

# 1

## Normal sleep

### ➔ Key points

- ◆ Sleep is an essential part of existence, without which there are serious psychological and physical consequences.
- ◆ Sleep is a biologically complicated state controlled by complex brain mechanisms that are involved in going to sleep, waking up, and switching between two very different types of sleep.
- ◆ An internal biological clock controls our periods of being asleep and awake, and also changes the levels of alertness and sleepiness within each 24 hours.
- ◆ Fundamental changes in sleep occur during childhood and adolescence.

### ✕ Myth versus fact

**Myth:** Sleep is just the shutting down of daytime activities.

**Fact:** There are complex brain processes involved in going to sleep and in switching from one type of sleep to another.

**Myth:** Sleep is just one state, the opposite of being awake.

**Fact:** There are two distinct types of sleep. A balance between the two is probably required, especially in children.



## What is sleep?

The most fundamental aspect of sleep is that it is an essential part of your existence in the sense that without it you cannot survive. Animal experiments have showed that, if kept constantly awake for approximately 10 days, rats undergo a profound deterioration in their basic bodily processes such as temperature control and they die.

As described in detail in this book, lesser degrees of sleep loss (and also poor-quality or broken sleep) can have serious, unwelcome psychological and even physical effects. Without regular periods of rest, animals are unable to function properly in all sorts of ways. Indeed, even plants can show clear periods of rest alternating with activity, usually but not necessarily coinciding with whether it is night or day.

Another basic feature of sleep is that, in humans and related species, it has very distinctive characteristics compared with other states of relative inactivity. The brain activity of hibernating animals is generally depressed as part of an overall slowing down of bodily processes. The same is true when someone is in coma or unconscious (for example, under a general anaesthetic). Sleep is different in a number of ways. For example, you can be roused from sleep but, in particular, sleep shows specific patterns of brain and other physiological activity.

Human sleep also shows additional interesting differences compared with other animal species. The duration of sleep within each 24-hour period varies from about 3 hours in a horse to almost 20 hours in bats. An adult human being holds a mid-way position with an average of 7–8 hours. These differences are perhaps partly explained by differing vulnerability to attack by predators, although other possible explanations have been suggested.

Humans usually sleep at night in a bed; hamsters, as an example, also sleep in their beds but during the day rather than at night. Some animals, such as cattle and horses, can sleep standing upright; others, such as leopards, may sleep in a tree. Dolphins and some other sea-dwelling mammals, who need to be awake enough to breathe intermittently at the surface, sleep in one half of their brain at a time, switching from one hemisphere to the other at intervals of minutes to hours.

Roosting birds are able to sleep while maintaining their balance on a perch. Fish and reptiles also sleep or at least rest regularly in a way similar to sleep.



## Why do we need to sleep?

Whichever way animals sleep, they need to do so, because the consequences can be serious if not dire. Sleep can also be seen as particularly important from the fact that adult human beings spend about one-third of their life asleep and children much more than this (see below). In fact, by early school age, the average child has spent more time asleep than eating, playing, exploring his environment, or interacting with others.

There has been much debate about the function of sleep, with many suggestions being made. Clearly, there is no single answer to this question. Sleep serves many different, related functions, the balance between them changing during the course of development and possibly varying from one species to another.

Different theories have emphasized mental and bodily restoration and recovery during sleep, or the laying down of memories in the brain so that learning from experience is possible. Others have suggested that dreaming is essential for the analysis of possibly deep-seated emotional problems and conflicts. On the physical side, growth, resistance to infection, and possibly the process of repair following injury or other damage to body tissues depend on adequate sleep.

What can be said with assurance is that, in humans, poor sleep is highly likely to cause potentially profound psychological and physical changes, which can be reversed if the sleep pattern is restored to normal. Unfortunately, these facts are not sufficiently well known by the general public and many professionals (including those involved in the health and welfare of children). Many parents are unaware that the sleep problems of their children can often be prevented or treated effectively, with the consequence that much unnecessary distress is caused both to the children and also to their parents.

## Sleep is a biologically complex process

It might be thought that sleep consists mainly of the shutting down of daytime activities. This is certainly not the case. The onset of sleep, waking up, and the two distinct types of sleep all involve complicated biochemical changes in different parts of the brain.

Sleep is not just one state. In fact, there are two very different types of sleep: non-rapid eye movement (NREM) sleep and rapid eye movement (REM) sleep. The reason why there are two contrasting types is not clear. It seems that a balance between these two types is necessary to function well.



## NREM sleep

In adults, this type makes up about 75% of sleep. It is divided into four levels of increasing depth, called stages, each of which has its own characteristic brain wave activity as recorded by an electroencephalogram or EEG. As sleep progressively deepens, increasing amounts of slow brain activity are seen.

