

Lab.4

Pineal Gland

The pineal gland, also known as the pineal body, is a neuroendocrine gland found towards the center of the brain. The term 'pineal' refers to the structure of the gland, which often resembles a pine cone. However, there is much variation in shape, with many human pineal glands being pea-shaped or fusiform (tapering at both ends). The average adult pineal gland is a tiny brown structure, typically 5-8mm long, that weighs around 150mg. It is highly vascularised, with a rich blood flow of around 4ml/min/g, second only to that of the kidneys.

It increases in size throughout early childhood and becomes fully developed at around age 5 to 7 years.

Histologically, 95% of the cells of the pineal gland are the pinealocytes, the rest are supporting cells. The primary role of pinealocytes is to synthesise and secrete the chronobiotic hormone melatonin, which plays a key role in synchronising the body's biological rhythms. Structurally, pinealocytes are believed to be related to the photosensitive rods and cones of the retina; although, in humans, they only have an indirect response to light, as detected at the retina, through a series of complex neural pathways.

Pinealocytes take up the essential amino acid tryptophan, which is enzymatically converted into the neurotransmitter serotonin and then into melatonin.

Pineal Gland Functions

Produce melatonin: One function of the pineal gland is to produce melatonin. Melatonin has various functions in the central nervous system, the most important of which is to help modulate sleep patterns. Melatonin production is stimulated by darkness and inhibited by light. Light sensitive nerve cells in the retina detect light and send this signal to the suprachiasmatic nucleus (SCN), synchronizing the SCN to the day-night cycle. Nerve fibers then relay the daylight information from the SCN to the paraventricular nuclei (PVN), then to the spinal cord and via the sympathetic system to superior cervical ganglia (SCG), and from there into the pineal gland. The compound pinoline is also claimed to be produced in the pineal gland; it is one of the beta-carbolines.

Regulation of the pituitary gland: Studies on rodents suggest that the pineal gland influences the pituitary gland's secretion of the sex hormones, follicle-stimulating hormone (FSH), and luteinizing hormone (LH). Pinealectomy performed on rodents produced no change in pituitary weight, but caused an increase in the concentration of FSH and LH within the gland. Administration of melatonin did not return the concentrations of FSH to normal levels, suggesting that the pineal gland influences pituitary gland secretion of FSH and LH through an undescribed transmitting molecule.

The pineal gland contains receptors for the regulatory neuropeptide, endothelin-1, which, when injected in picomolar quantities into the lateral cerebral ventricle, causes a calcium-mediated increase in pineal glucose metabolism.

Regulation of bone metabolism: Studies in mice suggest that the pineal-derived melatonin regulates new bone deposition. Pineal-derived melatonin mediates its action on the bone cells through MT₂ receptors. This pathway could be a potential new target for osteoporosis treatment as the study shows the curative effect of oral melatonin treatment in a postmenopausal osteoporosis mouse model.

Melatonin

Melatonin is a hormone that's mainly produced by the pineal gland. The importance of pineal melatonin in humans is not clear, but many researchers believe it may help to synchronize circadian rhythms in different parts of the body.

Circadian rhythms are physical, mental and behavioral changes that follow a 24-hour cycle. These natural processes respond primarily to light and dark.

