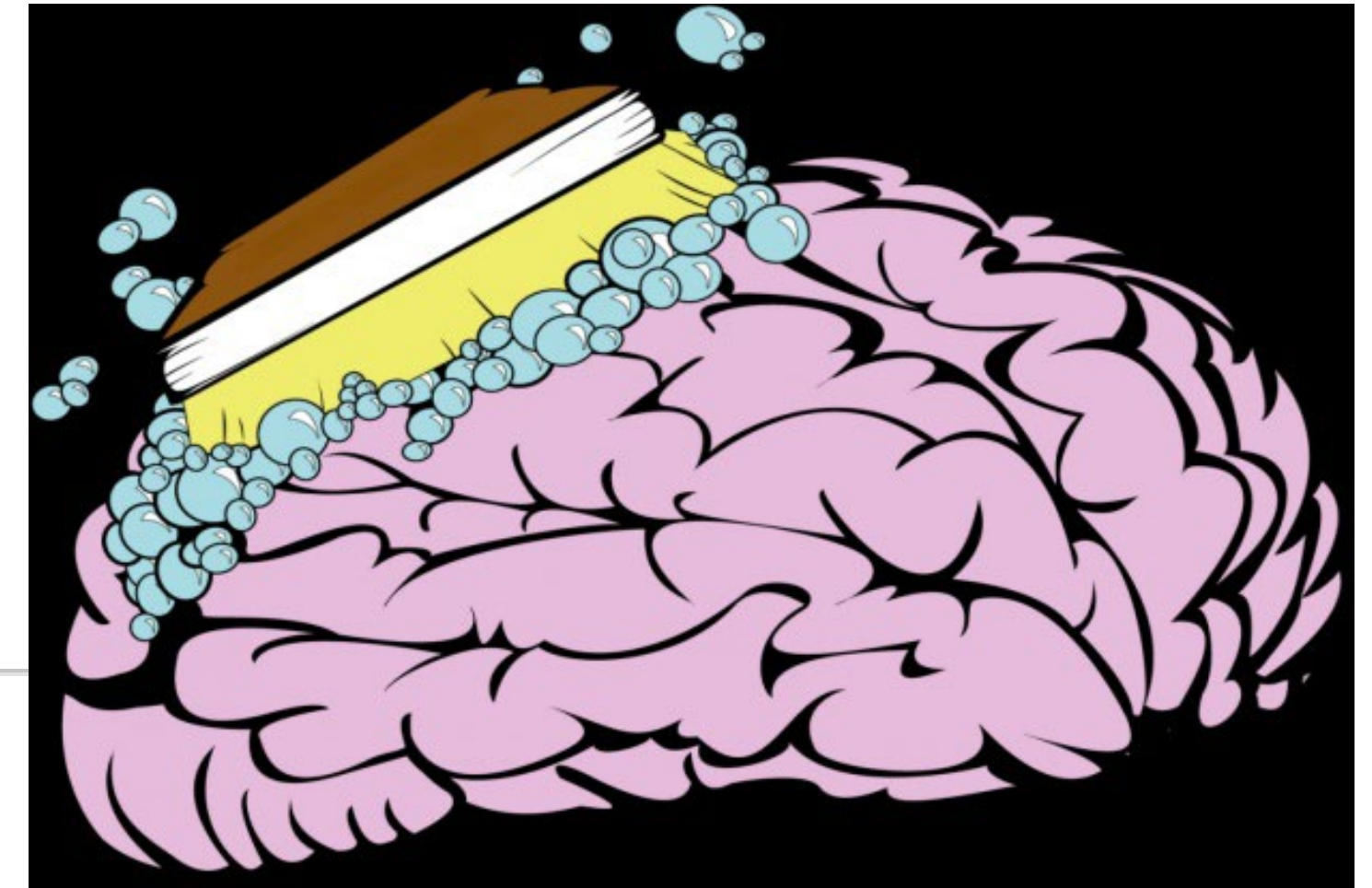
- Cardiovascular Disease
- Inflammation
- Obesity
- Type 2 Diabetes
- Dementia
- Cancer