Stages 1 and 2 are relatively light sleep; stages 3 and 4 are deep sleep from which it is particularly difficult to waken. Most deep sleep (which is also called slow wave sleep or SWS) occurs in the first 3 hours of overnight sleep. It is in this depth of sleep that sleepwalking and related disorders (see Chapter 15) occur. Fragments of dreams can occur in NREM sleep.

## REM sleep

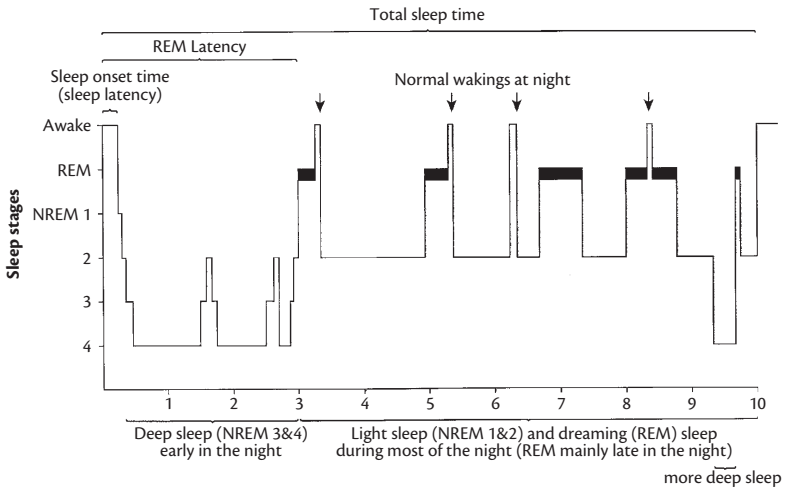
This is also called dreaming sleep because it is when most dreaming occurs. From the age of 2 and above, REM sleep comprises 25% of our sleep, but in newborns REM sleep takes up at least 50% of sleep (and more than this before birth). This suggests that it is particularly important for early brain development. It appears to play some part in memory although the details are unclear. In infants, the term 'active' sleep is used rather than REM sleep and at this age 'quiet' sleep is equivalent to NREM sleep.

At any age, the level of brain activity in REM sleep is high. For example, blood flow through the brain is increased compared with NREM sleep. EEG traces are similar to those recorded when you are awake and alert, yet it is not usually possible to move in this type of sleep, although some people can do so and, as a result, can act out their dreams (see Chapter 16). Another feature of REM sleep that is different from NREM sleep is prominent eye movements, and heart rate and breathing tend to be less regular in REM sleep.

It is possible that everyone dreams, but only some people can recall their dreams. Even blind people dream, although without any visual imagery if they have been blind from birth or from a very early age. Often, the content of dreams is a mixture of fragments of recent experiences or things that on your mind, but sometimes children and adults have recurrent upsetting dreams with a consistent theme based on distressing past experiences. Nightmares (see Chapter 16) are particularly frightening dreams; as they are related to REM sleep (which mainly occurs later in overnight sleep), they tend to occur later in the night. Dream-like experiences can occur when drifting off to sleep or in a drowsy state before waking up properly.

As illustrated in Figure 1.1, which shows the pattern of sleep stages in a healthy child, periods of NREM and REM sleep alternate with each other





**Figure 1.1** Hypnogram showing the characteristic progression of sleep stages overnight in a healthy school-aged child (from a book published by Mac Keith Press)

several times throughout the night. Ideally, a short while after settling into bed, drowsiness is followed by progressively deeper levels of NREM sleep. A period of deep NREM sleep, lasting 2–3 hours, is then followed by a brief first period of REM sleep. The rest of the night consists of alternating periods of light NREM sleep and increasingly long REM sleep periods, in children possibly ending with a more deep sleep before they finally wake up.

It is normal for anyone to wake briefly during the night, perhaps several times, although this may not be remembered. A problem only arises if it is difficult to get back to sleep at these times.

Complicated brain mechanisms control many of our bodily functions that fluctuate rhythmically:

- ◆ over a period of a day ('circadian' rhythms, such as our sleeping–waking cycle);
- ◆ over less than a day ('ultradian' rhythm, e.g. alertness fluctuations); and
- ◆ over more than a day ('infradian', e.g. the menstrual cycle).



## Sleep problems in children and adolescents the facts

When we sleep is regulated by a **circadian body clock** located in the supra-chiasmatic nucleus, which is part of the hypothalamus situated in the depths of the brain. This body clock usually ensures that the sleep–wake cycle is synchronized with the fluctuations in body temperature and the output of cortisol, a hormone involved in the response to stress. For example, body temperature falls during overnight sleep, being lowest in deep NREM sleep. Problems arise when these bodily processes become uncoupled as in jet lag or, more seriously, night-shift work. If this happens, sleep is disrupted and you are likely to feel uncomfortable or unwell in various ways.

