

01
SLEEP

Olli Sovijärvi / Teemu Arina / Jaakko Halmetoja

BIOHACKER'S HANDBOOK

UPGRADE YOURSELF AND UNLEASH YOUR INNER POTENTIAL



Biohacker's Handbook

Upgrade yourself and unleash your inner potential: Sleep

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This book is based on the personal experiences of its authors, and the advice it contains is based on a combination of experience and scientific research. This book and the viewpoints that it expresses should not be treated as medical advice. Consult with your doctor before ordering or using any of the herbs or supplements mentioned in this book.

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BONUS MATERIALS

The bonus material page (biohack.to/sleep) contains product recommendations, videos, audio recordings, book and article recommendations, references with hyperlinks, and the opportunity to send us your feedback and suggestions. These features are accessible in a browser or a mobile device.



If you need a QR code reader, open the following link into a browser, <http://biohack.to/qr>, and download a suitable application.

PREFACE

**BY BEN GREENFIELD, AUTHOR OF THE NEW YORK TIMES BESTSELLER
BEYOND TRAINING: MASTERING ENDURANCE, HEALTH AND LIFE**

When Teemu Arina first sent me a sneak peek of the *Biohacker's Handbook*, I have to admit that I was a bit wary. After all, biohacking is nowadays such a trendy, over-used term that much of the current literature – on everything from self-quantification to smart drugs to sleep – is simply the same old advice copied, repeated, and presented in new ways. You've no doubt experienced this phenomenon when reading an article on optimizing your health and encounter instructions to "sleep in a dark room", "exercise using high-intensity intervals" and "mix fats in your coffee". Yawn.

So, when I began reading the first chapter of the handbook, I was pleasantly surprised. The chapter opens with an explanation on sleep and sleep cycles that engages you with incredible detail on what happens to your brain and

body during sleep – detail that you simply will not find by Googling or speaking to a sleep physician. As the chapter spills into a thorough description of how your circadian rhythms operate, you realize that nearly every sentence is backed with multiple relevant research studies. Then the even better stuff begins: tools for upgrading sleep, in which you discover everything from the best mattress and futon choices, to the optimum humidity, to which plants are best in your bedroom, along with a host of other advice that you won't find elsewhere.

This book is different. Fresh. Real. It's a combination of obvious time spent in the trenches and rigorous scientific research. I could barely contain my excitement to finish the sleep chapter and move on to the content on exercise, mind, work and nutrition.

Then, my suspicions about authors Teemu, Jaakko and Olli were confirmed when I traveled to Finland to speak at the *Biohacker Summit*. I was transported into a biohacking world unlike any other I had experienced: a world that combined natural living concepts – such as forest foraging for wild mushrooms and superfoods; detoxifying in old, wooden smoke saunas; absorbing minerals; and engaging in cold thermogenesis while swimming in the Baltic Sea.

A world that also combined cutting-edge modern concepts – such as light–sound machines that build new connections in the brain, chairs equipped with pulsed electromagnetic frequencies, and rings that measure respiration, body temperature, heart rate variability and more.

Better yet, this new and unique version of well-researched, “holistic” biohacking was free of snake oils, sales pitches and pseudoscience. It was legitimate, thorough, and steeped in studies. In other words, I realized that these guys are the real deal.

I will readily admit that I’m very cautious about which books I recommend. However, when it comes to a cookbook for enhancing your brain, your body and your life using every cutting-edge tool and technique imaginable, and doing so in a manner that takes into account your health and longevity, along with the latest research, you will not find a better companion than the *Biohacker’s Handbook*. This book now holds a prioritized, well-deserved spot on my list of go-to resources for optimizing the human machine, and I’m pleased that you too have discovered the magic within the pages you are about to read. Enjoy the experience.



Ben Greenfield

Author, speaker, biohacker
BenGreenfieldFitness.com

DEAR READER!

You are holding in your hands the *Biohacker's Handbook*, which weaves together novel perspectives on technology, nature and self-development. The biohacker sees his or her body as a complex system that can be probed, analyzed, understood, and put to test. Such controlled experimentation (i.e. biohacking) can be used to pursue self-development and deeper self-understanding.

The idea for writing this book (which combines studies, insight and visual materials) was born from the insatiable thirst of its three authors for optimizing bodies and minds, both on the individual and collective levels. Technology expert **Teemu Arina**, nutritional expert **Jaakko Halmetoja** and medical doctor **Olli Sovijärvi** met in the spring of 2013 to discuss the big challenges of our time: work pressure and incessant stress, and their consequences to health and well-being.

This book is written for the busy person who burns the candle at both ends. Some have tried to find equilibrium by lifestyle changes – for example through dietary interventions, exercise routines and time management techniques – only to end up back at square one. Indeed, how can people learn to know themselves, find a balance, and successfully execute their plans for change, when they are so stressed?

This book contains tools for those of you who are self-made pioneers, journeying into the unknown, towards a higher understanding of yourselves. It teaches you to go deeper, to dismantle inner locks, to open new doors, to test your own beliefs, and to overcome any of the limits of your own body and mind.

Whatever your background or goal, finding a balance with your environment is paramount.

AUTHORS



OLLI SOVIJÄRVI, M.D.

Dr Olli Sovijärvi is a pioneer of holistic medicine in Finland. At the beginning of his career Dr Sovijärvi worked as a medical duty officer at the Finnish Red Cross Blood Service. In 2006 he graduated from the University of Helsinki with a Licentiate degree in Medicine and became self-employed in 2008. In 2010–2011 Dr Sovijärvi completed an Integral Theory degree at the John F. Kennedy University, focusing on psychology and philosophy.



For the first five years of his career as a physician Dr Sovijärvi was employed by Finland's first medical recruitment agency. The job description involved scheduled patient care as well as emergency care and being on call. He has worked at nearly 50 different clinics around Finland.

His numerous media appearances, social media articles and Finland's first health podcast have expanded the general public's awareness of what health care can be. Dr Sovijärvi has also acted as consultant to various companies and service providers operating in the fields of wellness and health technology.

Since 2013 Dr Sovijärvi has been practicing medicine at a private clinic that specializes in nutrition and holistic health care. The clinic employs physicians and nurses practicing functional medicine. The clinic features the only trace element laboratory in Finland. He also runs training sessions and presentations on the topics of biohacking, performance optimization, nutritional issues and maintaining the intestinal balance. In his free time he enjoys athletics, playing with his child, music and good humor.



TECHNOLOGY EXPERT TEEMU ARINA

Teemu Arina is a world-renowned expert on digital work, learning and leadership, a serial technology entrepreneur and a speaker specializing in futuristic themes. He is also a front man of the Quantified Self movement in Finland as well as the founder and curator of the *Biohacker Summit* event.

Mr Arina is considered one of the key thinkers of digitalization worldwide. His special areas of interest include key issues in online learning, social media, digital work, digital health and holistic well-being. He is a 2015 Leonardo Award Laureate with the theme "Humanity in Digitization". The science award is sponsored by the European Parliament, the German Ministry of Education and Research and UNESCO. It is awarded annually to individuals who have produced pioneering work in the field of learning.

As a professional speaker, Mr Arina gives an average of 100 lectures per year in countries such as the United States, the United Kingdom, Japan, the Netherlands, Italy, Spain, Russia and Germany. In Finland he was a finalist for the Speaker of the Year award. Mr Arina has consulted senior management on initiatives involving digitalization, coached startup businesses and acted as the chairperson for steering committees of online learning development projects funded by the European Union.

He started his first technology company at the age of 16 and worked as a high school teacher at 17. Through teaching he developed an interest in online learning, intelligent human behavior and overcoming various boundaries. In his free time Mr Arina enjoys tinkering with technology, cycling, photography, spending time outdoors and cooking.



NUTRITION EXPERT JAAKKO HALMETOJA

Jaakko Halmetoja is a nutrition expert, non-fiction writer and active lecturer. He is passionate about maintaining a state of exceptional health through nutrition and lifestyle in a way that is fun and enjoyable.

Known as a pioneer of the superfood phenomenon, popularizer of the chaga mushroom and other medicinal fungi and “chocolate alchemist”, Mr Halmetoja has introduced the general public of Finland to the health benefits and unique uses of various foods and medicinal plants through TV and radio appearances and more than 600 public lectures.



Mr Halmetoja has been running a business since he was 20 years old. He trained as a paratroop jaeger in the Finnish Defence Forces and has previously won the Finnish championship in submission wrestling. As an entrepreneur he manages cafés that specialize in producing super-healthy delicacies. More recently Mr Halmetoja has acted as an advisor to several growth companies operating in the health sector, in Finland as well as internationally. Jaakko spends his free time in the garden or outdoors getting exercise – with a smile on his face.

Visual design, layout and illustrations: **LOTTA VIITANIEMI**

Advisor and studio critic: **DR. SAM INKINEN**





01
SLEEP



“Sleep is the best meditation.”
– Dalai Lama (b. 1935)

*“Man should forget his anger
before he lies down to sleep.”*
– Mahatma Gandhi (1869–1948)

“If you can dream it, you can do it.”
– Walt Disney (1901–1966)

“Sleep is half of my training.”
– Jarrod Shoemaker (b. 1982)

“I’LL READ JUST ONE MORE ARTICLE...”

John is a modern-day knowledge worker who, despite the fact that it is already late, decides to browse through just one more article before going to sleep. Some vital emails are also awaiting his response. On top of it all, tomorrow’s presentation is still not ready. The rainy Thursday night is destined to be long, like many previous nights. Although his eyes feel heavy, push on he must.