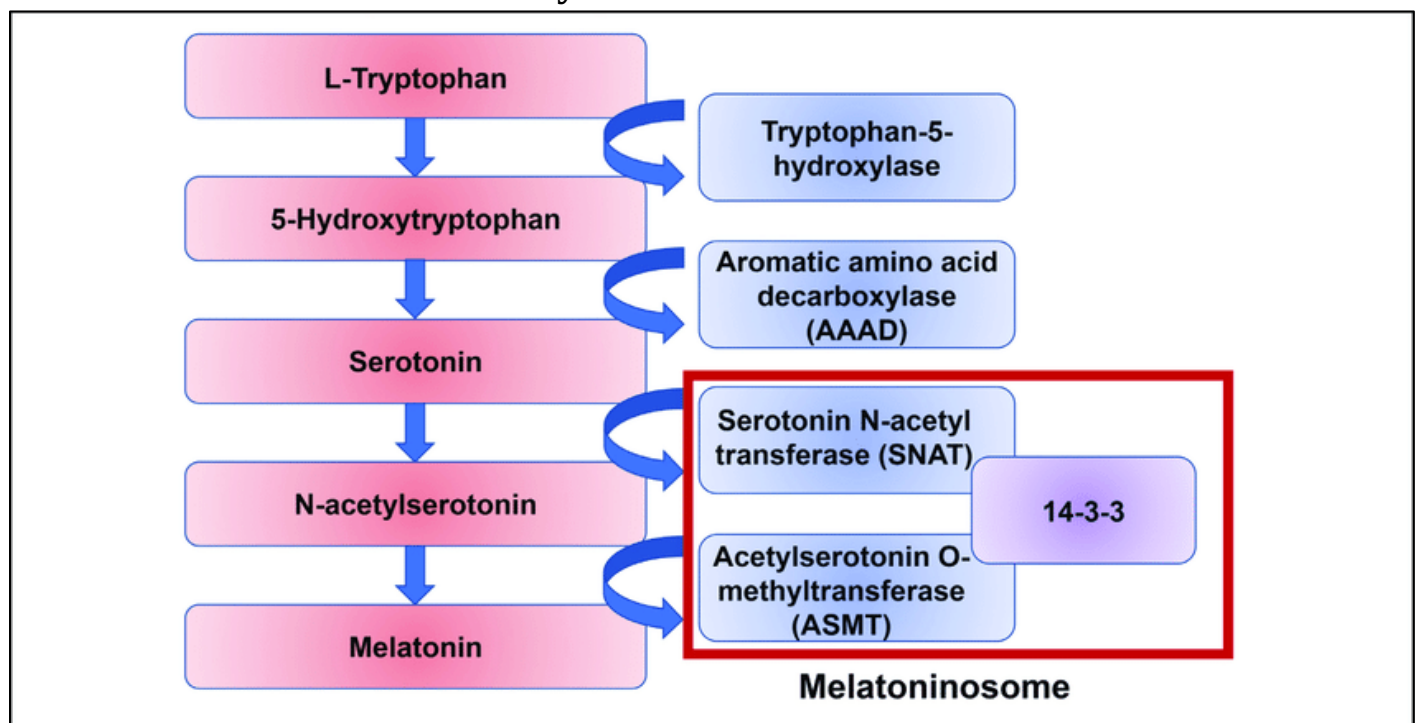
The pineal gland releases the highest levels of melatonin when there's darkness and decreases melatonin production when exposed to light. In other words, the low levels of melatonin in the blood during the daylight hours and peak levels of melatonin during the nighttime.

Because of this, melatonin has often been referred to as a "sleep hormone." While melatonin is not essential for sleeping, the sleep get better when the highest levels of melatonin in the body.

Melatonin also interacts with biologically female hormones. Research has shown that it helps in regulating menstrual cycles.

Melatonin can also protect against neurodegeneration, which is the progressive loss of function of neurons. Neurodegeneration is present in conditions such as Alzheimer's disease and Parkinson's disease.

Biosynthesis of melatonin



Role of melatonin

Initially, melatonin is released into the densely arranged local blood vessels of the pineal gland and the cerebrospinal fluid of the third ventricle; it then enters the general circulation and is distributed systemically around the body. It is also synthesised and released from a wide range of other human organs, tissues and cells, including the retina, bone marrow, lymphocytes, platelets, skin and gastrointestinal tract.

Can a person live without a pineal gland?

Yes, a person can live without the pineal gland. However, the body may have a difficult time with sleeping patterns and other physiologic functions related to the circadian rhythm without a pineal gland due to a lack of melatonin.

In very rare cases, a person with a pineal tumor may need surgery to remove their pineal gland. This is known as a pinealectomy.

