International Journal of Multiphysics
Volume 18, No. 4, 2024
ISSN: 1750-9548

The Miraculous Chemicals of The Brain: The Power of Hormones

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Abstract

The brain provides central control of other organs in the body. It does this with remarkablechemicals called hormones. By regulating the release of these chemicals, it ensures the coordination and balance of the body. There are many hormones in our body such as dopamine, serotonin, oxytocin, and melatonin. These hormones have been linked to appetite and sleep disorders in our body; It has many functions on serious diseases such as Parkinson's, Alzheimer's, and hypertension. As a result of the deficiency of these miraculous chemicals, many neurological, physiological, and psychiatric disorders occur. Therefore, knowing the basic structure, duties, and activities of these hormones is very important for human physiological and mental health. Understanding the intricate workings of these hormones is crucial for comprehending the underlying mechanisms of various neurological, physiological, and psychiatric disorders. Furthermore, advancements in research continue to unveil the intricate interplay between these miraculous chemicals and human health, offering promising avenues for therapeutic interventions and disease management.

Keywords: Brain, hormone, disease, physiological.

1. Introduction

1.1. Brain

Brain; The organ that fills the inside of the head, gray, to white in color, and covered with three layers of membrane, is the most important part and center of the nervous system. Most vertebrates and invertebrates (except for spiky skins, some of the sponges, overalls, etc.) have a brain. The brain, the most complex structure in the vertebrate body, is the central nervous system responsible for the functioning of senses such as taste, hearing, sight, smell, and balance. The brain is located in the cranial cavity, which protects it. In general, its shape, size, and weight may vary according to the shape of the skull, the body measurements of the living being, and the development status of the body. The brain, which differs in size between species, weighs between 1,300 and 1,500 grams in humans (Figure 1.) (Table 1.) (Kandel et al. 2000).

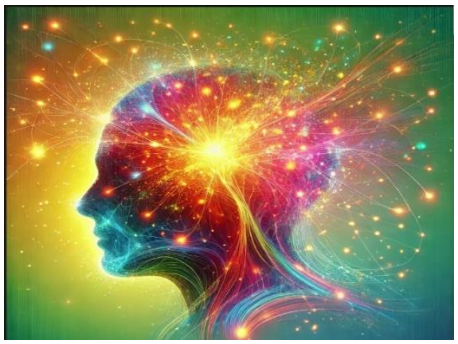

Figure 1. The Mysterious World of the Human Brain

Table 1. Physiological and Chemical Structure of the Brain

Physiological Structure of the Brain	Chemical Structure of the Brain
Its weight typically ranges from 1,300 to 1,500 grams.	The main building material of the brain is proteins.
It has a gray color and a soft structure.	Additionally, it contains fatty tissues like lecithin.
The volume of the brain varies from individual to individual, generally ranging from 1,130 to 1,260 cm^3.	Nervous functions occur as a result of the combustion of glucose combined with oxygen.
It contains approximately 86 billion neurons.	This process provides the necessary energy for chemical signal transmission between cells.

1.1.1. Main Tasks of the Brain

It regulates the basic functions of the human body such as hunger, sleep, thirst, and consciousness. Performs memory events and learning activities. It regulates the blood pressure and temperature of the human body. It performs hormone secretion (Peng & Sun, 2023).

1.2. Hormone

Hormones are chemical messengers in our bodies. They are produced by the endocrine glands. The main endocrine glands are the pituitary, pineal, thymus, thyroid, adrenal glands, and pancreas. They also produce hormones in the testicles of men and the ovaries of women. Because hormones are so powerful, even small amounts of them can make major changes and effects on our cells and bodies (Russo-Picasso & Springer, 2023).

1.2.1. Chemical structure of hormones

Hormones can be chemically divided into proteins and steroids. All hormones in the human body except sex hormones and hormones from the adrenal cortex are proteins or protein derivatives (Ahrorbek et al.2023).

1.2.2. Mechanism of action of hormones

Hormones are carried throughout the body through the blood and only affect certain cell receptors. This situation is similar to the role of key and lock. Hormones exert their characteristic effects on target cells by changing the activity of cells. Protein hormones react with receptors on the cell surface, and the events that result in the hormone effect occur more quickly. Steroid hormones, on the other hand, react with receptor sites within a cell. This mode of action occurs more slowly since it involves the synthesis of proteins (Hall & Hall 2020).