Despite John’s mounting tiredness, the presentation gets finished. It is 3 o’clock at night already. John shuts down his computer and goes to bed, even though plenty of work remains. He has difficulty going to sleep, although the alarm is set to ring in 4 hours and 30 minutes. He is dead tired. Anxiety lurks as thoughts about tomorrow’s presentation wander through his mind. The sound of cars passing beneath the window disturbs his rest. John stares at the blue light emanating from the wireless router. His eyes are red and squinted. He wastes another hour twisting and turning in bed, until sleep finally descends upon him.

In the morning, the noise of the alarm pierces his dormant mind. In confusion, John rolls around in bed for another 10 minutes. He doesn’t feel like waking up, although he absolutely must. He only has 45 minutes to get out of the

apartment. His thoughts are fuzzy and unfocused, and his willpower is gone. In stress, he charges out of the bed. He doesn’t have time to prepare breakfast or eat anything. Driving out of his garage, he almost collides with another car. Close call.

“I must get a cup of coffee.” At the conference cafeteria, face flushing red he quickly downs a cup of coffee, followed by another, waiting for the conference to start. After a while it is his turn to take the stage. John’s presentation doesn’t go exactly as he envisioned: He is mixing up with his words, slides appear to have spelling mistakes and arguments seem disintegrated and clumsy. Final judgement from the audience: lukewarm applause. “Well, that wasn’t exactly my best performance”.

At lunchtime, he gobbles down more food than usual. After the meal he visits the restroom. His stomach is acting up and his chest hurts, too. “What a nighmarish day!” he mumbles. He feels like going straight back to bed, to make up for those lost hours of sleep, but his various afternoon meetings are right around the corner. “Ugh... At least it’s Friday.”

OWL – THE KING OF THE NIGHT

"When the owl sings, the night is silent."

– Charles de Leusse (b. 1976)

The archetype of sleep is naturally the owl – the quiet observer of night-time and dusk. The owl is known for its sharp night vision and nearly silent flight. Owls also have a very keen sense of hearing thanks to their large ear openings and the feathers that bounce sound waves.

In ancient times it was believed that eating owl eyes improved night vision. The owl appears in folklore as the symbol of wisdom. In Ancient Greece, the owl was the symbol of Athena, the goddess of wisdom.

In the dream world, the owl is also considered the symbol of insight, magic and expanded consciousness.



WHY SLEEP MATTERS

DID YOU KNOW

48 % OF AMERICANS REPORT
INSOMNIA OCCASIONALLY, WHILE
22 % EXPERIENCE INSOMNIA EVERY
OR ALMOST EVERY NIGHT.

SOURCE: NATION SLEEP FOUNDATION

John's case underlines the importance of a good night's sleep for performance, cognitive functioning and health. Using appropriate strategies, John could have fallen asleep earlier, improved the quality of his sleep, and faced the challenges of the day with ease. John was already tired to begin with and the night stretched even longer due to decreased productivity. With sufficient sleep behind him, he would have achieved better results in a shorter time frame. The presentation, too, would have been of higher quality and delivered with fewer mistakes.

There is plenty of evidence that sleep is important. We can all recognize its value in our personal lives. Sleep is an anabolic state during which the body replenishes its energy storages, regenerates tissues and produces proteins. Without enough sleep, the human body cannot function properly.

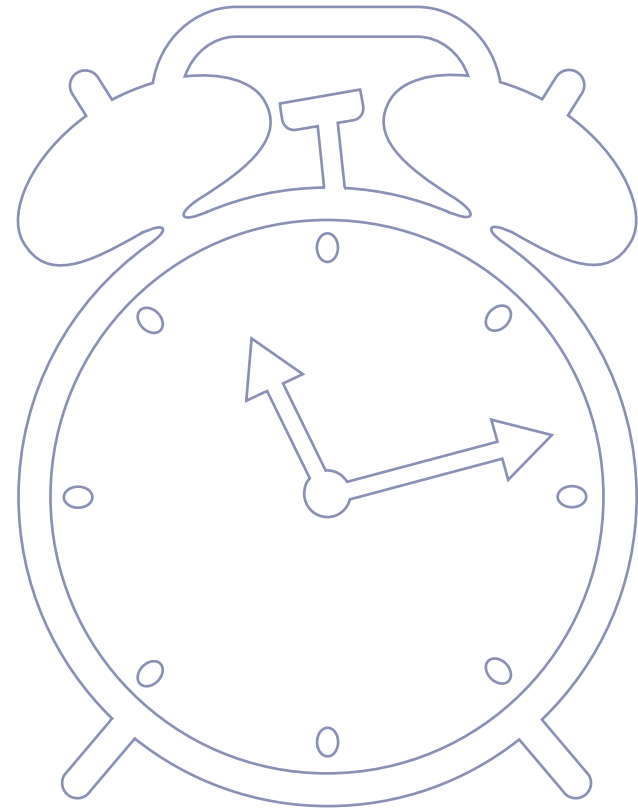
Staying up late releases cortisol, which is known to increase the production of cell signalling molecules like cytokines, which are a sign of inflammation. Sleep deprivation causes unhealthy changes in the immune system of the body, including white blood cells. The common marker of inflammation, C-reactive protein (CRP), may also increase.¹

Sleep deprivation has been shown to raise systolic blood pressure and increase the consumption of fat-heavy and sugar-heavy foods. Chronic sleep deprivation leads to insulin resistance, even with young test subjects. Lack of sleep has been shown to be a predictor of weight gain,² and increases the risk of traffic accidents,³ the diagnosis of type 2 diabetes,^{4,5} mental illnesses such as depression,⁶ seasonal flu⁷ and cardiovascular diseases.^{8,9}

Sleeping problems have increased in conjunction with sitting and the increased usage of electronic devices. According to a 2011 study by National Sleep Foundation, 63 % of Americans say they do not sleep enough during the week. About 15 % of adults between 19 and 64 say they sleep less than six hours on weeknights. 95 % use some type of electronics like a television, computer, video game or cell phone at least a few nights a week within the hour before bed. Artificial light exposure can disrupt sleep by suppressing release of the sleep-promoting hormone melatonin.¹⁰

From the biohacker's perspective a sufficient and good sleep at night contributes to better performance, awareness, mood, ability to handle stress, skin quality,¹¹ sports performance, the capacity to learn new things, and the ability to maintain general wellbeing. The aim of the biohacker is to reserve as much time as possible for important things, while simultaneously making sure that sleep is not compromised. This ensures that recovery becomes possible and that new learnings can be integrated and assimilated.

It is common wisdom that adults should get at least 7 to 8 hours of sleep every night. A systemic review conducted at the University of Warwick observed that the risk of mortality amongst people who got 6 hours or less of sleep per night increased by 12 %, but also the risk of mortality amongst those who slept for nine hours or more increased by as much as 30 %.¹² However, sleeping ten hours is beneficial for those with increased need for sleep, for example for recovering athletes and growing children. The studies also show that there are some people – i.e. those who carry a variation of the DEC2 gene – who can survive with two hours less sleep on average than other people. What is then enough? How can we make sure we get enough quality sleep without sacrificing any of the vital tasks that we want to get done every day?



SLEEP STAGES – THE SECRET TO BETTER SLEEP

Sleep alternates between two phases: orthodox sleep and REM sleep. These phases can be distinguished from one another in EEG (electroencephalography). The majority of sleep is orthodox sleep (deep sleep, quiet sleep, slow-wave sleep) that can be further divided into three NREM (non-rapid eye movement) stages: N1, N2 and N3. These are in contrast to REM sleep, or R sleep (paradoxical sleep, rapid eye movement sleep).¹³

W – Wakefulness (beta waves): infrequent and low-frequency beta waves predominate in the EEG.

Meditative state with one's eyes closed: increasingly synchronised alpha and theta waves are visible in EEG, along with increased production of serotonin. A number of proven health benefits have been observed while using techniques such as meditation to increase one's alpha and theta waves.^{14 15 16}

N1

N1 – The first stage (theta waves, 4–8 Hz): EEG shows irregular oscillations. Theta waves are slower and higher in frequency than alpha waves. This is a transitory phase from wakefulness to light sleep. The sleeper changes position

frequently, and is in a deep meditative state. However, if someone were to wake the person up, he or she might not feel like they had fallen asleep. Duration: about 10 minutes.

N2 – The second stage (sleep spindles, 11–16 Hz): A period of light sleep, during which there is little movement and the breathing is quiet. The second stage involves periodic surges in brain wave frequency, the so-called sleep spindles. Brain activity during the second stage is more active than in the first stage. Dreaming becomes possible. Getting enough stage two sleep improves motor skills.¹⁷ The person can still be easily woken up during this stage. Duration: 20 to 30 minutes.