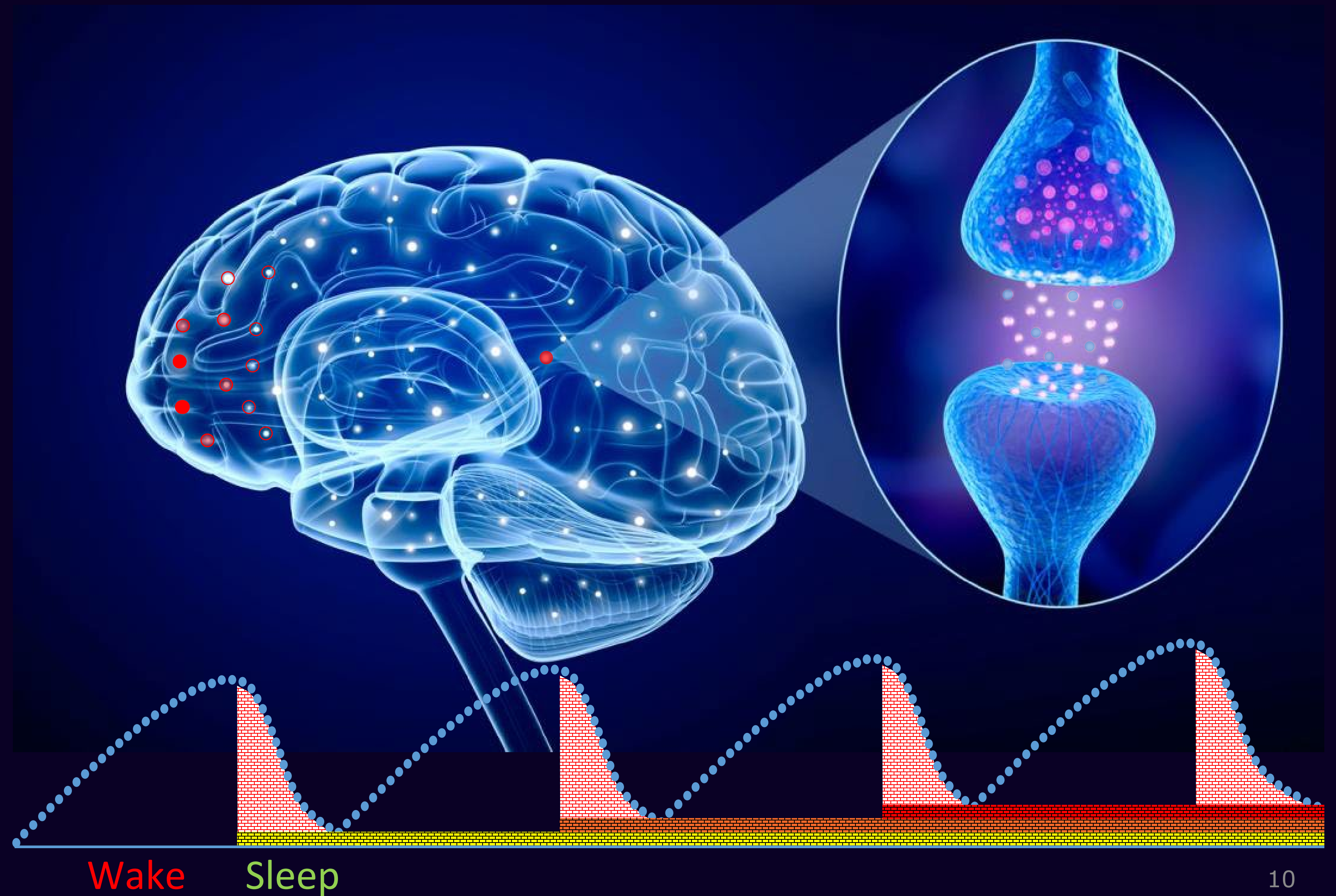


# Sleep Mechanisms

**Wakefulness is toxic:**



# Sleep Debt & the Exhausted Brain

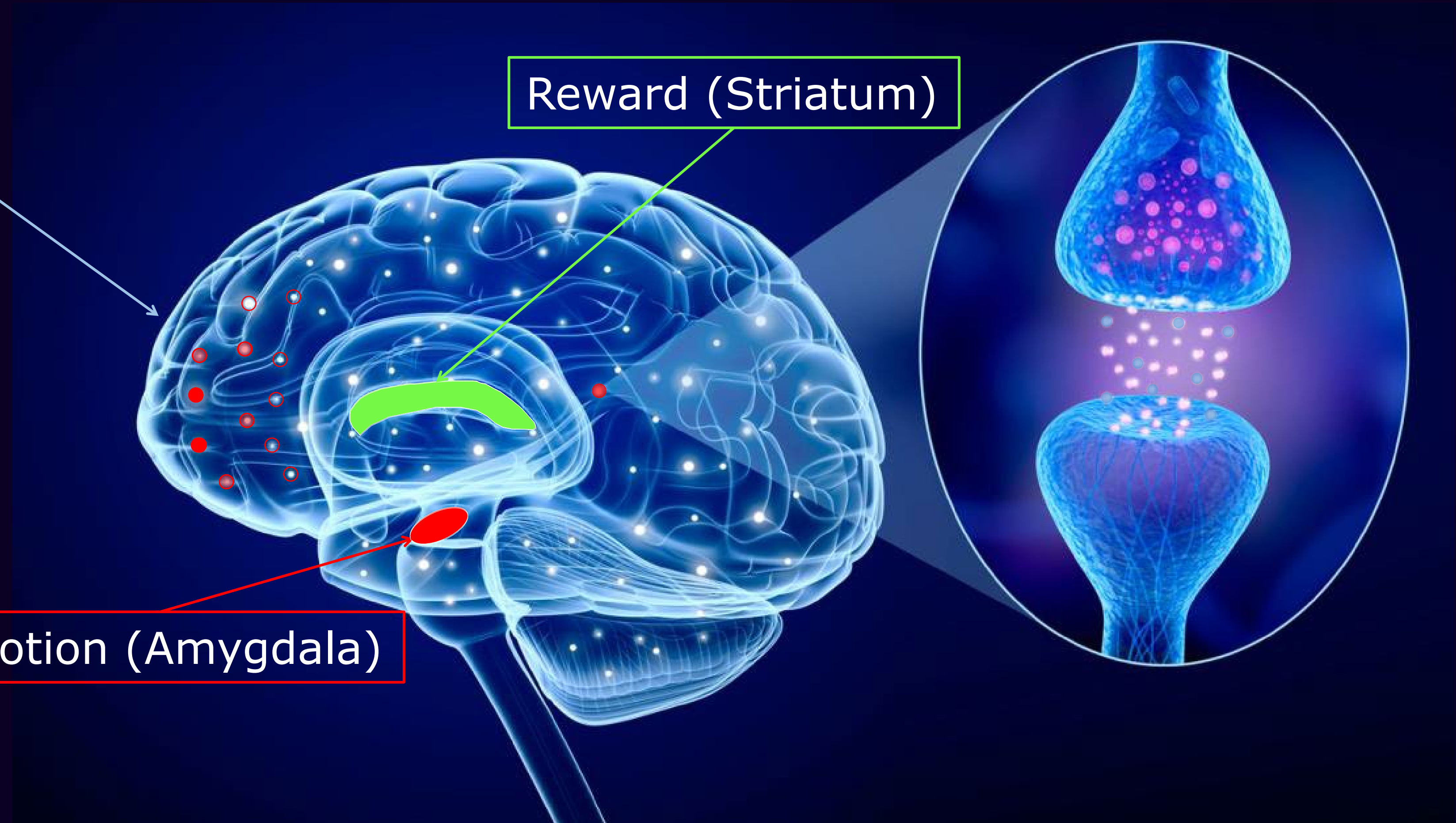


# Sleep Debt & Mental Health

Prefrontal Cortex:  
• Reason  
• Logic  
• Decision Making

Reward (Striatum)

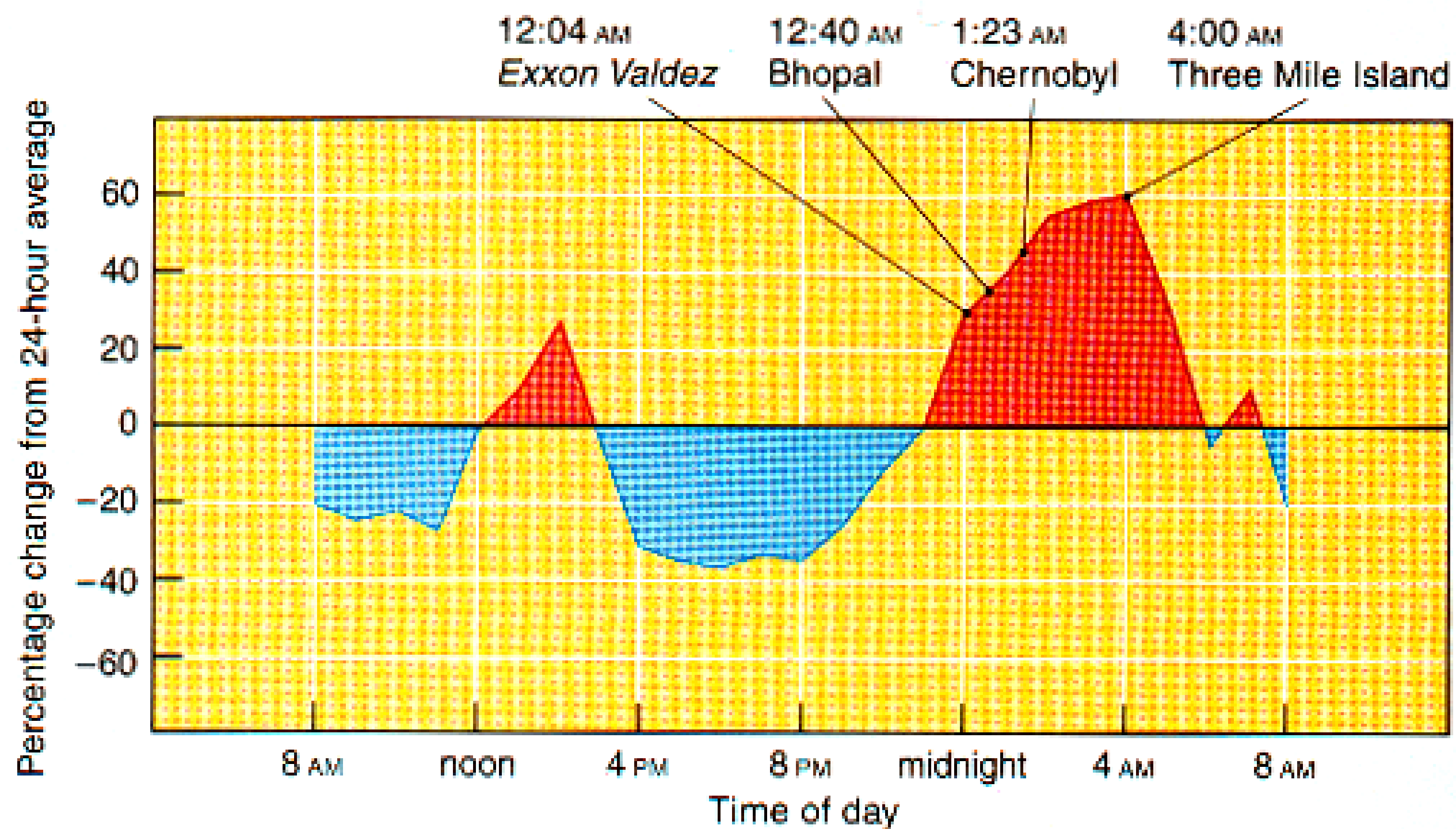
Emotion (Amygdala)





# Industrial Accidents

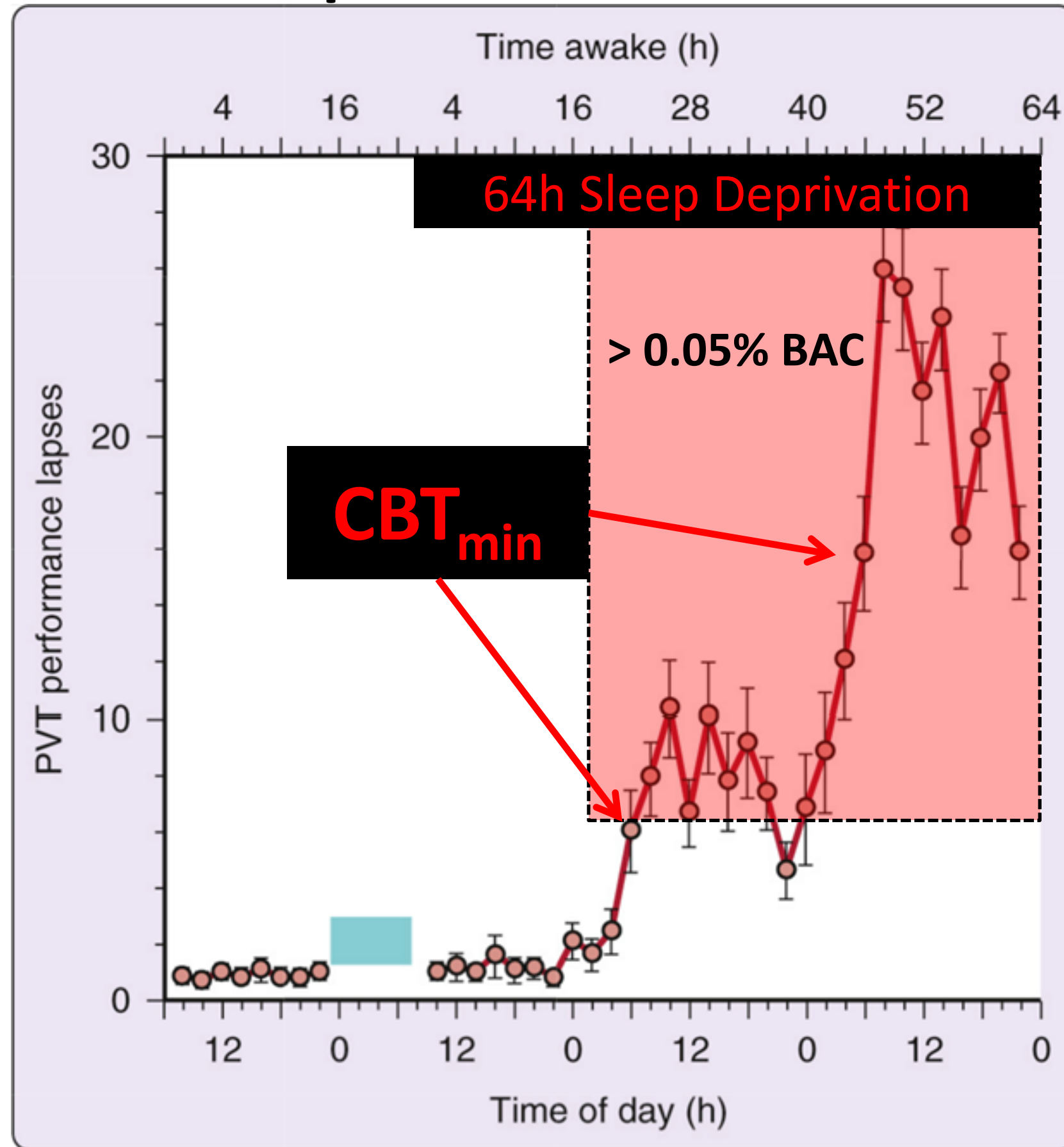
**Probability of Errors During Shift Work**