1.2.3. Control of hormone secretion

Most hormones are controlled by some kind of negative feedback mechanism. In such a system, the gland is sensitive to the concentration of the hormone it regulates. The negative feedback system maintains homeostatic balance in the body by reversing increases and decreases in body conditions (Hall & Hall 2020).

2. MIRACLE CHEMICALS IN THE BRAIN

2.1. Serotonin

Serotonin, also known as 5-hydroxytryptamine (5-HT), was discovered in 1948 by Maurice Rapport and Irvine Page (Figure 2.). The name serotonin comes from the Latin word serum and the Greek word tonic (Erspamer and Asero 1952). Studies have shown that serotonin is found in many tissues, including the brain, lungs, kidneys, platelets, and gastrointestinal tract. Serotonin has been proven to be a neurotransmitter based on information such as the localization of serotonin receptors in specific regions of the vertebrate brain and the presence of serotonin in the nerve endings of neurons in parts isolated from the mammalian brain (Ubuka, T. 2021).

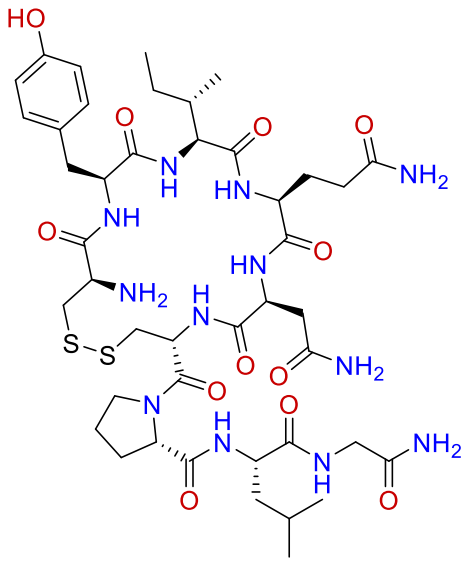

Figure 2. Serotonin Structure

2.1.1. Serotonin Formation Metabolism

Serotonin is a biogenic monoamine similar to epinephrine, norepinephrine (NET), dopamine (DAT), and histamine. Serotonin is produced in two stages. In the first stage, tryptophan, an essential amino acid, is hydroxylated by the enzyme tryptophan hydroxylase to the compound 5-hydroxytryptophan (5-HTP). In the second step, 5-hydroxytryptophan is decarboxylated to form 5-hydroxytryptophan. It has been proven as a result of pharmacological studies that in the presence of tryptophan, the stages of hydroxylation and decarboxylation occur very quickly **(** Kuhn,& Hasegawa 2020).

2.1.2. Serotonin Synthesis and Storage Sites

Serotonin is produced and stored in the central nervous system in presynaptic neurons such as serotonergic neurons, catecholadenominergic neurons, and the pineal gland. Serotonin is produced outside the central nervous system, in enterochromaffin cells, and in very small amounts in platelets, where approximately 90-95% of the serotonin present in the body is stored there (Bakshi & Tadi, 2020).

2.1.3. The Association of Serotonin with Depression and SSRIs

As a result of the research, it has been concluded that psychological problems such as depression, mania, and anxiety are related to the decrease in the amount of serotonin in the central nervous system (Kandel et al. 2000). Selective Serotonin Reuptake Inhibitors (SSRIs) are used to increase serotonin levels. SSRIs inhibit the reuptake of serotonin by binding to SERT, a protein that allows serotonin to be taken back from the synaptic space to the presynaptic neuron. In this way, they increase the amount of serotonin present in the synaptic connection .The types of SSRIs approved by the FDA for the treatment of depression, anxiety, and other mood disorders are Citalopram, Escitalopram, Fluoxetine, Fluvoxamine, Paroxetine, and Sertraline (Moncrieff et al.2023).

2.1.4. Some Physiological Effects of Serotonin

2.1.4.1. Vascular tone

Serotonin causes a vasoconstrictor effect by inducing contraction through 5-HT2 receptors located on the surface of vascular smooth muscle (Kanova & Kohout, 2021).

2.1.4.2. Platelet aggregation

Serotonin acts as a mild stimulator of platelet aggregation, but its efficacy is very high in the presence of ADP and Thromboxane A (Chu et al. 2021).

2.1.4.3. Hypertension

In experiments, serotonin injected directly into the Central Nervous System has been shown to cause both hypertension and hypotension (Hirooka, 2020).