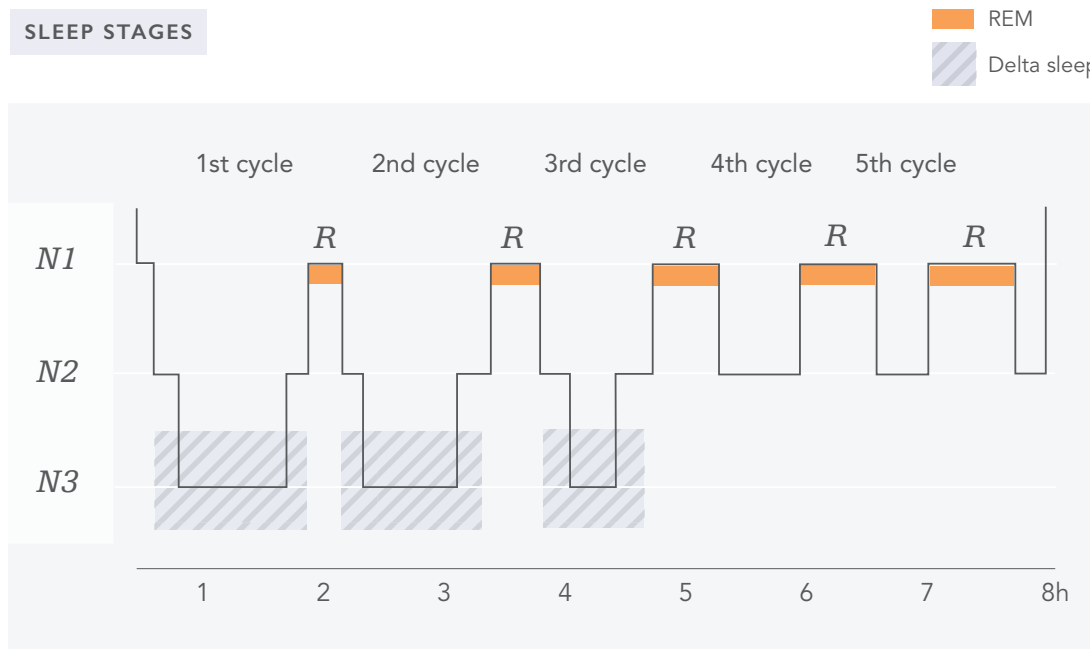
N2

N3 – The third stage (delta waves, 0–8 Hz): A period of deep sleep, where breathing is stable and EEG readings consist of slow delta waves. Muscles are completely relaxed, and the pulse, body temperature and blood pressure have decreased. Production of human growth hormone begins, and the regenerative mechanisms of the body are activated. The sleeper will not wake if another person walks into the room. Pulse, blood pressure and body temperature are at their lowest. Duration: 30 to 40 minutes. Elderly people experience a shorter duration, by as much as six minutes.

N3

R – REM Sleep (alpha and beta waves): During REM sleep, the brain is awake, but the rest of the body is asleep. The muscles in the neck and the body are paralysed to prevent sleepwalking. During REM, the eyes are moving under the eyelids, and dreaming is at its peak. The typical adult has an average of 4 to 5 REM stages every night. The first stage lasts about 10 minutes, while subsequent stages are often

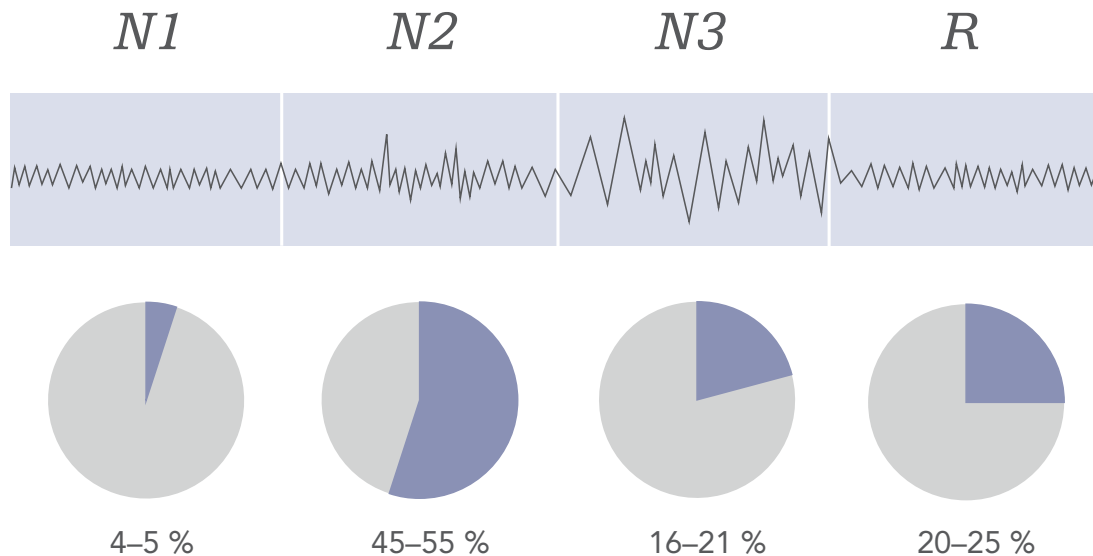
longer, around 30 minutes. REM sleep is important for the regeneration of the brain's nerve cells.¹⁸ Tests measuring the effects of sleep deprivation have shown that REM sleep is absolutely indispensable as deprivation leads to irritability, fatigue, memory loss and reduced capacity for concentration. Infants experience a lot of REM sleep: On average 50 % of the total 16 hours of sleep per night is REM sleep.¹⁹



During a typical adult's 7 to 8 hour sleep, the sleeper moves from the first stage, to the second, and to the third stage, then back again to the second stage. After this, the sleeper either wakes up or goes straight to REM sleep. From then on, the cycle repeats itself some 4–5 times.

One full cycle lasts about 90 minutes. From the perspective of getting a good night's sleep, it is paramount to maximise the amount of deep sleep (N3) by going through at least three cycles. Getting enough sleep reorganises one's memory²⁰ and improves one's learning capacity.²¹ In the later cycles, the amount of REM increases and the amount of deep delta sleep decreases, until eventually the latter disappears completely.

DIFFERENT STAGES OF A SLEEP CYCLE AS SEEN ON EEG



CIRCADIAN RHYTHM FOR MAINTAINING ENERGY LEVELS AND IMPROVING SLEEP

Circadian rhythms are biological processes linked to the cycles of the day. Many bodily functions vary according to these rhythms, including the following:

- **Body temperature**
- **Pulse rate and blood pressure**
- **Reaction time and performance**
- **The production of melatonin, serotonin and cortisol**
- **Intestinal activity**

Travellers who make frequent long-distance flights often have direct experience in the importance of getting acclimated to a new time zone. One's inability to adjust can lead to sleeping problems and disturbances in cognitive functions. People who do shift work, or work under bright lights, can face similar issues. Problems arise whenever the daily rhythm is disturbed.

Human beings have an internal clock that lasts about 25 hours and resets itself daily when it is exposed to daylight.²² Blind people can thus have sleeping problems, and yet, even without the ability to see sunlight, their bodies function mostly just fine.²³

Light clearly has a central role in the regulation of our daily lives, and can be used to reset our circadian rhythms.

Luminosity should reach at least 1000 lux in intensity to have such an effect – compare this to the 320–500 lux in a typical office and the 32,000 to 130,000 lux in direct sunlight.

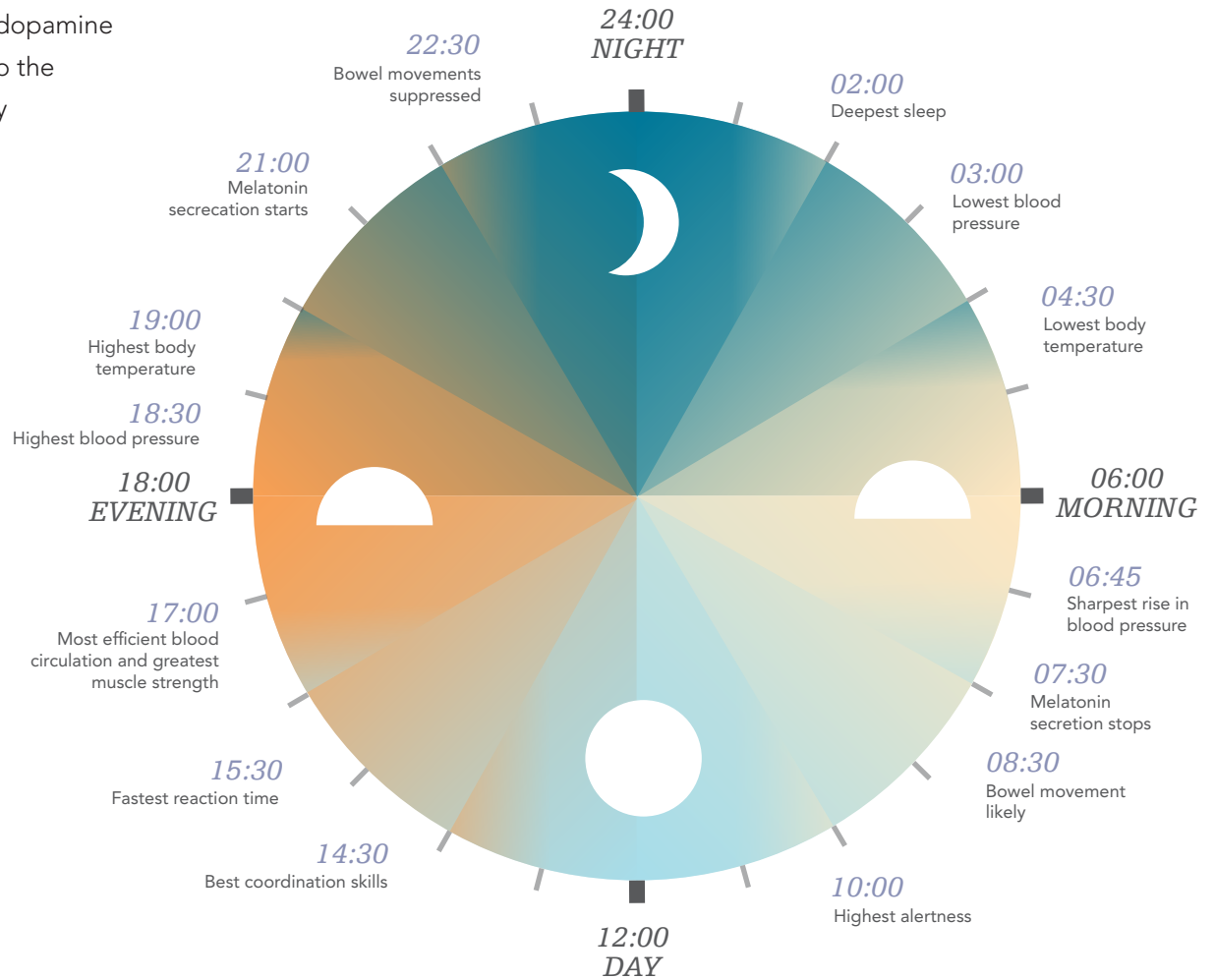
Light directly affects the production of melatonin, the so-called “hormone of darkness”, which is secreted mostly by the pineal gland during the hours of darkness. Melatonin plays a crucial role in the regulation of the sleep–wake cycle.