# CBT<sub>min</sub>: The Danger Zone

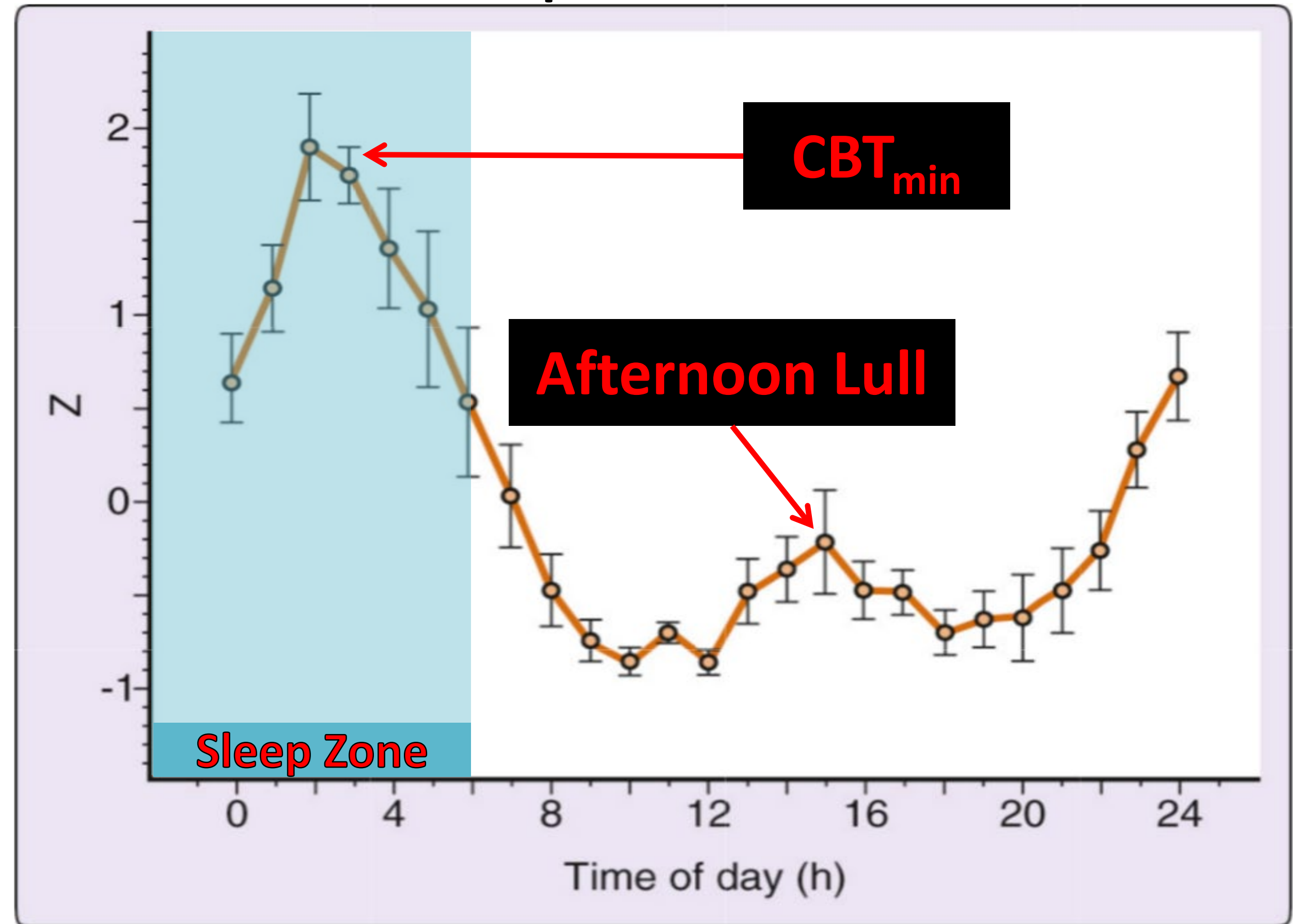
## Lapses in Attention



Citation:

Dawson, 1997 Fatigue, alcohol and performance impairment

## Transport Accidents



Citation:

Folkard, 1997 Black times: temporal determinants of transport safety



# Three Mile Island



**Sleep deprived night shift workers failed to notice a stuck valve was causing the reactor to lose coolant.**

**Citation:**

Principles & Practice of Sleep Medicine, p. 666



# Space Shuttle Challenger



**This disaster was partially attributed to heavily sleep deprived managers making critical errors in judgement.**

**Citation:**

Principles & Practice of Sleep Medicine, p. 666

# Chernobyl Nuclear Plant



**This disaster was also attributed to human error due in part to fatigue while on the night shift after working more than 13 hours.**

**Citation:**

Principles & Practice of Sleep Medicine, p. 666



# Exxon Valdez Oil Spill



**After staying awake for more than 18 hours, a fatigued third mate failed to properly account for the ship's position.**

**Citation:**

Principles & Practice of Sleep Medicine, p. 666



# AA Flight 1420



**Citation:**

Principles & Practice of Sleep Medicine, p. 666

**Near the end of their 14-hour duty shift, the pilots made an error in judgement when choosing to land in a severe thunderstorm at night.**

# Metro-North Train



**The engineer operating the train fell asleep. The subsequent investigation determined he had sleep apnea.**

**Citation:**

Principles & Practice of Sleep Medicine, p. 666

# Critical Factors

- Shift Length
- Sustained Wakefulness
- Sleep Intrusions
- Time of Day
- Errors in Judgement

## Citations:

Acheson, 2007 Effects of sleep deprivation on impulsive behaviors in men and women

Venkatraman, 2007 Sleep deprivation elevates expectation of gains and attenuates response to losses following risky decisions

**A CN freight train crashed into a VIA passenger train in Hinton, Alberta.  
CBC News reported that TSB investigators suspect the CN crew fell asleep.**



Why can't I sleep?

# Objective Measurement

## Sleep Stages

fitbit alta HR

OVERVIEW

FITNESS

SMART

STYLE

APP

SHOP NOW

\$149.95 - \$179.95

Get a better night's sleep.

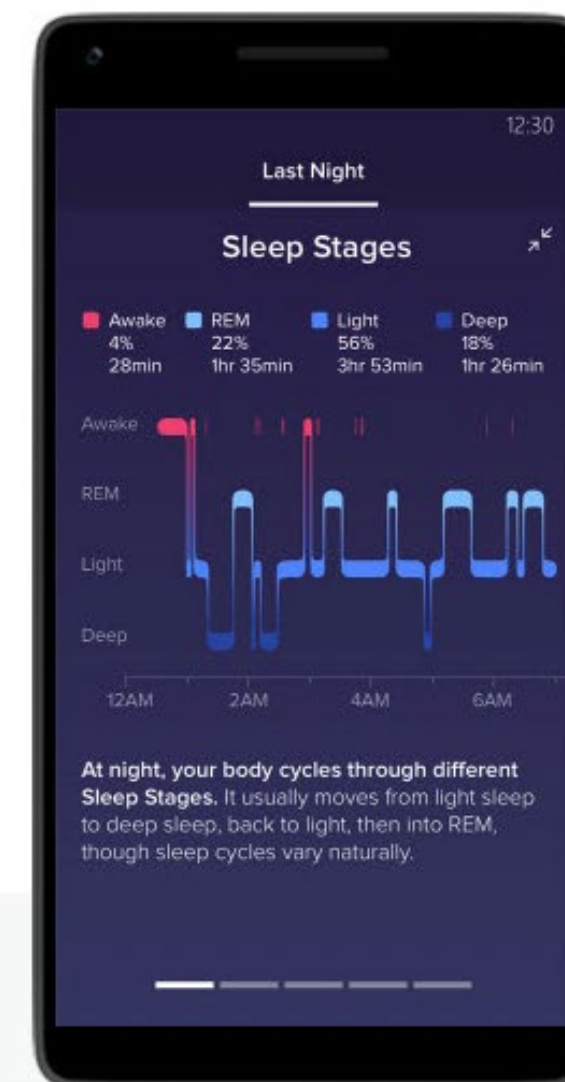
### Auto Sleep Tracking & Alarms

Automatically track your sleep duration and consistency. Then wake up peacefully with a silent alarm.

### Sleep Stages NEW

Using heart rate, Alta HR shows your time in light, deep and REM sleep to help you understand your sleep quality.