2.1.4.4. Pulmonary hypertension

Serotonin has a mitogenic effect that causes hypertrophy and proliferation in the smooth muscle cells of the aortic and pulmonary arteries (Song et al. 2021).

2.1.5. Side Effects of Serotonin

2.1.5.1. Sexual dysfunctions

SSRIs can cause various sexual dysfunctions such as erectile dysfunction and genital drowsiness. Such distress is one of the most common factors in getting people to stop taking medication (Bahrick 2008).

2.1.5.2. Emotional atrophy

In SSRIs, emotional atrophy, which is characterized by a decrease in positive and negative emotional violence, apathy, and aversion, is more common compared to other antidepressants (Price et al. 2009).

2.1.5.3. Withdrawal syndrome

Abrupt discontinuation of SSRIs after long-term use may bring withdrawal syndrome symptoms such as nausea, vomiting, tremor, vertigo, and insomnia. In order to minimize such situations, dose reduction should be achieved and drug withdrawal should be ensured (Schatzberg et al. 2006).

2.1.5.4. Serotonin syndrome

Serotonin syndrome is an undesirable drug reaction that can be fatal and is caused by the pharmacological interaction of two drugs with high doses or serotonergic effects to abuse a serotonergically acting drug. It is characterized by excessive stimulation of serotonin receptors in the peripheral and central nervous system. Clinical manifestations include chills and diarrhea in mild cases; in more severe cases, hyperthermia, rigidity, and death (Werneke et al. 2020).

2.1.6. Treatment of Serotonin Poisoning

Cyproheptadine is the most commonly used drug in the treatment of hyper-serotonergic syndromes due to its 5-HT receptor antagonist properties . Chlorpromazine is another drug used in serotonin toxicity due to its 5-HT receptor antagonist properties. In the treatment of seizure situations, benzodiazepines should be given. In the case of hyperthermia, empirical treatment should be carried out (Dogan, 2023).

2.2. Dopamine

The synthesis of dopamine (3,4-dihydroxyphenylethylamine) was first carried out independently in 1910 by researchers Mannich, Jacobson, Barger, and Ewins (Figure 3).

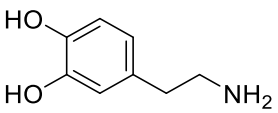

Figure 3. Dopamine Structure

Dopamine, a precursor to norepinephrine, is a third-generation endogenous catecholamine. Dopamine has a sympathomimetic effect, stimulating alpha and beta-adrenergic receptors and releasing norepinephrine from sympathetic nerves. Research on dopamine has shown that this catecholamine has specific effects as well as its adrenergic effects through "specific dopaminergic receptors" found in the central nervous system, cardiovascular system, and renal arteries. Unlike other catecholamines, dopamine has been used in a variety of clinical situations because it acts differently at different concentrations thanks to its "specific receptors". Some of these are

endotoxic, cardiogenic, and hemorrhagic shock, congestive heart failure, acute renal failure, and drug intoxication (Neumann et al. 2023).

2.2.1. Biosynthesis of Dopamine

The biosynthesis of dopamine starts with the amino acid tyrosine. Tyrosine is hydroxylated by the enzyme tyrosine hydroxylase to form L-Dopa (L-3,4-dihydroxyphenylalanine). This reaction requires oxygen and tetrahydrobiopterin (BH4) as cofactors. Subsequently, L-Dopa is decarboxylated by the enzyme aromatic L-amino acid decarboxylase (AADC), also known as DOPA decarboxylase, to produce dopamine. Dopamine plays crucial roles in various physiological processes within the nervous system, including neurotransmission and the regulation of mood, behavior, and movement. The biosynthesis of dopamine is tightly regulated, as abnormalities in dopamine levels or function can lead to neurological disorders such as Parkinson's disease or schizophrenia. (Chandel, 2021).

2.2.2. Dopamine Breakdown

The breakdown of dopamine occurs in 2 different ways:

1. Dopamine, which is located in the vesicles in the stomata at the dopaminergic nerve ending, is broken down into dihydroxyphenylacetic acid (DOPAC) thanks to the mono amino oxidase (MAO) enzyme. Outside the cell, DOPAC is methylated by the enzyme catechol-0-methyl transferase (KOMT), thus forming Homovanic acid (HVA), the main metabolite of dopamine (Figure 4).