A newborn baby does not produce melatonin until it is three months old. From then on, the production increases towards adolescence, and finally settles down in adulthood. In a mid-aged person, the production of melatonin starts to decrease again. It is suspected that this is one of the reasons why older people do not usually get as much sleep as younger people.

The intensity of light isn't the only factor in melatonin production; its wavelength also has an effect. During daylight, blue light (short wavelength, around 420–485 nm) dominates, which blocks melatonin production. Research shows that white LED lighting is five times more efficient at blocking the production of melatonin than incandescent light bulbs.²⁴

In order to optimize sleep, it is important to understand how other hormones influence circadian rhythms. High levels of dopamine and serotonin have been linked to the feeling of alertness, and adversely low levels to sleepiness. Cortisol, known as “the stress hormone,” contributes to sudden wakefulness in the middle of the night. Its production is especially active for the first 30 minutes or so after waking up.

CIRCADIAN RHYTHM²⁵

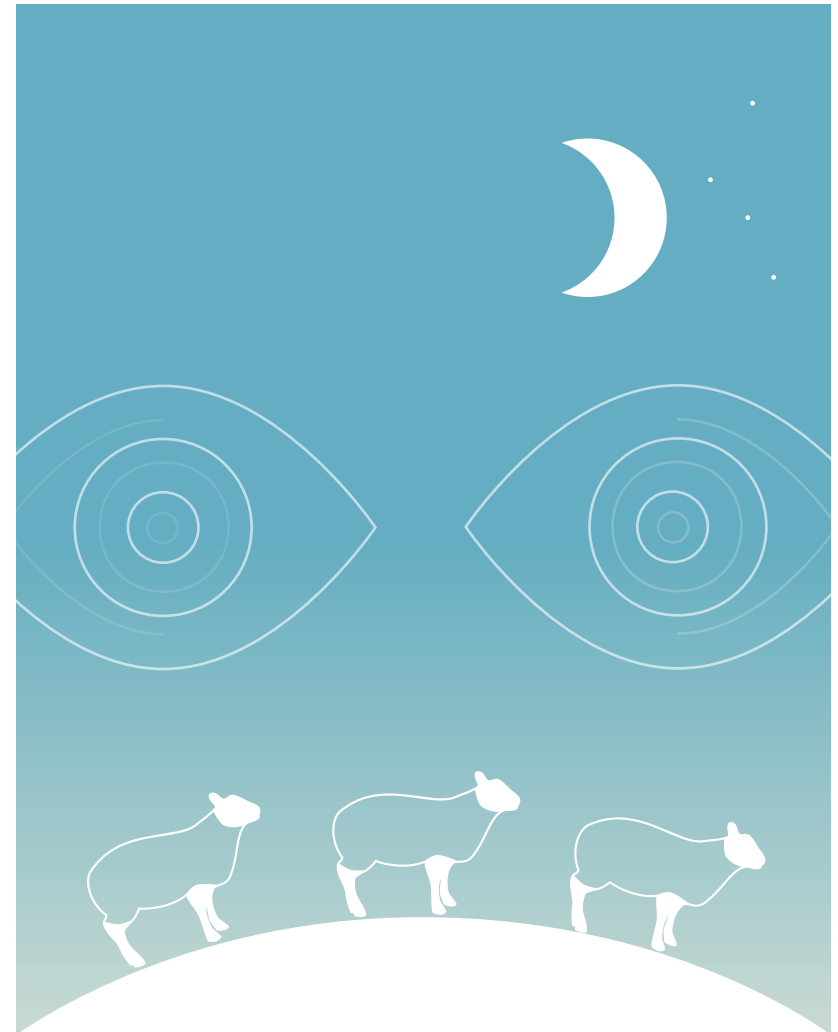




TOOLS FOR UPGRADING SLEEP

People who experience sleeping difficulties may first turn to prescription sleeping pills. Sleeping pills are a \$1.6 billion industry in the United States alone.²⁶ The use of sleeping pills, however, carries a range of risks. These include dependency and withdrawal symptoms – such as sleeplessness, tiredness and memory problems – undesirable brain changes, and many others. The drug Halcion, for example, which was withdrawn from the UK market in 1991 but is still available in most other countries, despite it causing depression and memory loss.²⁷ In other words, the harm caused by sleep medication may outweigh its benefits.

Let's start from the basics. There are various proven methods backed by research that can be tested before relying on sleeping pills that often surpass natural mechanisms in the body and may cause more harm than good.



SETTING UP YOUR BEDROOM

DARKENING THE ROOM AND OPTIMAL LIGHTING

Sunlight, moonlight and LEDs on electronics can disturb sleep. Instead, try:

- Using blackout curtains
- Darkening the LEDs of your electronic devices with black adhesive tape
- Switching lamps to brands that do not emit the blue spectrum of light
 - Special lamps that change the spectrum of light according to the cycle of the day
 - Dim salt lamps



BED QUALITY AND ERGONOMICS

Bed materials that do not breathe may induce allergies, and beds which are unergonomic may disturb your sleep. Instead, try:

- A mattress or futon made of organic cotton, wool, hemp or natural rubber (instead of being covered with polyurethane foam and chemicals that are potentially allergenic)
- Oat, cherry, spelt or buckwheat pillows



- Choosing materials for your sheets and blankets that promote better thermo-regulation (organic cotton, leather, silk, etc.)
- Sleeping without clothes (so that the rubber bands on the waist cannot block your lymphatic system)
- Sleeping without a pillow
- Using a pillow that supports the neck
- Having a pillow between your legs (when sleeping on your side)
- Sleeping on your back or right side. Other positions put stress on your internal organs.
 - Use a heavy comforter and bed sheets if you have a tendency to change positions frequently during the night
 - Sleeping on your stomach is not recommended to anybody (except to those suffering from spinal disc herniation)
 - Sleeping on your back is not recommended if you suffer from sleep apnea due to the risk of respiratory arrest



ELECTROMAGNETIC POLLUTION

Some people may experience sensitivity to electromagnetic radiation. Dozens of studies have been conducted on electromagnetic hypersensitivity (EHS), but its existence has not been successfully verified. Some studies suggest that “grounding” can alleviate insomnia.²⁸

Instead, try:

- Using a grounding mat
- Placing WLAN routers and mobile phones at a distance, and switching mobile devices to flight mode
- Walking barefooted during the day, or using grounding (earthing) shoes
- Scanning the radiation levels in the bedroom (with EMF and EMC detectors)

AIR QUALITY

Research shows that poor indoor air quality affects respiratory organs and can thereby cause sleeping problems.²⁹ Instead, try:



- Ventilating the bedroom during the day
- Excluding the possibility of mold (DIY measuring kits or measurements done by professionals)
- The use of house plants to increase humidity, turn carbon dioxide into oxygen, and release negative ions into the air (for example, golden cane palm (*Dypsis lutescens*), snake plant (*Sansevieria trifasciata*) and devil's ivy (*Epipremnum aureum*)³⁰)



- Ventilating the bedroom properly at night, but avoid a direct draft near the head
- Air filtering (UV, HEPA, carbon filtering, photocatalytic oxidation, air ionizer)
- Adjusting humidity with technical tools. Most people prefer 30–50 % humidity.
- Having a house that ventilates properly and choosing appropriate indoor materials: natural construction methods, eco paints and finishing materials
- Using specific incenses and relaxing essential oils (ylang ylang, vanilla, lavender) may increase sleepiness at the cost of air quality