From an early age, the sleep–wake cycle becomes linked with the night–day cycle by the influence of external cues (‘zeitgebers’), the main one being the experience of daylight. Other cues are mealtimes and social activities, which become particularly important for blind people deprived of the main zeitgebers.

The suprachiasmatic nucleus is acted upon by **melatonin**, a hormone produced mainly in the pineal gland in the brain during darkness (‘the hormone of darkness’) and suppressed by the perception of bright light. Therefore, melatonin promotes sleep during the night and its suppression by daylight encourages wakefulness. Synthetic melatonin has been used to treat some disorders of the sleep–wake cycle (see Chapter 7) including those caused by blindness.

The natural sleep–wake cycle lasts about 24 hours, but this can be disrupted by exposure to light while studying or working late at night. Lack of sleep will result from then having to get up in time for school, college, or work before sleep requirements have been met.

**Alertness and the degree of sleepiness varies within each 24 hours.** The tendency to sleep is greatest in the early hours of the morning at the time of deep NREM sleep. Trying to work at this time is difficult, and mistakes and accidents (including driving accidents) may well occur. To a lesser extent, sleepiness increases in the early afternoon (the ‘post-lunch dip’). Use is made of this in countries where having a siesta is the rule.

Generally, we are most alert in the evening before the onset of sleepiness. This can be the best time to study. Parents should avoid putting their child to bed too early, i.e. during this period, because he will be unable to sleep, which is distinct from refusing to settle.

The timing of the different levels of alertness and sleepiness can be different from one person to another (including children). From an early age, some people wake up about 2 hours earlier than most other people and are very alert in the



morning but then tire early in the evening. These are so-called ‘morning types’ or ‘larks’. In contrast, others tend to wake relatively late and have difficulty getting going in the morning, but become alert and active in the evening, perhaps until quite late (‘evening types’ or ‘owls’).

Not surprisingly, larks have special difficulty coping with night-shift work because, in these people in particular, they are required to be active when their body clock is telling them to sleep.

These ultradian sleep–wake rhythms also vary at different ages. The body clock change that occurs at puberty is important in explaining the sleep problems that are particularly common in adolescents (see Chapter 7). At this stage of development, there is a tendency for the sleep phase to shift to a later time than at an earlier age. This causes difficulty getting to sleep and, as a result, insufficient sleep may well be obtained by the time it is necessary to get up for school, college, or work.

Incidentally, the opposite shift (i.e. to an earlier onset of sleep) occurs in old age. An early bedtime may well mean waking in the early hours because the amount of sleep required has been obtained by that time. This ‘early morning waking’ in older people should not be misinterpreted as a sign of depression in which early waking is associated with inadequate sleep. Something similar can happen in children who have habitually been put to bed particularly early and have soon gone to sleep, in which case their bedtime should gradually be delayed.

### Changes in sleep patterns during childhood

Another example of the complicated nature of sleep is the striking change in sleep patterns during childhood. Most obvious is the amount of sleep needed for satisfactory function during the day. This is obvious from Table 1.1, which shows the average amount of sleep that is needed at different ages to function satisfactorily during the day. Some healthy children need more and others less than the amounts stated.

Studies of premature babies show that prolonged sleep (up to 20 hours a day) begins well before birth. Full-term babies sleep approximately 17 hours, with at least 50% taking the form of ‘active’ or REM-type sleep as described above. One result is that they tend to wake more often and readily than at an earlier age. Also, infants pass directly into REM sleep when they fall asleep.

Because their body clock has not developed properly, the sleep–wake pattern of young babies is so irregular that they have to be fed repeatedly during the night. However, this should not be necessary by about 6 months of age, at which time



**Table 1.1** Average sleep requirements at different ages in childhood and adolescence

Age	Sleep requirement
Newborn, full-term baby	16–18 hours
1 year	14 hours
2 years	13 hours
4 years	11.5 hours
7 years	10.5
10 years	9 hours
Adolescence (after puberty)	9 hours (possibly more)
Late adolescence	8 hours

the baby should be biologically able to confine feeding to the daytime, allowing his parents to sleep themselves at night.

By the end of the first year, most children sleep about 15 hours a day and daytime naps (originally taking up perhaps half of the total sleep time) should have started to reduce significantly until by about 3–4 years of age they have stopped completely in most children.

Through the toddler stage and later childhood, the gradual reduction in total time asleep steadily reduces until in later childhood (before puberty) most children need about 10 hours of sleep each night. Sleep is particularly sound at this age.

As mentioned above, puberty marks a change in the function of the circadian body clock. At this adolescent stage, it becomes physiologically difficult to get to sleep until later than before. This, combined with late-night study or social activities, can easily lead to insufficient sleep. Teenagers usually need at least 9 hours of sleep, without which they are at risk of various problems (see Chapter 7).