[SEE BENEFITS OF SLEEP TOOLS](#)



## Sleep Stages



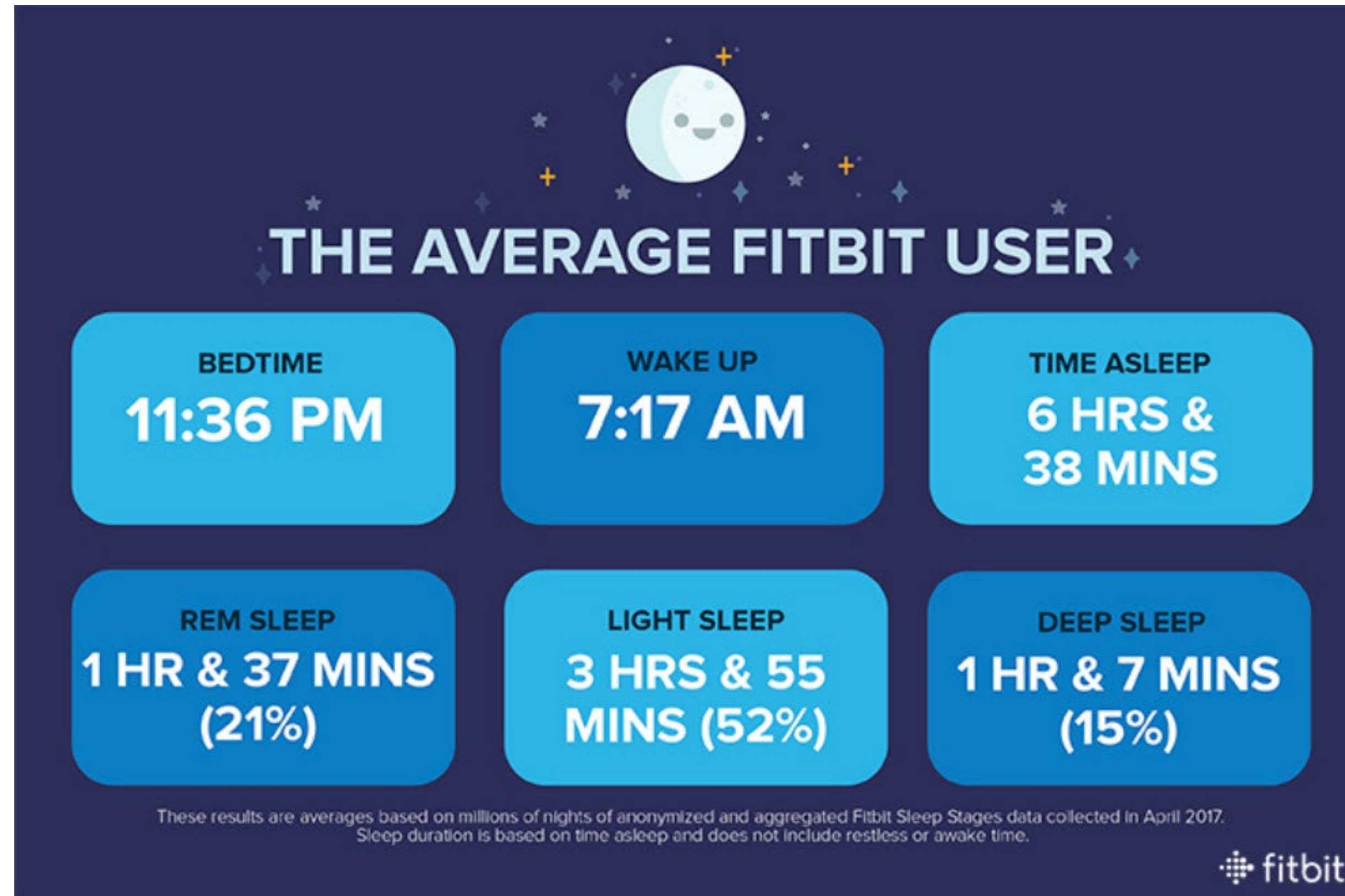
# Elite Sleep





# Objective Measurement

Sleep is the first thing we sacrifice!





# Sleep & Aging

30 – 60 years old



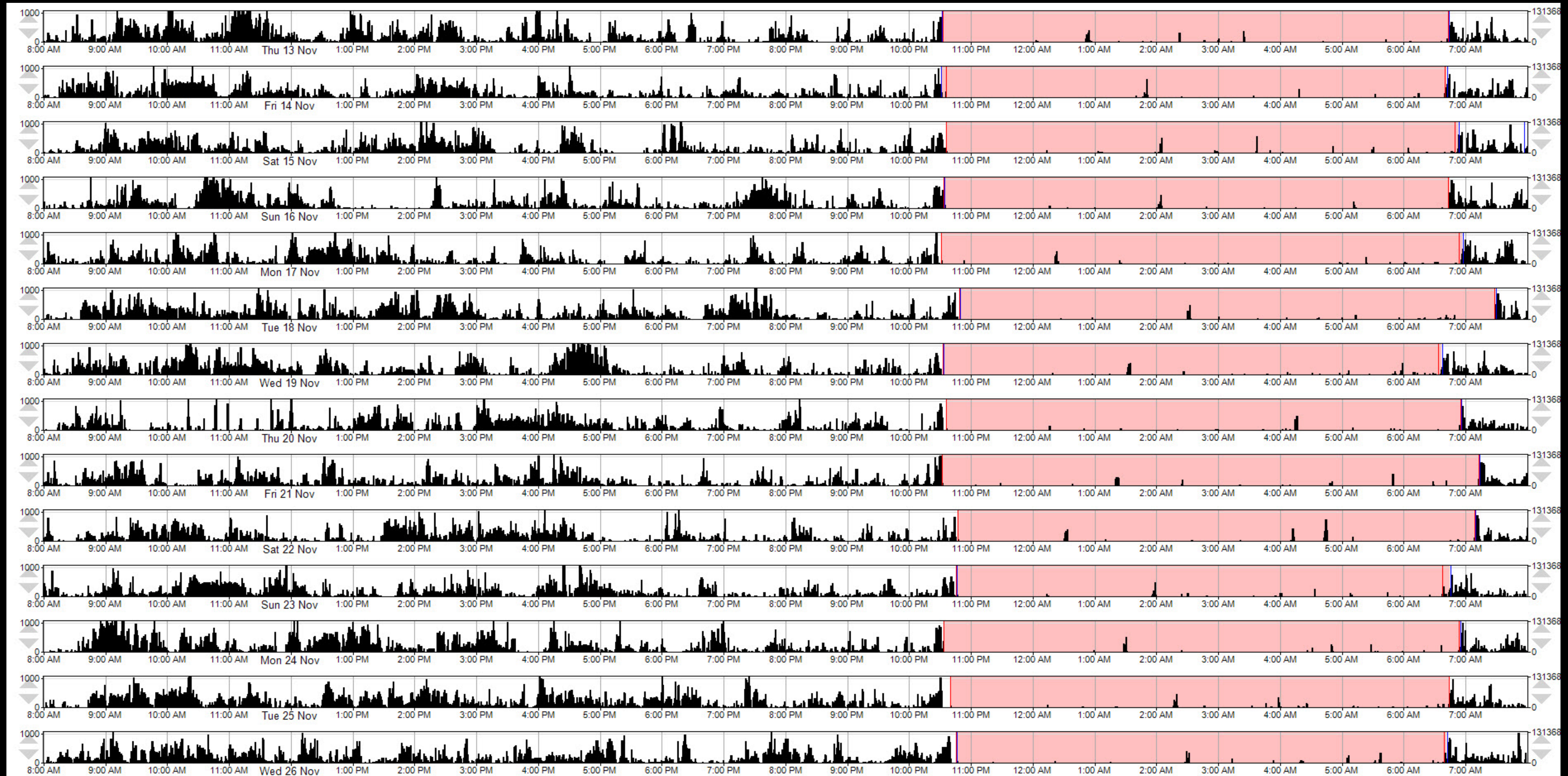
**Citation:**

Carrier, 2011 Slow wave sleep changes during the middle years of life



# An Example of Good Sleep Quality

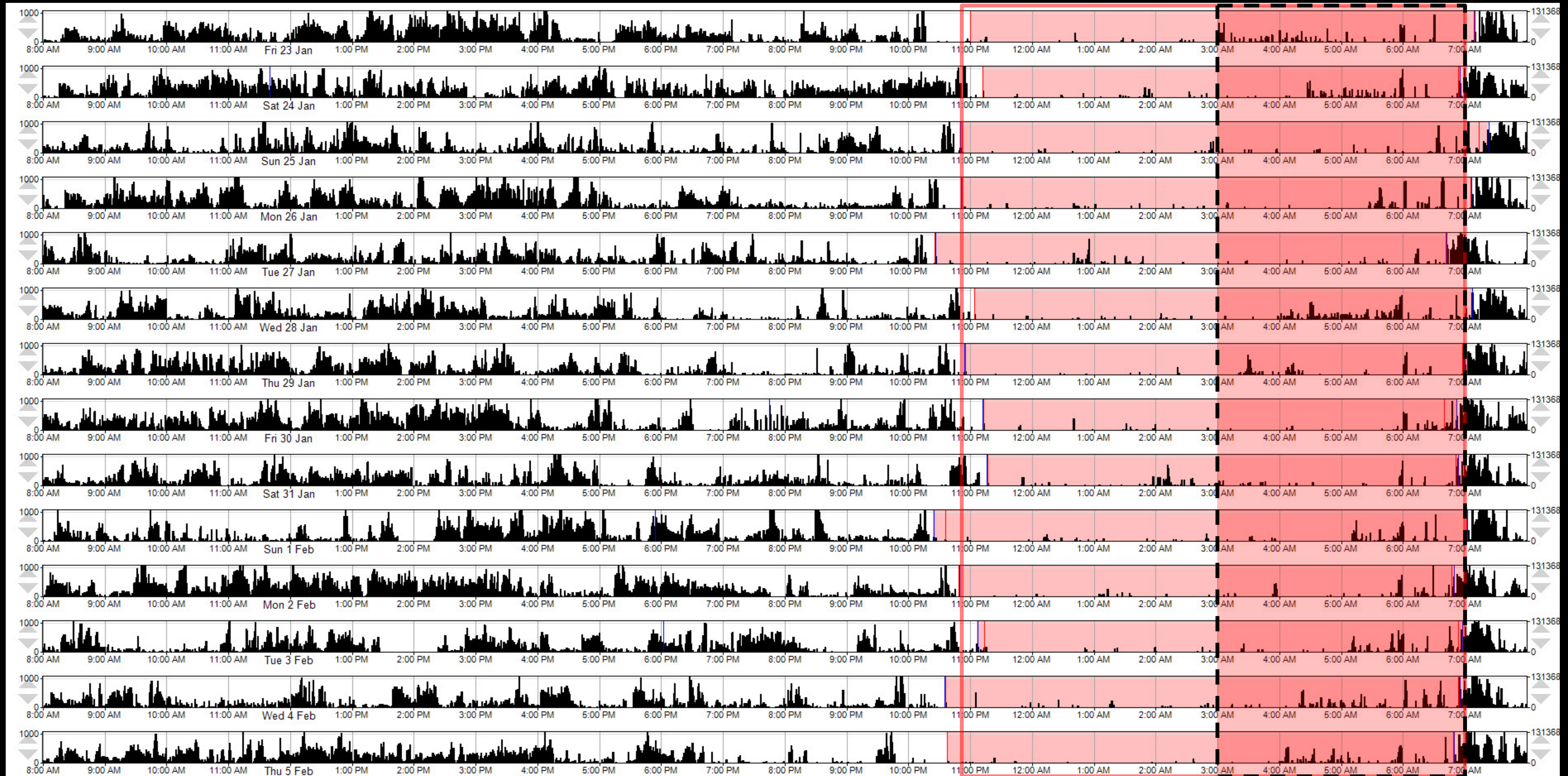
Duration = 461 min; Efficiency = 93.1%; Fragmentation = 14.9