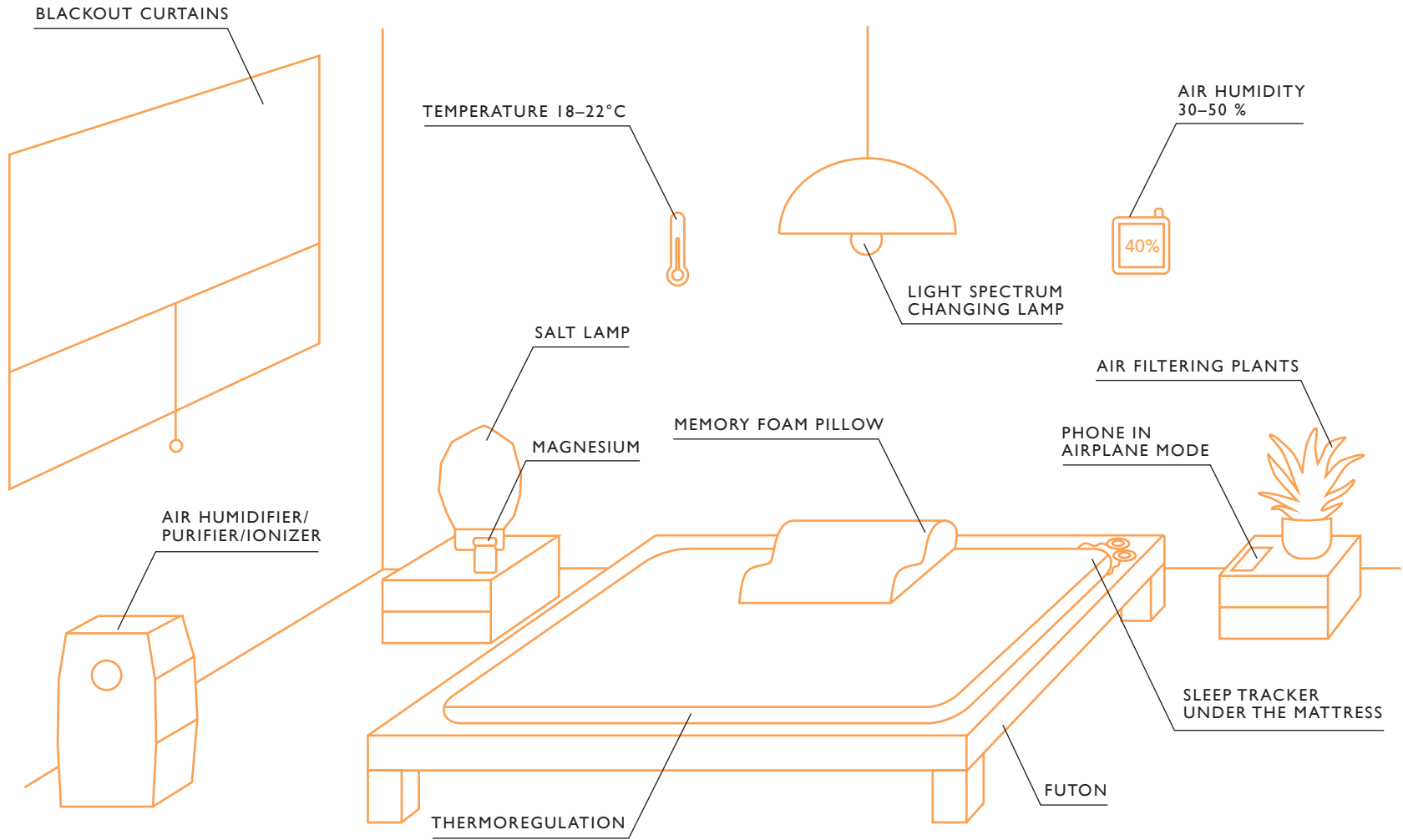
TEMPERATURE

The temperature of the body drops during sleep. Sleeping in a room that is too hot, or too cold, makes it difficult to maintain optimal thermoregulation. Instead, try:



- Adjusting radiators and air conditioning
- Keeping windows open and ventilating the space properly
- The optimal temperature for most people is around 18–22 degrees Celsius (64–69 Fahrenheit)

BIOHACKER'S BEDROOM



PREPARING DURING THE DAY TO GET BETTER SLEEP AT NIGHT

GET ENOUGH BLUE SPECTRUM LIGHT

Getting enough blue spectrum light (short wavelength 450–490 nm) during the day, especially right after waking up, is an important factor in maintaining one's alertness and circadian rhythm.

- Spend time in sunlight
 - Take a minimum 15 minute walk daily
 - Set up your workstation next to the window
- Avoid the use of sunglasses during the day that block blue spectrum light. It may start the production of melatonin at the wrong time.
- Use a full spectrum light therapy lamp

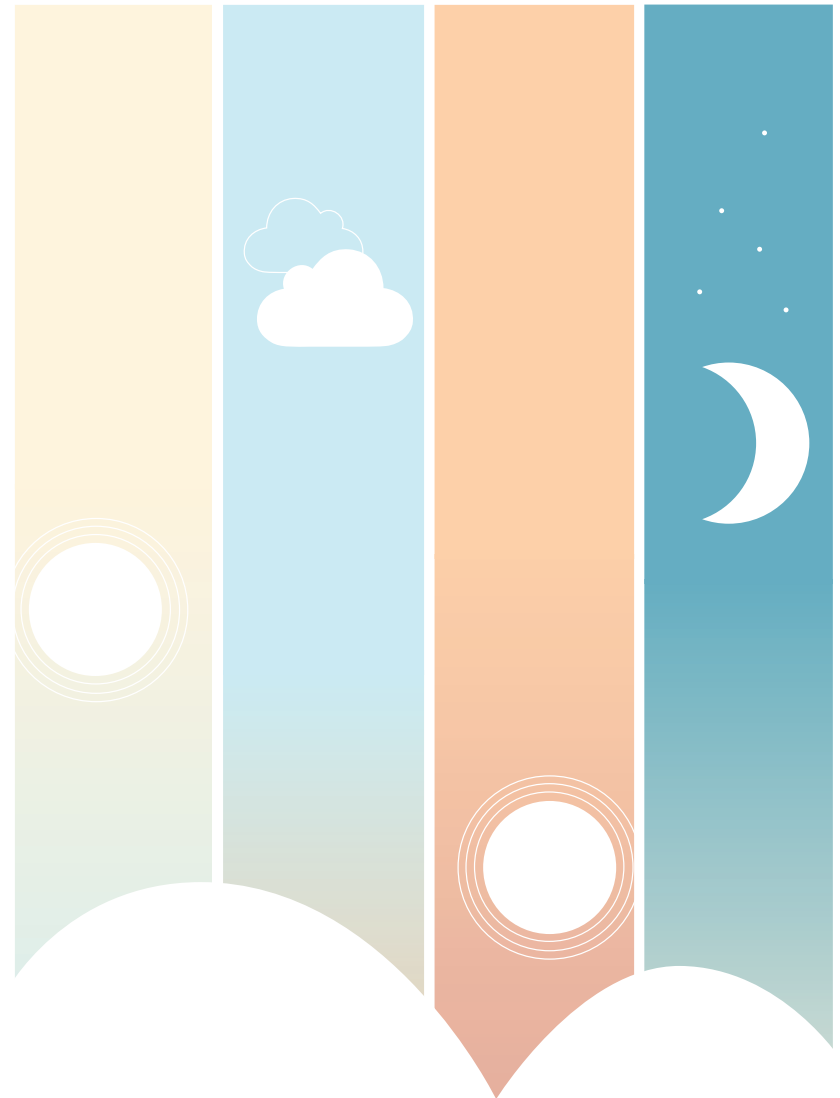
TAKE REGULAR DAILY EXERCISE

- 20 to 30 minutes of exercise daily helps balance the daily rhythm³¹ and significantly improves sleep quality³²

GET RID OF MUSCLE TENSION

Pain in the muscles and connective tissue may cause insomnia.

- Try acupuncture, massage, sauna, yoga and stretching
- Take relaxing baths (e.g. with magnesium chloride in the bath water during evenings)



GETTING READY FOR BEDTIME

GO TO BED BY THE CIRCADIAN RHYTHM

Going to bed and waking up at the same time every day increases the quality of sleep and decreases health risks.³³

- Balances nocturnal body temperature
- Minimise moonlight during the night, because it can interfere with melatonin production³⁴