2. Dopamine is methylated by the enzyme catechol-0-methyl transferase (KOMT) to 3-methoxythyramine (3-MT). 3-methoxythyramine (3-MT) forms Homovanic acid (HVA) thanks to the mono amino oxidase (MAO) enzyme (Figure 4)

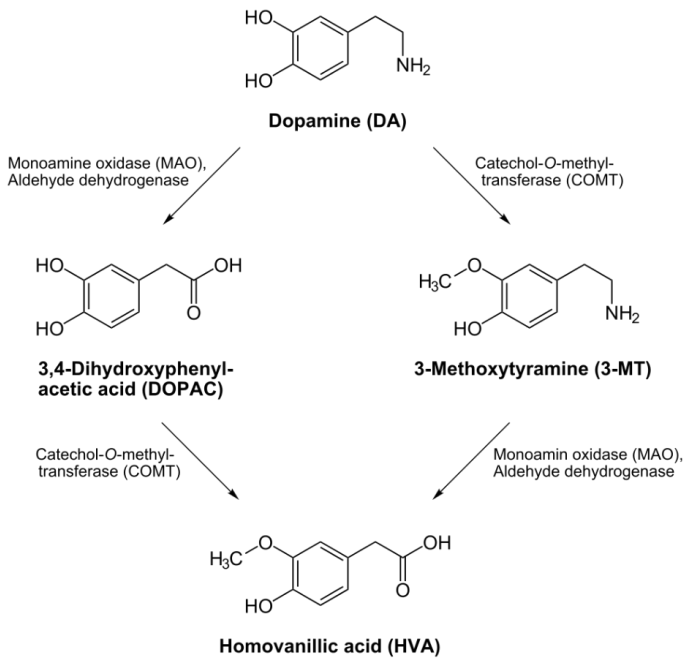

Figure 4. Dopamine Breakdown (Taj & Jamil, 2018).

2.2.3. Some Physiological Effects of Dopamine

2.2.3.1. Effect of dopamine on the kidneys

As a result of animal experiments, dopamine has been found to have dose-dependent diuretic, natriuretic, and renal vasodilator effects on the kidneys. Infusion of dopamine i.v. increases the excretion of sodium, chlorine, and water from the kidney and has little effect on potassium excretion. In patients with acute renal failure, it has been

shown that diuresis does not start in the use of dopamine and other diuretics alone, while in patients with dopamine and a diuretic are given together, urine flow increases and serum urea and creatine levels gradually improve towards pre-oliguric levels. Thus, in patients with acute renal failure, the combination of a potent diuretic with dopamine makes it possible to meet the need for dialysis (Olivares-Hernández et al. 2021)

2.2.3.2. Effect of dopamine on vessels

The effects of dopamine in vascular smooth muscles depend on dose. It exerts a vasoconstrictor effect in a high-dose vascular bed and a vasodilator effect in a low-dose infusion. The fact that dopamine, which has a vasodilator effect at a low dose, reduces blood pressure without causing tachycardia is seen as a great advantage compared to antihypertensive drugs. While dopamine reduces blood pressure, the heart rhythm does not change or mild bradycardia may occur (Dey et al. 2020).

2.2.3.3. Effect of dopamine on the heart

Dopamine stimulates beta-1 adrenergic receptors in the heart to release norepinephrine from sympathetic nerve stores. Thus, like sympathomimetics, they increase the rate of heart contraction (Gorain et al. 2020)

2.2.4. Clinical Use of Dopamine

Dopamine is given by intravenous infusion or orally. It has been determined that the half-life of dopamine given by intravenous infusion is 2 minutes. Dopamine taken orally is inactivated by MAO inhibitors found in the intestinal lumen and liver cells. Since dopamine is a powerful drug, it should be given to the patient in a diluted form. For this, 5% dextrose or 0.09% NaCl solution can be used. Dopamine should not be given together with sodium bicarbonate. This is because dopamine and other catecholamines are inactivated at alkaline pH (Channer et al. 2023).

2.2.5. Indication for Dopamine

The use of dopamine in the treatment of shock is widespread. Surgical interventions on the heart are used in the treatment of acute heart failure, which occurs instantly. It is used in acute renal failure, in cases of intoxication, and the treatment of cirrhosis. It is also available in the treatment of low-flow refractory congestive heart failure that does not respond to diuretics or digitalis.

2.2.6. Dopamine Side Effect

The main side effect is that it causes cardiac tachyarrhythmias at high doses. Peripheral extravasation, local ischemia, and ulceration can be seen in the extremities where long-term dopamine infusion is performed. This side effect can be corrected by local pentolamine infiltration. The occurrence of hypotension during infusion can be corrected by increasing the infusion rate. In addition, stopping the infusion suddenly can cause hypotension. Therefore, it is appropriate to cut it by decreasing it. In addition, during dopamine infusion, headaches, nausea, vomiting, dyspnea, and angina attacks may be encountered.