# An Example of **Poor** Sleep Quality

Duration = **368 min**; Efficiency = **75.7%**; Fragmentation = **41.0**





# Sleep Architecture & Aging

Variable	Older (mean $\pm$ S.E.M.)	Young (mean $\pm$ S.E.M.)	<i>P</i>
Sleep latency (min)	11.2 $\pm$ 2.1	14.0 $\pm$ 4.4	0.4525
REM latency (min)	56.0 $\pm$ 6.9	77.4 $\pm$ 10.7	0.0970
TRT (min)	478.3 $\pm$ 2.3	479.2 $\pm$ 1.4	0.7369
Wakefulness (min)	107.3 $\pm$ 11.4	39.5 $\pm$ 4.8	0.0001
TST (min)	370.8 $\pm$ 11.6	433.1 $\pm$ 5.0	0.0002
Sleep efficiency (%)	77.5 $\pm$ 2.4	90.4 $\pm$ 0.9	0.0001
Stage 1 (%)	18.0 $\pm$ 2.8	7.7 $\pm$ 1.5	0.0046
Stage 2 (%)	49.6 $\pm$ 3.0	53.2 $\pm$ 2.2	0.3634
Stage 3 (%)	8.6 $\pm$ 1.7	6.4 $\pm$ 0.9	0.2421
Stage 4 (%)	4.6 $\pm$ 2.0	13.0 $\pm$ 1.7	0.0043
SWS (%)	13.2 $\pm$ 2.7	19.4 $\pm$ 1.8	0.0792
REM sleep (%)	19.1 $\pm$ 1.1	19.6 $\pm$ 1.6	0.8006

- Older adults get less sleep
- Older adults might not be washing their brains enough!

Citation:

Dijk, 1999 Ageing and the circadian and homeostatic regulation of human sleep



# Sleep Stages

# Poor Sleep

Awake 17 % 1hr 23min  
REM 12 % 59min  
Light 65 % 5hr 15min  
Deep 6 % 29min



Let's talk about DRUGS!

# Sleep Stages

Awake 11 % 35min  
REM 6 % 17min  
Light 61 % 3hr 10min  
Deep 22 % 1hr 7min

# Sleep-Aid + CBD





# Sleep Stages

# Alcohol

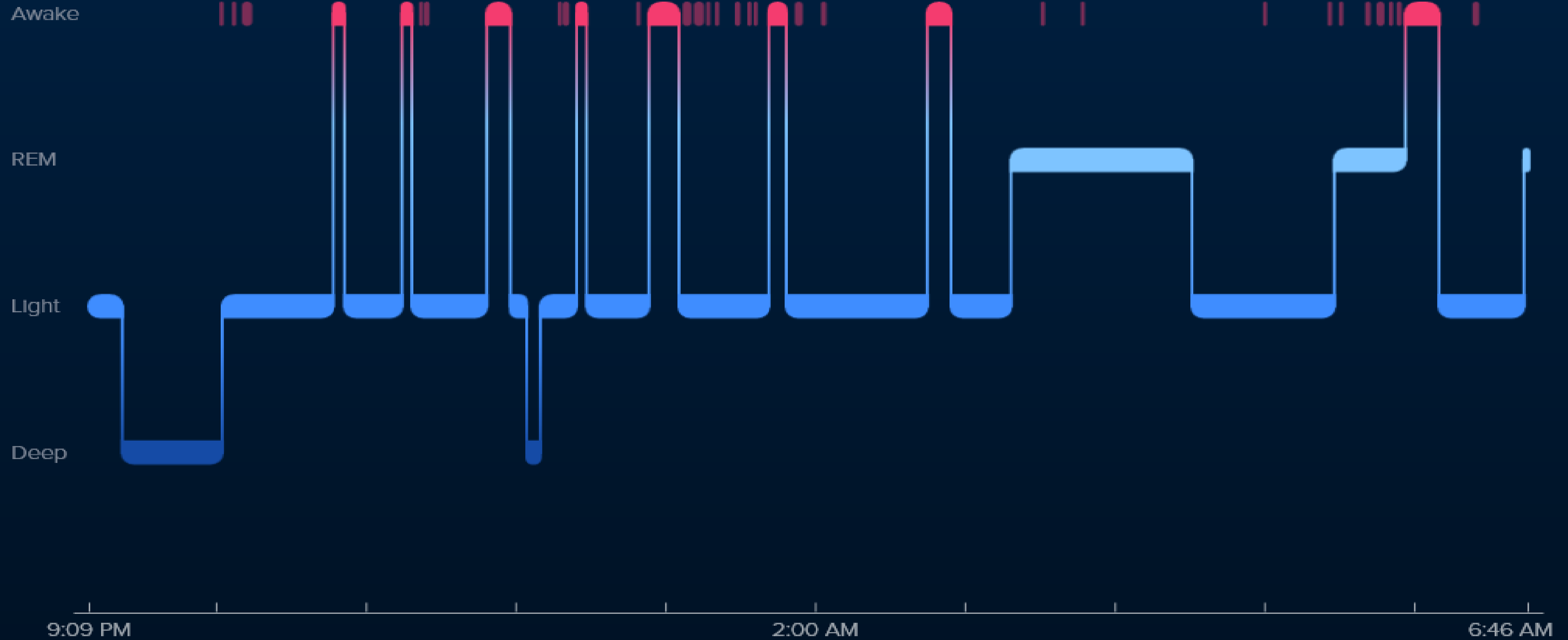
- Awake 11 % 45min
- REM 15 % 1hr 4min
- Light 66 % 4hr 35min
- Deep 8 % 32min



# Sleep Stages

Awake 16 % 1hr 32min  
REM 17 % 1hr 37min  
Light 59 % 5hr 43min  
Deep 8 % 45min