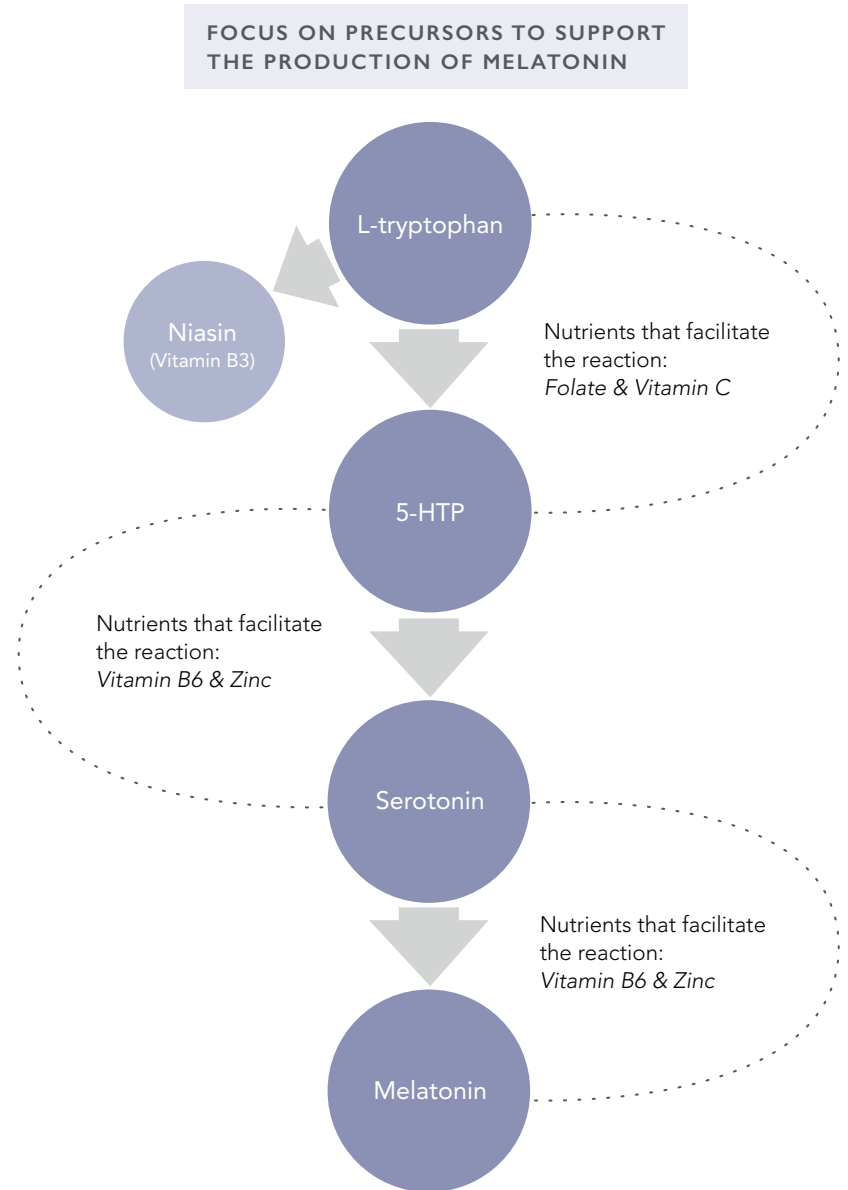
TAKE NUTRIENTS THAT HELP WITH FALLING ASLEEP AND IMPROVING SLEEP QUALITY

Supplements and adequate nutrients in your diet can support the body in the production of melatonin, help the body to relax, and induce brain wave patterns associated with the N1 phase.

- Magnesium citrate acts as a mild sedative that helps the body to fall asleep. It also increases the amount of deep sleep and decreases nocturnal cortisol levels.^{35 36} An appropriate dosage is 400 mg.

- Magnesium glycinate, magnesium glycerophosphate and magnesium taurate also provide amino acids that support liver functions at night. The appropriate dosage varies from 200 to 1000 mg.
- Potassium citrate, or potassium carbonate, works synergistically with magnesium. It can lower the incidence of nocturnal spasms in the limbs, and balance the quality of sleep.³⁷
- Tryptophan acts as a precursor to serotonin and melatonin. Tryptophan levels can be elevated in the evening by consuming some of the following food products about 1 or 2 hours before going to bed: white and brown rice, banana (not overripe), pumpkin seeds, turkey, chicken, eggs, nuts, whole grains, brown rice, lentils, sesame seeds, sunflower seeds, white fish and avocado (not overripe). Calcium and vitamin B6 facilitate the absorption of tryptophan.
- Relaxing adaptogens: lingzhi mushroom (reishi), holy basil and Indian ginseng (ashwagandha)
- Theanine increases alpha waves and can be helpful for falling asleep.³⁸ Experiments with rats have shown that theanine improves the quality of sleep when coffee has been ingested during the day.³⁹
- Zinc naturally raises testosterone levels.⁴⁰ Sufficient levels improve the quality of sleep.⁴¹

- Taurine decreases stress and anxiety,⁴² and increases the amount of the anxiety-inhibiting neurotransmitter GABA in the body.⁴³ An appropriate dosage is:
 - 500–1500 mg of taurine every night, 1 hour before bedtime
 - 250–500 mg of GABA, 2–3 times a day
- Supplements with a therapeutic purpose (only to be used as a last resort):
 - 200 mg of 5-HTP or 3 mg of melatonin an hour before going to sleep. The effect can be augmented with 50 mg of vitamin B6 and zinc. Their combination, ZMA (Zn+Mg+B6), is also recommended.
 - 500–1000 mg L-tryptophan, 1–2 times daily, preferably at night time. It is best absorbed when ingested together with carbohydrates. Folate and vitamin C help in converting it to 5-HTP.
- Take vitamin D in the morning or during the day, with fatty foods. Do not take it in the evening, since vitamin D interacts with melatonin production.⁴⁴



MAGNESIUM

Magnesium is one of the key minerals in more than 200 metabolic reactions. The body contains up to 20–28 grams of magnesium, one half of which is in the cells and the other half in the bones. It is estimated that 68 % of Americans suffer from magnesium deficiency of some type. Measuring the magnesium level in the blood is not sufficient to rule out possible deficiency as only 1 % of magnesium is freely available in the circulation.⁴⁵ Inadequate magnesium intake is associated with vitamin D deficiency as magnesium promotes the synthesis of vitamin D from sunlight on the skin.⁴⁶ Magnesium has significant health benefits – it prevents stress, depression and many chronic illnesses and improves the quality of sleep. Magnesium also has an important role in the energy production of muscle and cardiac muscle cells.



AVOID SUBSTANCES THAT DISTURB YOUR SLEEP

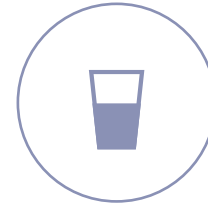
- Avoid caffeine (coffee, tea, energy drinks, guarana, maté) 5–8 hours before going to bed. You can use 1000–2000 mg of vitamin C to make caffeine leave the body quicker (Kakadu plum, camu camu, Acerola cherry, rose hip, ascorbic acid). Alternatively you can chew whole cardamom seeds (5 to 10 pieces) to destimulate the central nervous system.
- Avoid theobromine and theophylline (both found in chocolate and kola nut) 6 to 10 hours before going to bed.
- Limit late-evening alcohol consumption to two doses maximum. Alcohol reduces REM sleep. Enjoy your last glass of alcohol no later than 90 minutes before going to sleep.
- Tyramine increases the production of noradrenaline, which boosts brain activity and keeps you awake. The following food products contain tyramine, so they should be avoided at dinner: bacon, cheese, chocolate, eggplant, potato, sauerkraut, sausage, spinach, tomato and wine.



DRINK BEVERAGES THAT HELP YOU FALL ASLEEP

Some beverages will typically affect the GABA anxiety-inhibiting neuro-transmitter in the brain.

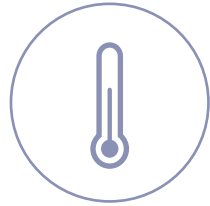
- Valerian⁴⁷ 150–300 mg, at bedtime
- Chamomile 400–1600 mg, at bedtime
- Passion flower 100–200 mg, 2–3 times a day
- Hops 100–200 mg, 2–3 times a day
- Kava 120–150 mg, at bedtime



MAINTAIN ADEQUATE HYDRATION THROUGHOUT THE NIGHT

Dehydration – but also excessive water consumption – can keep you up at night.

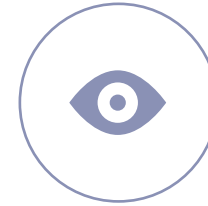
- Drink water, especially if you've consumed common diuretics (like alcohol, coffee or tea)
- Limit your beverage consumption in the evening if you notice you often wake up at night to go to the bathroom. A good dose is 2–3 dl about 90 minutes before going to bed.
- The liver is typically at its most active between 1 a.m. and 3 a.m., and wakefulness during these hours can be a sign of dehydration
- Saw palmetto or nettle root teas might relieve prostate problems



DECREASE YOUR BODY TEMPERATURE BEFORE GOING TO BED

The temperature of the body drops during the night, and the drop can be aided in a number of ways.

- Avoid exercise (= stimulation of the central nervous system and rise in body temperature) for two hours before going to bed
- Induce cold thermogenesis in the evening (e.g. cold shower, winter swimming, or ice bath)
- Try sleeping naked



EMPTY YOUR MIND OF THE WORRIES OF THE DAY

After a long work day, or with a large workload ahead, it is especially easy to get stuck with incessant thoughts, which stimulate brain activity and prevent falling asleep.

- Use meditation to empty your mind
- Stop working an hour before going to bed
- Write down a to-do list for work tomorrow, so that unfinished business does not get stuck in your head
- Write in a gratitude journal before going to bed (e.g. three things that happened during the day that you can feel grateful for)
- Write down positive affirmations (to program your mind for the next day)



TAKE CARE OF NIGHTLY BLOOD SUGAR LEVELS

If blood sugar levels drop during the night, it releases glucose-regulating hormones such as adrenaline, glucagon, cortisol and growth hormone. This process can wake you up.

- Eat no later than two hours before going to bed
- Consume slowly digestible foods (such as meat) no later than four hours before bedtime. This allows the food to be digested in your system.
- Try 1 or 2 tbsp of MCT oil, or omega-3 oil, 30 to 60 minutes before bedtime
- Try 1 or 2 tbsp of collagen or whey protein. Do not mix with sugars.
- Try a spoonful of organic honey to replenish the liver's glycogen reserves. These reserves are depleted in 12 hours. Do not mix with proteins.

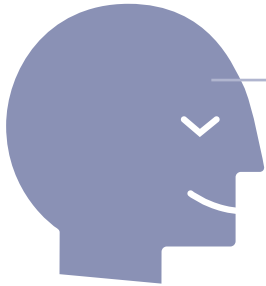


AVOID BLUE SPECTRUM LIGHT IN THE EVENING AND TRY SIMULATING SUNSET

Increasing red spectrum light and decreasing blue spectrum light kickstarts the production of melatonin.