2.2.7. Dopamine Drug Interactions

It should not be used in patients who are being treated with MAO inhibitors or who have recently been treated. Phenothiazines and butyrophenones can block the vasodilator effect of dopamine in the kidney and some other vascular beds by inhibiting dopaminergic receptors. These drugs also reduce the vasoconstrictor effect of dopamine because they can block alpha-adrenergic receptors. Beta-blockers, on the other hand, reverse the positive effects of this drug on cardiac output (Tan et al. 2022)

2.3. Oxytocın

The word "oxytocin" is derived from the Greek words (ωκνξ, τοκοχξ), meaning "rapid birth," after Dale discovered the uterine-contracting properties of oxytocin in 1906. It is a mammalian hormone that acts as a neuromodulator in the brain (Figure *5*.) (Lee et al. 2009).

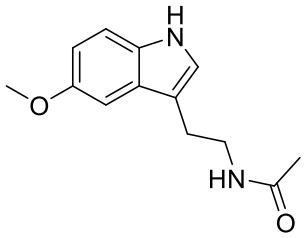

Figure 5. Oxytocin Structure

2.3.1. Synthesis, Secretion and Degradation of Oxytocin

Synthesis

Oxytocin is synthesized in the hypothalamus as an inactive precursor together with the carrier protein neurophysin I. Oxytocin is also produced in much smaller amounts in areas of the brain other than the hypothalamus. Oxytocin is synthesized outside the central nervous system: in bone marrow osteoblasts liver, subcutaneous fatty tissue and heart (McCormack et al. 2020).

Secretion

Oxytocin can be secreted from areas such as the back of the pituitary gland and the heart Birth and infant lactation status are the most important stimuli for oxytocin secretion (de Jong et al. 2015).

Destruction

Oxytocin is degraded by multiple aminopeptidases synthesized in different cell types, including adipocytes and leukocytes.

2.3.2. Route of Oxytocin Delivery

Oxytocin is a 9-amino acid peptide that cannot cross the blood-brain barrier and enter the central nervous system. Since oxytocin is not able to cross the blood-brain barrier, intravenous and oral administration of oxytocin is ineffective. Intranasal administration has so far been the primary route of oxytocin delivery in humans (Insel 2016).

2.3.3. Some Physiological Effects of Oxytocin

2.3.3.1. Effect of oxytocin on learning and memory

In human studies, oxytocin has been found to have an amnesic effect in both men and women. When Oxytocin infusion is administered to women for 4 or 8 hours for the treatment of miscarriage, it has been found to significantly reduce memory, accuracy, and stability. Significant impairments in learning processes such as first-word storage and retention speed have been observed in healthy men given oxytocin (Bruins et al. 2012).

2.3.3.2. The effect of oxytocin on anxiety, stress and depression

There is strong evidence that oxytocin is involved in the regulation of mood in humans. People with major depression have been reported to have lower plasma oxytocin levels. Increased psychological distress and decreased parental attachment have been associated with low plasma concentrations of oxytocin (Vică ML, et al., 2022). Increased oxytocin levels after childbirth have been associated with improved mood and reduced anxiety. Intranasal administration of oxytocin reduces the activation of the amygdala in response to conditions such as fear or anxiety For example: Administering intranasal oxytocin before speaking in front of an audience reduces the social stress that can occur (Kirsch et al. 2005).

2.3.3.3. The effect of oxytocin on commitment and trust

Women who look at pictures of their loved ones have increased brain activity in reward-related dopaminergic pathways that contain high levels of oxytocin receptors. Higher levels of the hormone oxytocin were detected in urine tests of owners who reported a high degree of attachment to their dogs than in urine tests of owners who

reported a lower degree of attachment to their dogs. In the postpartum period, oxytocin levels have been associated in direct proportion with maternal attachment behaviors such as caring for the baby, calling out, and a caring touch (Walter et al. 2021)

2.3.3.4. The effect of oxytocin on appetite

In the studies carried out, it has been shown that Oxytocin participates in the regulation of appetite, especially in its role in metabolism. Oxytocin has an anorectic effect. Increased oxytocin production leads to reduced food intake (Kerem et al. 2021).