# Stimulants

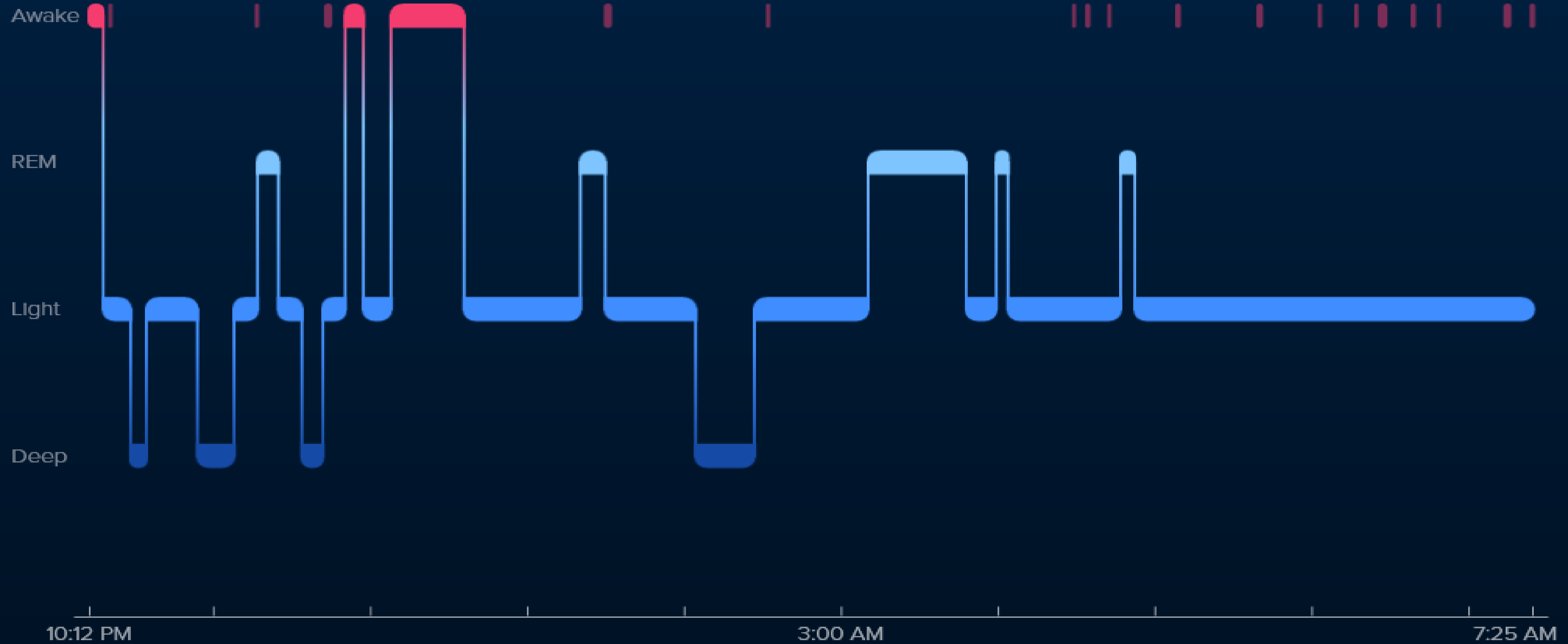




## Sleep Stages



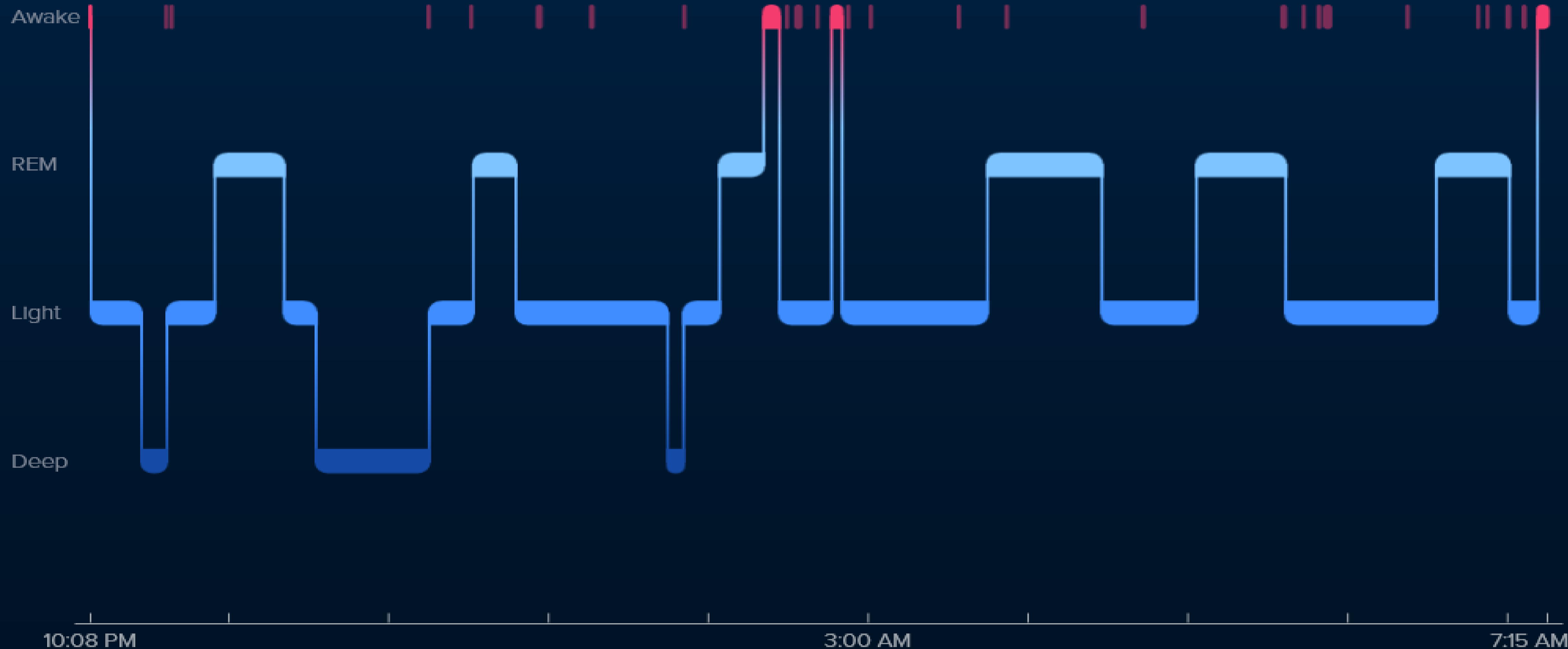
# Antihistamines



# Sleep Stages

# REM Rebound

Awake 7 % 37min  
REM 29 % 2hr 38min  
Light 54 % 4hr 55min  
Deep 10 % 57min

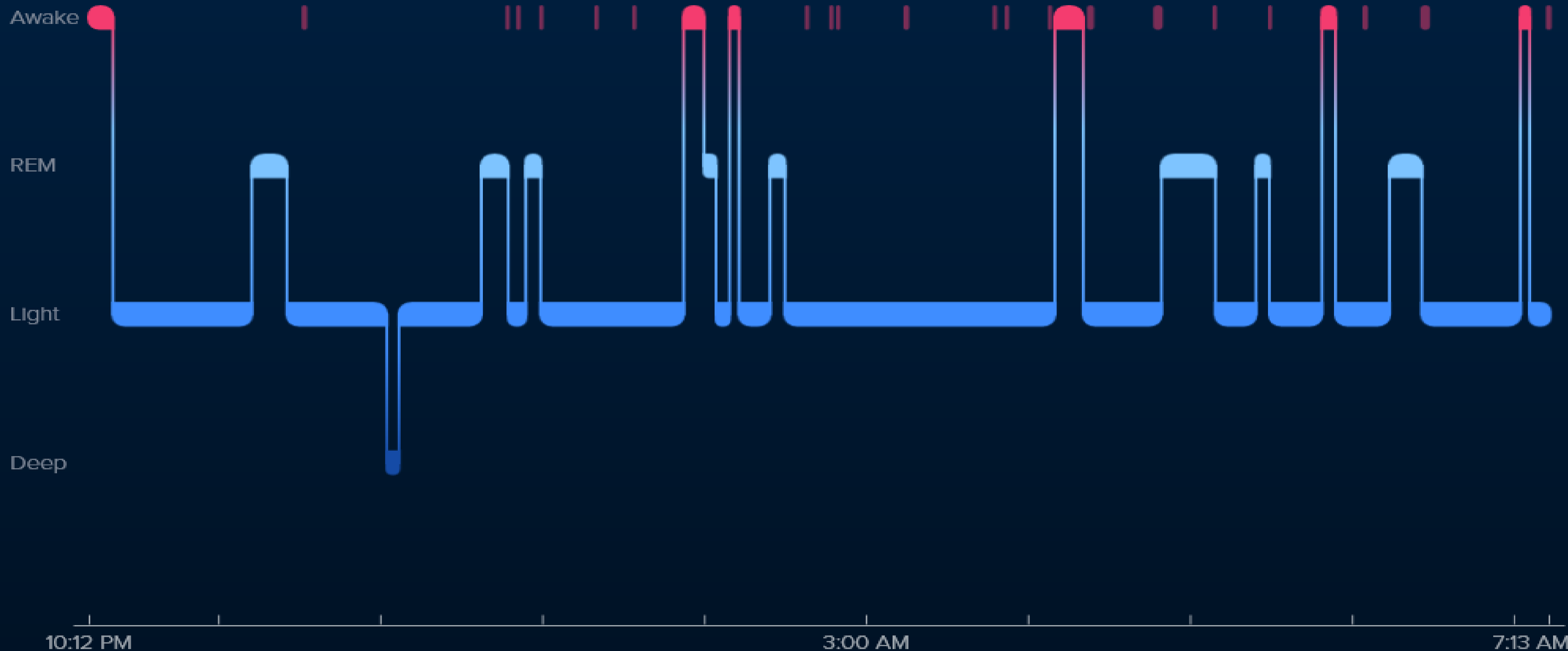




## Sleep Stages



# Hyper Vigilance



# Sleep Stages

# Debauchery

- Awake 9 % 28min