- Avoid using the computer, mobile phone or television, for an hour before going to bed
- If you must use your computer in the evenings, filter out blue spectrum light with an appropriate computer program or a filter (a layer of film) on top of your screen
- Use special shades that filter out blue spectrum light when going to sleep or when visiting the bathroom at night

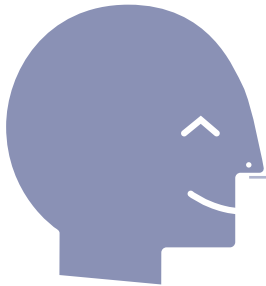
GOING TO BED



RELAXATION AND STRESS RELIEF

Sympathetic nervous system activity can disturb sleep.

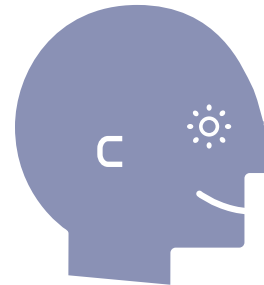
- Relieve stress with heart rate variability (HRV) training before going to bed
- Use a spike mat to improve blood circulation in the skin and the release of endorphins and oxytocin which help you to calm down and relax
- Practice breathing exercises
- Listen to relaxing audio tracks
- Have sex
- Go to sauna



OPENING UP YOUR RESPIRATORY TRACT

Breathing problems can disturb your sleep.

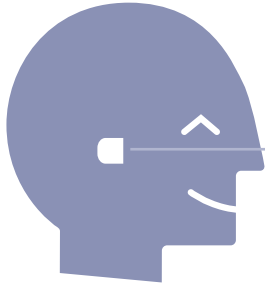
- Learn to breathe through your nose
- Use a nasal strip or a nasal spray to keep your respiratory tract open
- Use a neti pot for nasal cleansing
- Improve the air quality in your bedroom



SOUND AND LIGHT STIMULATION

Many apps and devices based on sound and light stimulation are designed to help you fall asleep.

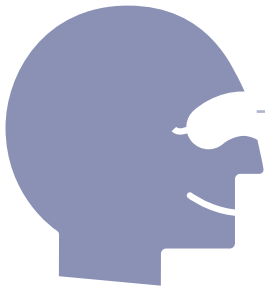
- Listen to binaural beats, a type of sound stimulation (to be used in conjunction with headphones that are compatible with sleeping)
- Create a natural soundscape with a computer or mobile apps
- Light stimulation with red spectrum light that induces melatonin production



SOUNDPROOFING

Distinctive sounds that stimulate too much cognitive activity can prevent you from falling asleep and reduce the quality of your sleep.

- Use earplugs suitable for sleeping
- Use pressure regulating earplugs for airplane travel



BLOCKING OUT LIGHT

Blue spectrum light, in particular, can easily disturb sleep. For example when you are travelling it is not always possible to isolate the entire room from external light sources.

- Use eye patches or sleeping masks that prevent the light from reaching your eyes
- Use blackout curtains



ELECTRIC STIMULATION

Stimulating the brain electrically has been proven to have an effect on the production of neurotransmitters such as GABA and serotonin,⁴⁸ which can help treat sleeping problems.

- Try Cranial Electrotherapy Stimulation (CES), also known as “electrosleep”⁴⁹



LUCID DREAMING

During a lucid dream, the person knows he or she is sleeping.

- Write down a sleep diary to help remember your dreams
- Try self-suggestion right before going to bed; and reality checks during dreams
- Wake yourself up during a lucid dream and try to remember your dreams
- So-called sleep herbs such as *Artemisa vulgaris*, *Heimia salicifolia*, *Synaptolepis kirkii* and *Huperzia serrata* may support the practice of lucid dreaming

WAKING UP

WAKE UP NATURALLY

Emulating a natural environment can reduce the stress response caused by a regular alarm clock.

- Use a wake-up light that imitates a natural sunrise
- Create a gradually developing soundscape that emulates nature waking up to its full glory

JUMP-START YOUR BODY

The body has been fasting for the entire night. Muscles might be tense as a result – but there are ways to reduce this tension.

- Ingest 400 ml of water (for rehydration), 2 tbsp of lemon juice (to balance gastric acids) and half a teaspoon of salt (for your adrenal glands) within 30 minutes of waking up
- Try inversions, and a hand- or headstand, to improve the circulation in your body and to boost your adrenal glands
- Try yoga, jogging or stretching
- Try a warm shower or bath finished by a cold shower (that closes the pores in your skin)
- Try vibration plate, jumping jacks, or mini-trampoline to increase blood and lymph circulation



MEASURING AND TRACKING SLEEP

The history of collecting data on the physiology of sleep goes back to the late 19th century. Sigmund Freud was already interested in dreams in a time before the invention of EEG and a proper understanding of REM sleep. In 1913, the French scientist Henri Piéron wrote *Le problème physiologique du sommeil*, in which, for the first time, sleep was dealt with from a physiological perspective. German psychiatrist Hans Berger recorded the first electroencephalogram (EEG) in 1924. The father of modern sleep research, Nathaniel Kleitman, performed ground-breaking work on the circadian clock and rapid eye movement (REM) sleep in the 1950s. Later on, in 1968, Dr. Allan Rechtschaffen and his colleague Anthony Kales co-published the iconic *A Manual of Standardized Terminology, Techniques and Scoring System for Sleep Stages of Human Subjects*. Right up to the present day, this has been the primary source for describing the various stages of sleep.

In the last five years, technologies for measuring sleep have escaped sleep research laboratories and fallen into the hands of consumers. A modern biohacker, using affordable consumer products, can collect a lot of data from his or her sleep.

SLEEP QUALITY CAN BE MEASURED, FOR EXAMPLE, WITH THE FOLLOWING APPROACHES:

- EEG (electroencephalography): tracks the various phases and cycles of sleep
- EMG (electromyography): measures jaw muscle tension
- EOG (electrooculography): measures eye movements
- HRV (heart rate variability): measures stress level during the night and the body's response. The parasympathetic nervous system activates itself during orthodox sleep while the sympathetic nervous system activates itself during REM sleep.⁵⁰
- Nocturnal movements: one's sleep should have periods every night that last at least 15 minutes where there is no discernible movement
- Temperature: room temperature
- MSLT (Multiple Sleep Latency Test)
- MWT (Maintenance of Wakefulness Test)
- Body temperature: drops during the night
- Melatonin readings from saliva
- Heartbeat: drops during the night
- Oxygen saturation: levels of oxygen in the blood
- Blood pressure: drops during the night
- Sound levels: background noise and snoring

TIPS FOR MEASURING SLEEP

There are many consumer products available for measuring sleep:

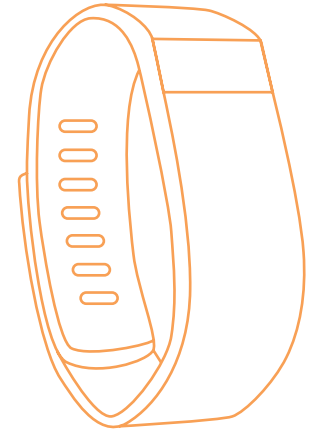
- Activity trackers and watches with a sleep tracking function
- Wearable jewelry such as smart rings and pendants with a sleep tracking function
- Sleep trackers that sense body movements during sleep using radio waves
- Sleep trackers that are placed under the bed sheets
- Sleep applications that utilize the motion sensors of a smartphone
- Sleep trackers fastened to the head that sense eye movements or electroencephalogram signals
- Heart rate belts that measure sleep quality

In terms of accuracy and user convenience, a sleep tracker placed under the bed sheets is the preferred option. A significant portion of activity meters recognizes the various stages of sleep based on body movements only. These include many activity trackers and smartphone applications. Adding a separate sensor to track the heart rate and

respiratory frequency significantly improves the measuring accuracy. There are sleep trackers available that use electroencephalograms; these may be even more accurate.

It is possible to start tracking sleep simply using a smartphone application although their accuracy is quite poor compared to devices designed specifically for the purpose. In terms of user convenience, trackers placed under the bed sheets, smart rings and contactless body movement sensors are the least likely to cause sleep disruptions.

Activity trackers, heart rate belts and various headgear may be uncomfortable to use as they may disrupt the optimal blood flow. If you are concerned about electromagnetic radiation, choose a device that is not placed directly on skin and that can be switched to flight mode during the night. In terms of the electromagnetic radiation risk, it is smart to choose a Bluetooth device with a short range (0.5–1.0 mW).



To maximize sleep quality, aim for the following:

- REM sleep representing 20–25 % of the time spent asleep
- Deep sleep representing 10–20 % of the time spent asleep
- Sleep for 7–8 hours per night
- Falling asleep quickly (in less than 15 minutes)
- Little to no waking up during the night
- Increased heart rate variability (HRV) during the night, indicating the activation of the parasympathetic nervous system (RMSSD)
- HF component is sufficiently high (HF increases during the activation of the parasympathetic nervous system)
- Daily resting heart rate in the morning is constant or decreasing compared to the monthly average
- Little to no snoring
- No unusual restlessness or movements during the night
- The soundscape during the night contains nothing that stands out

It is not always possible to get enough sleep – traveling or a busy work schedule may mean reduced hours of sleep. When this is the case, pay special attention to the recovery of the nervous system (HRV), the time it takes to fall asleep and the amount of deep sleep in proportion to the total time spent asleep. If the morning resting heart rate begins to creep up, try to organize rest days to boost recovery.