- REM 17 % 51min
- Light 74 % 3hr 37min
- Deep 0 % 0min

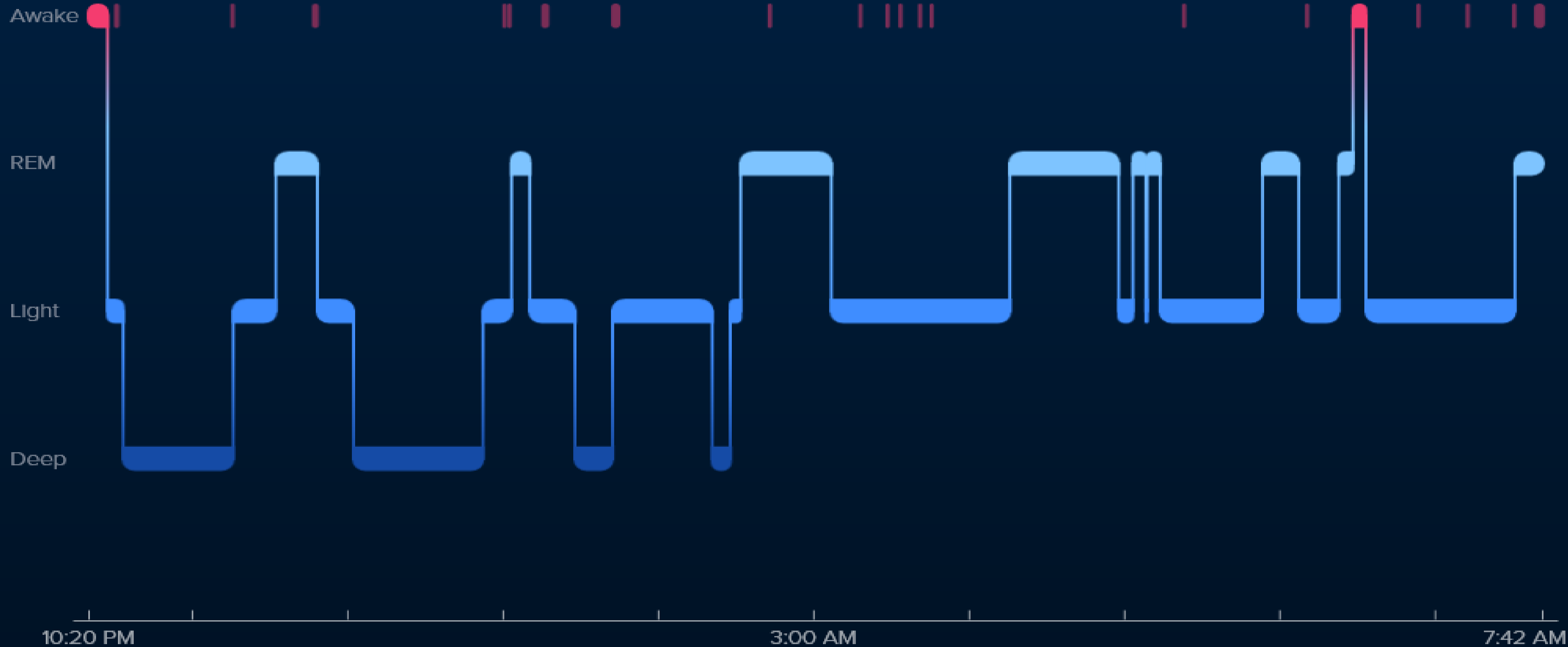




# Sleep Stages

- Awake 5 % 29min
- REM 24 % 2hr 16min
- Light 51 % 4hr 44min
- Deep 20 % 1hr 53min

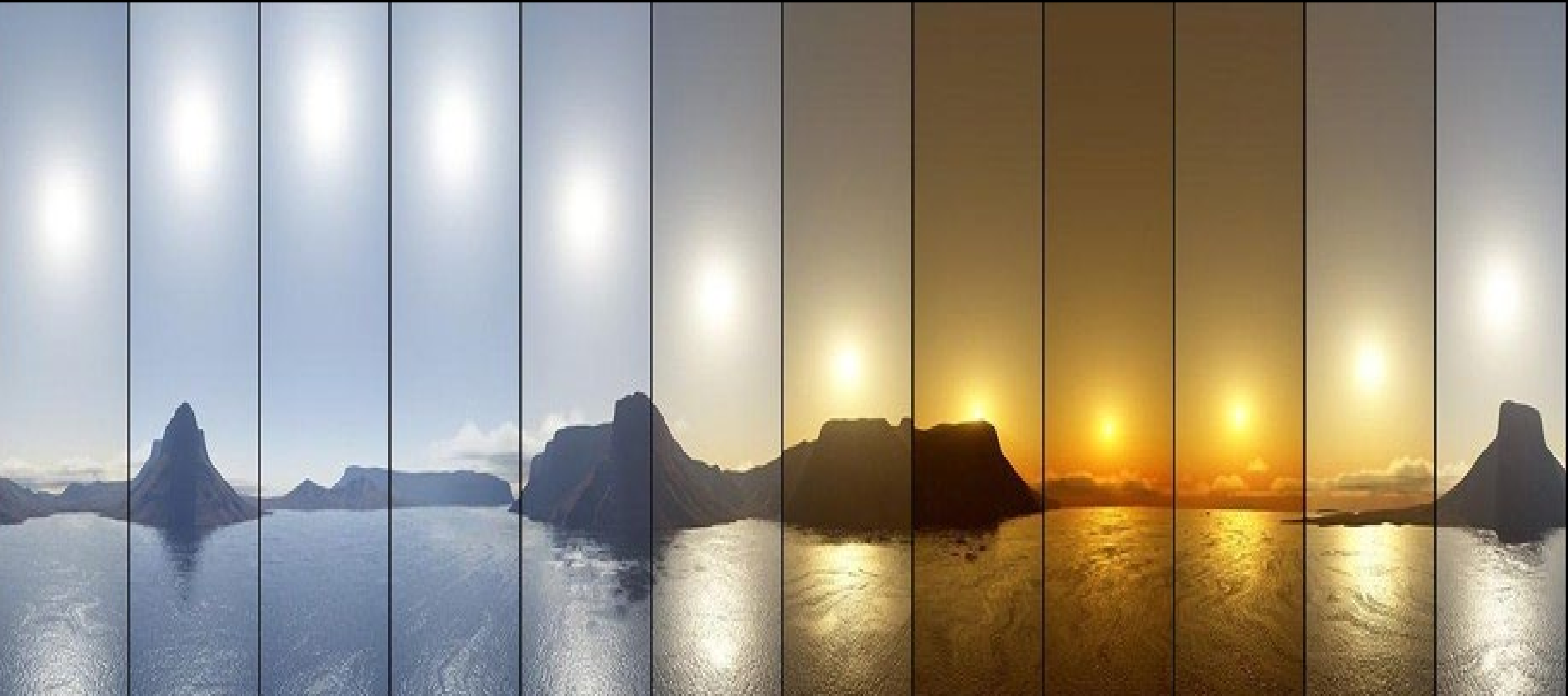
# Recovery Sleep



Circadian Rhythms are the Secret  
to Sleep Health!