More device suggestions in the book's bonus materials:



biohack.to/sleep



TIPS AND GUIDES

POWER NAPS

The Spanish surrealist Salvador Dali loved to nap. While sleeping on his armchair, he would dangle a spoon on top of a tin plate. Upon dozing, the spoon would fall onto the dish and wake him up. Salvador's naps were real "power naps."

The secret to efficient napping is to prevent yourself from falling deeper than the N1 and N2 stages of sleep. Naps should last no longer than 20 minutes. Longer naps often lead to grogginess. This so-called "sleep inertia" phenomenon is caused by the increased production of adenosine. If one wishes to catch up for lost sleep, or accelerate one's ability to learn,⁵¹ it can sometimes be beneficial to sleep a bit longer. In such cases, it is best to plan out the nap so that it lasts for a complete cycle, i.e. about 90 minutes. The best time to nap is about 6–8 hours after waking up.

Studies show that naps can improve memory and reverse the performance deteriorating effects caused by sensory overload.⁵² In studies conducted at the sleep laboratory of the University of Loughborough it was discovered that

naps lasting less than 15 minutes reduced mistakes by 9 % in a monotonous driving test. In the same test, people who ingested 200 mg of caffeine before the nap made 34 % less mistakes.

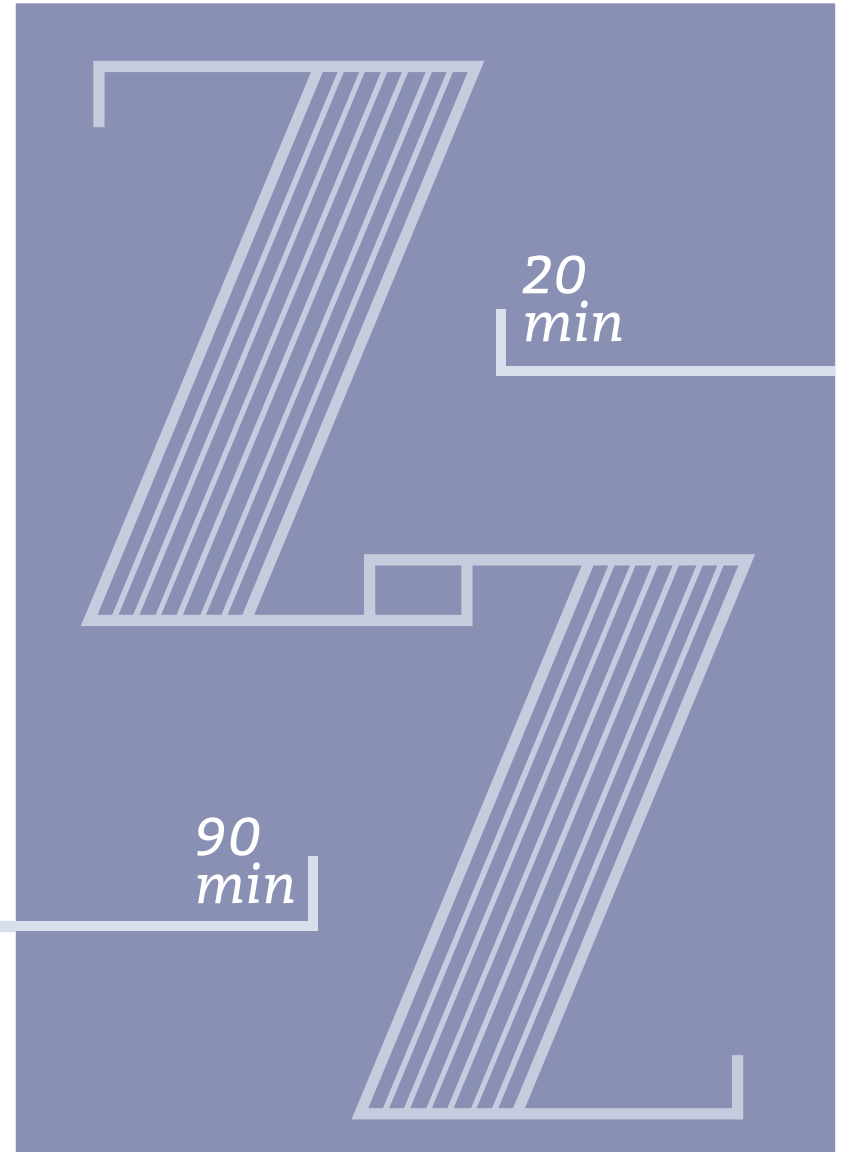
Combining caffeine and napping is an efficient combo. It takes about 20–45 minutes for the caffeine to kick in. A cup of coffee right before napping doesn't begin to have an effect until after the nap is over, which means that it won't negatively affect your sleep.⁵³





A RECIPE FOR AN EFFICIENT NAP:

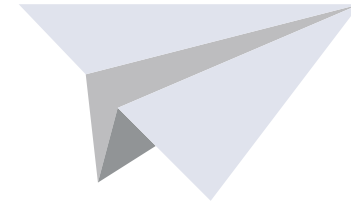
- Avoid caffeine and other stimulants 1–4 hours before the nap
- Drink a cup of coffee, or ingest 200 mg of caffeine, immediately before your nap
- Set the alarm to 20 minutes (with or without caffeine) or 90 minutes (without caffeine)
- Cover your eyes with a sleeping mask that filters out distracting light
- If you are in a noisy environment, use earplugs or experiment with headphones playing white noise
- Breathe in deeply and calmly. Impersonating someone sleeping actually may help
- Our recommendation is to try napping with a spike mat to release endorphins and increase blood flow





SLEEPING IN THE AIRPLANE

A flight is a chance to make up for lost sleep, but many have found it easier said than done. Below, we have collected a number of tips that might make it easier to sleep in an airplane (or other modes of transportation):



Avoid stimulants like coffee approximately 6 hours before the flight.	Dress yourself comfortably. Wear a warm hat and replace your shoes with woollen or flight socks.
Use the toilet immediately upon boarding.	Try supplements to improve the ability to fall asleep, such as L-theanine and melatonin.
Choose a window seat. This way you don't have to make room for passengers who wish to use the toilet.	Tell the flight attendant and the person next to you that you intend to sleep and do not wish to be disturbed.
Make more leg room by selecting a seat in the Exit row, or use websites that help you to pick the ideal seat on a plane.	Remove all disturbances by wearing a sleeping mask and earplugs. From our experience, noise cancelling headphones with proper earmuffs work even better.
Avoid noisy seats immediately adjacent to the toilet or the plane's engines.	

Try to fall asleep the moment you board the plane. Takeoff and the initial ascent usually last long enough so that by the time the food arrives you feel already well-rested. However, do not adjust the backrest of the seat into a reclining position, and do not forget to fasten the seatbelt, as otherwise the flight attendant may feel compelled to wake you up. This applies to landing: learn to sleep with your backrest in a vertical position and the seatbelt fastened.



STRESS-FREE WAKE-UP

On some mornings you may feel energised and fully active, while at other times you feel slow and groggy – no matter how many hours you have slept. This is most likely caused by waking up from the deepest stages of sleep, while adenosine is still affecting your central nervous system. A regular alarm clock is not intelligent enough to differentiate between stages of sleep.

With specific technologies, it is possible to have an alarm clock that wakes you up at the right moment. This is possible with the kind of apps that monitor the stages of your sleep and attempt to wake you up when you are coming out of deep sleep. In these apps, you set the time window within which you want the device to wake you up. The larger the time window the more likely it is that you will be woken up at the optimal time.

Device and app suggestions in the bonus materials:



biohack.to/sleep

Cortisol (the so-called stress hormone) production is at its peak around 30 mins after waking up. At that moment your adrenal glands will produce about 50 % more cortisol than normally. Waking up earlier than you usually do further accentuates the stress response. According to various studies the stress response may be alleviated with the following methods:

- Unpronounced soundscapes during the night (sounds of nature or distant traffic noise) reduces the stress response in the morning.⁵⁴ There are apps available that produce such soundscapes.
- Waking up later in the morning.
- Waking up in the dark rather than in the daylight. From an evolutionary standpoint, it could simulate the feeling of being protected from natural predators.⁵⁵
- Stressful experiences and thoughts about a mounting workload can increase stress response in the morning. The night before, write down wandering thoughts and three most important things you need to do the next day. After that, consider meditation. This helps you to clear your mind before going to sleep.

Kickstart your adrenal glands with the help of table salt and an inverted body position. Ingest $\frac{1}{2}$ a liter of water mixed with $\frac{1}{2}$ a teaspoon of salt within 15 minutes of waking up. Lay down on your back, with your legs lifted up to the wall for about 8 minutes. This helps to stimulate the adrenal glands, which in turn reduces the stress response.^{56 57}



LATE-NIGHT SLEEP-INDUCING SNACK

Mix the following nutrients and supplements in a bowl with a fork. Ingest about an hour before going to bed.



SANDMAN'S SNACK

- *half an avocado*
- *handful of soaked and crushed almonds and/or raw pumpkin seeds (Styrian variety)*
- *1 tbsp of unpasteurized honey*
- *half a banana (not overripe)*
- *a touch of non-raffinated salt*

Depending on your taste, you can also add the following:

- *1 dl of relaxing tea: passionflower, chamomile, kava or valerian*
- *1 tbsp of bee pollen*

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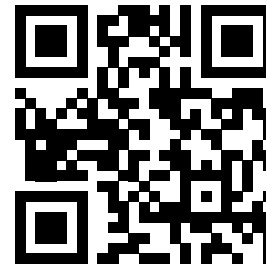
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