# Circadian Rhythms



# Promoting Circadian Regulation

**Tell your clock what time it is!**

**Coordinate time cues – light, mealtimes, & physical activity**

**Be consistent**

**Nap**





# Protect your Sleep Window!

Be active after mealtimes

Preserve your Melatonin onset

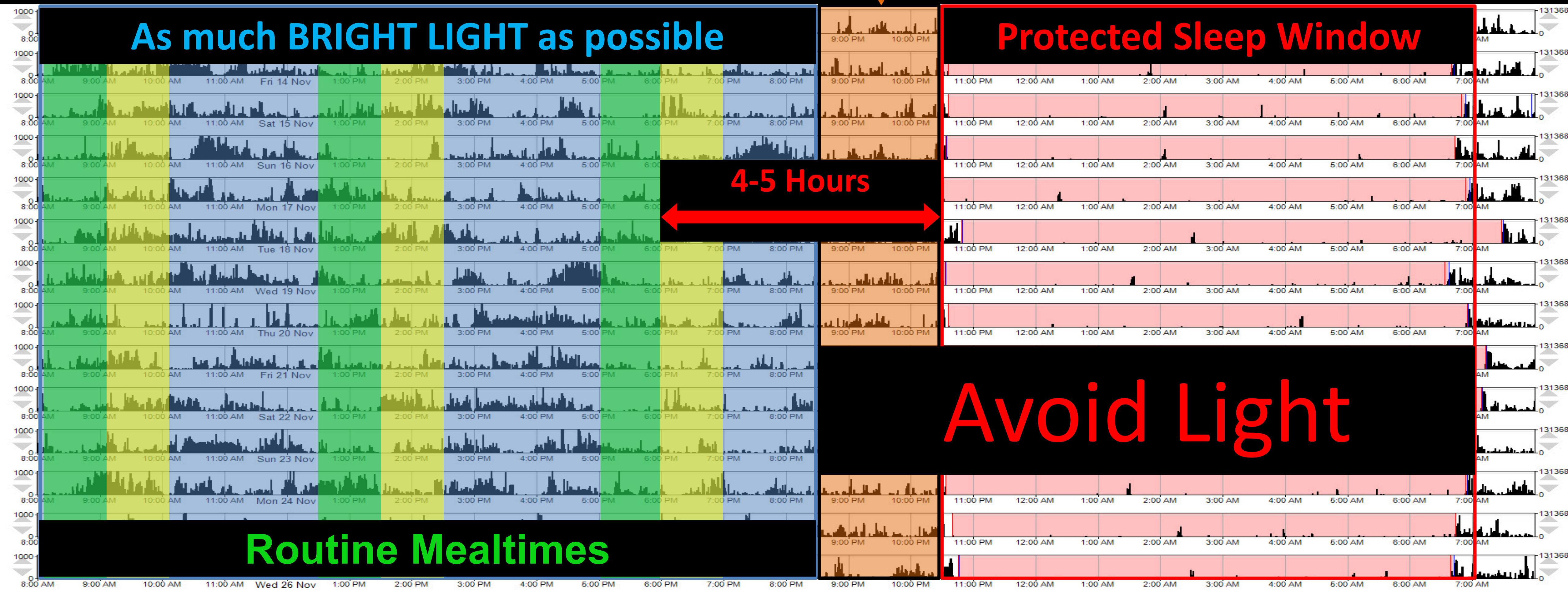
As much BRIGHT LIGHT as possible

Protected Sleep Window

4-5 Hours

Avoid Light

Routine Mealtimes

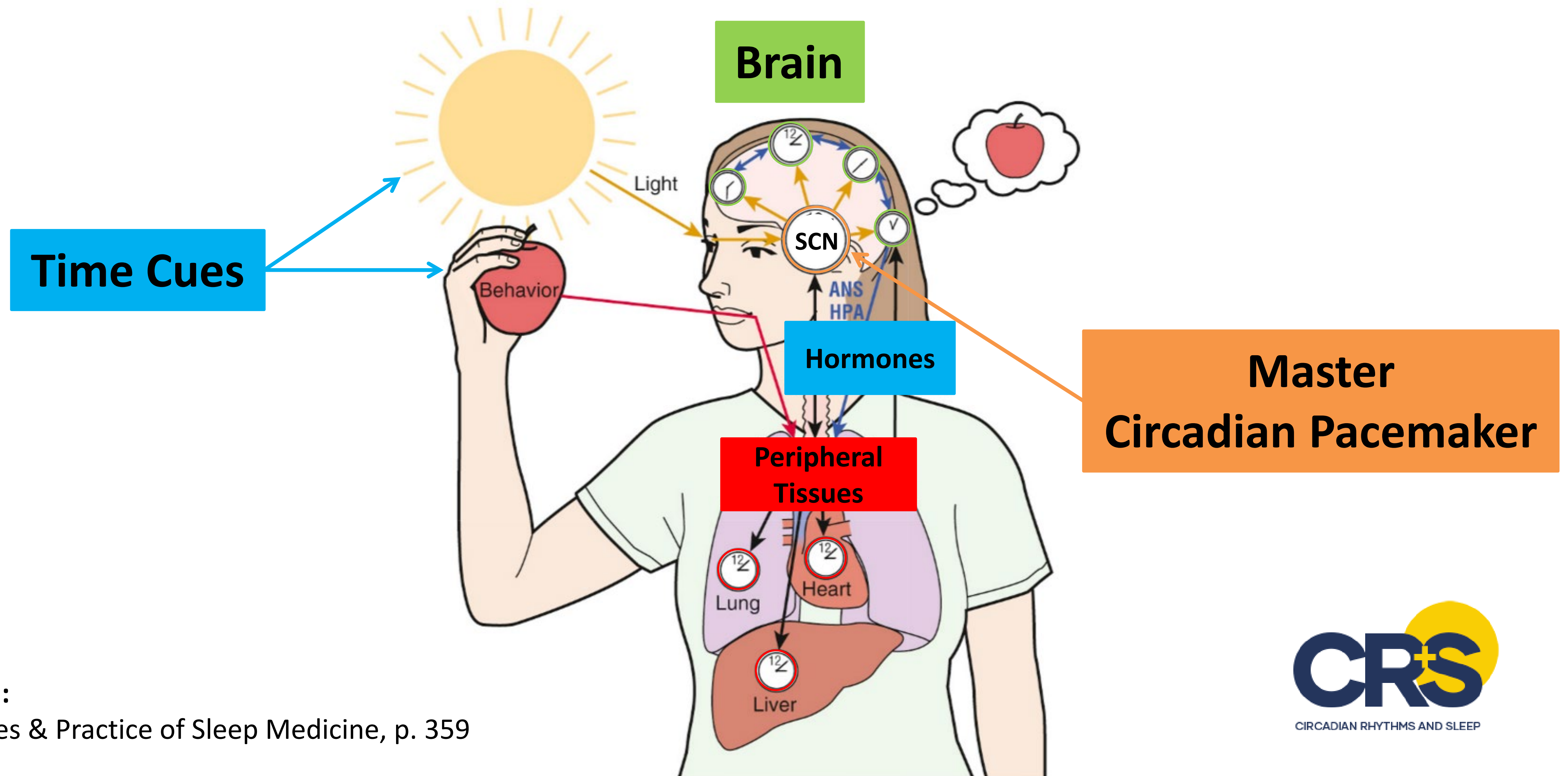






CIRCADIAN RHYTHMS AND SLEEP

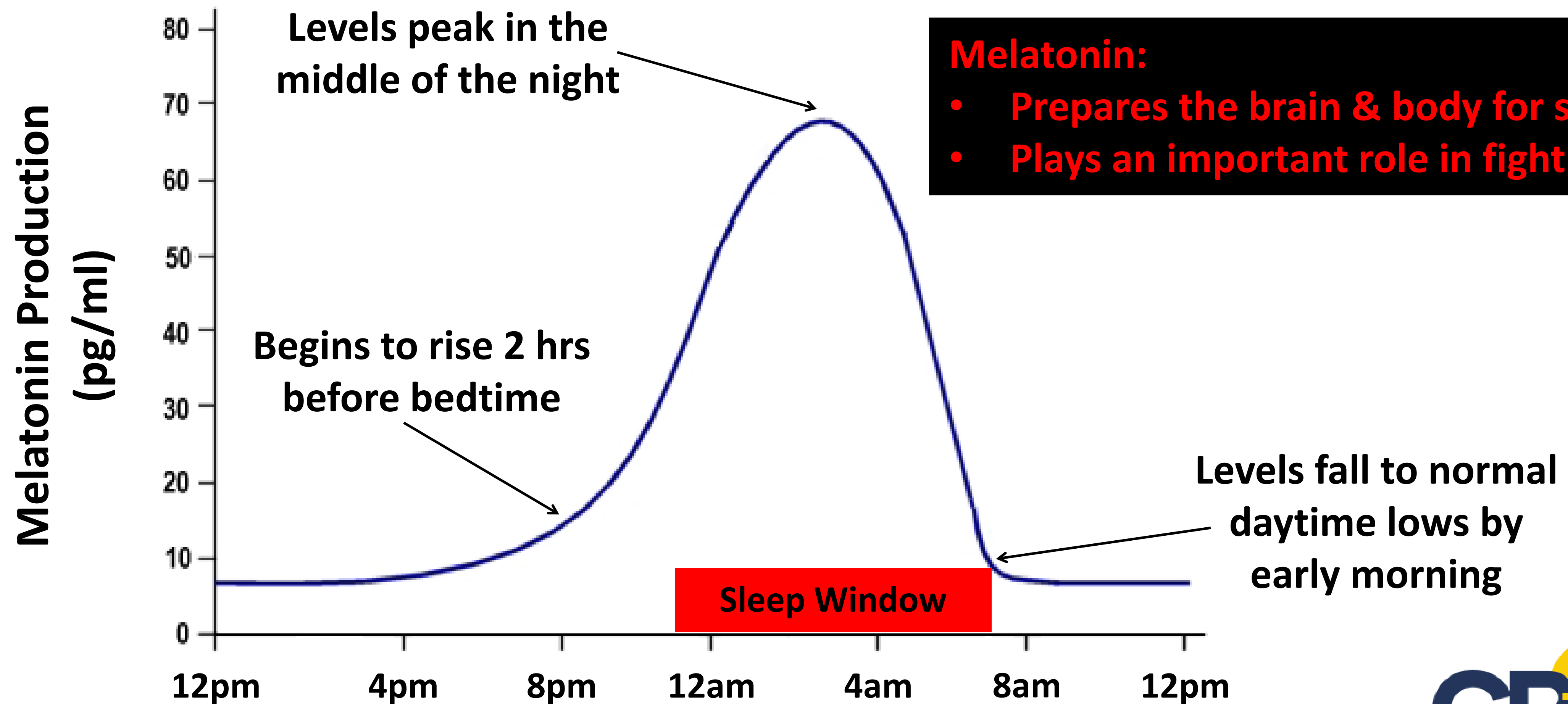
# How many do we have?



**Citation:**  
Principles & Practice of Sleep Medicine, p. 359



# Melatonin Rhythm



## Melatonin:

- Prepares the brain & body for sleep
- Plays an important role in fighting cancer

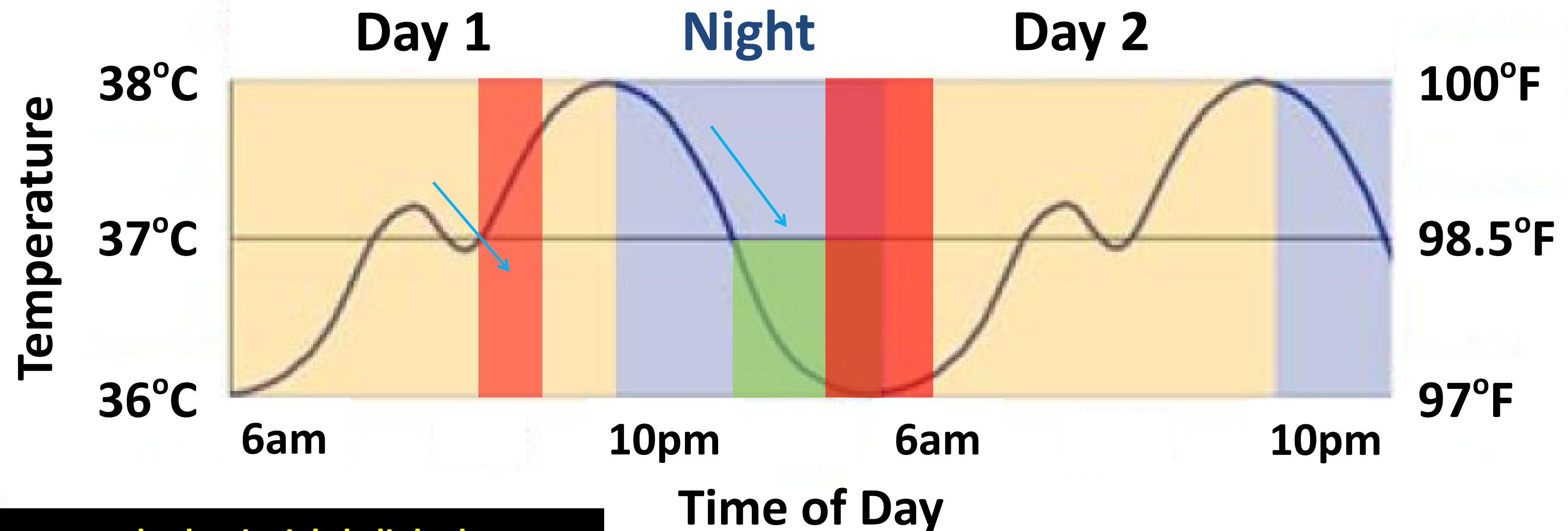
### Citations:

Principles & Practice of Sleep Medicine, p. 438  
Brzezinski, 1997 Melatonin in humans



# Core Body Temp Rhythm

## Circadian Rhythm of Core Body Temperature (CBT)



**Core body temperature rhythm is tightly linked to:**

- Sleep drive (i.e., the urge to sleep)
- REM sleep (concentrated in the 2nd half)
- Cognitive function (lowest after CBT bottoms out)

Citation:

Principles & Practice of Sleep Medicine, p. 370