2.3.3.5. The effect of oxytocin on water and salt balance

Studies have found that the physiological plasma level of oxytocin has a natriuretic effect in the glomerular or tubular region of the kidneys. The hormone oxytocin is also known to increase the glomerular filtration rate (GFR). They have characterized oxytocin as a hormone that regulates body osmolarity without causing hypertension, increasing the excretion of sodium in the urine (Natochin et al. 2020).

2.4. Melatonin

The hormone melatonin, also known as N-acetyl-5-methoxytryptamine, is secreted from the pineal gland, especially at night (Figure 6.) Melatonin is a natural neurotransmitter. It is involved in many biological and physiological regulations of the body. It is an effective hormone for the human biorhythm (circadian rhythm). Its main function is to maintain the biological clock of the body and regulate its rhythm. Other known functions include its contribution to cell regeneration and the immune system. Melatonin was first identified in 1958 when a molecule from the pineal gland bleached the dark skin of a frog and precipitated melatonin granules that appeared in the pigment cells of amphibian skin. However, in mammals, it was found to not affect pigment (Murala et al. 2022).

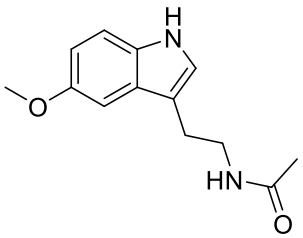

Figure 6. Melatonin Structure

2.4.1. Melatonin Synthesis and Metabolism

Tryptophan, a precursor to melatonin synthesis, is taken up from plasma by the pineal gland. Tryptophan is an essential amino acid and must be obtained from food. In pinealocytes, tryptophan is mainly hydroxylated to 5-hydroxytryptophan by tryptophan hydroxylase. The enzyme tryptophan hydroxylase involved here is the first enzyme in the serotonin production pathway, known as the neurotransmitter, and forms the rate-limiting step in this pathway. 5-hydroxytryptophan can easily cross the blood-brain barrier 5-hydroxytryptophan is converted to 5-hydroxytryptamine (serotonin) by losing the carboxyl group via the enzyme L-amino acid decarboxylase. 5-Hydrocytryptamine (serotonin) cannot cross the blood-brain barrier Serotonin is then acetylated to N-acetylserotonin by the enzyme N-acetyltransferase (NAT). Finally, N-acetylserotonin is converted to melatonin by the enzyme Hydroxyindole O-methyl-transferase (HIOMT). The metabolism of melatonin takes place in the liver. Metabolized melatonin converts to 6-hydroxymelandin and then to 6-sulfatoxymelatonin, its main metabolite, which is excreted in the urine. This substance in urine is mainly used to assess the function of the pineal glands in children (Tan et al. 2020).

2.4.2. Melatonin and Sleep Disorder

As melatonin levels increase, stimuli are perceived less, and drowsiness increases. This increase in melatonin levels lasts for about 10-12 hours during the night. Therefore, the level of melatonin in the blood is higher at night

than during the day. Melatonin is also called the "Dracula hormone" because it is a hormone secreted in the dark. The secretion of this hormone falls with daylight. However, not only daylight but also bright artificial light has been reported to suppress melatonin release. Melatonin therapy is recommended for pediatric patients with attention deficit, hyperactivity, and sleep-onset insomnia. The use of melatonin has been reported to improve sleep duration and quality in people with sleep problems, rapid eye movement (REM) irregularity, restless legs syndrome, delayed sleep phase syndrome, manic people with sleep problems, and those with fibromyalgia (Poza et al. 2022).

2.4.3. Melatonin and Apoptosis

Melatonin is believed to increase the body's antioxidant capacity, promoting programmed cell death known as apoptosis, and thus preventing cancer. Furthermore, a recent study reported that melatonin induced apoptosis in human neuroblastoma cancer cells. Available data have shown that melatonin has a regulatory role in apoptosis. Melatonin therapy has also been reported to have stimulating or inhibitory effects on apoptosis in various biological systems. Despite these important data, the effects of melatonin on apoptosis have not been fully elucidated (Mafi et al. 2023).

2.4.4. The Relationship of Melatonin with Old Age

Although the amount of melatonin secreted is determined to be age-dependent, it may vary from person to person. Children secrete more melatonin than adults. This release decreases with age. In newborns, melatonin circadian rhythm is not observed for 3-4 months. Melatonin and 6-sulfacateoxymelatonin levels are very low immediately after birth. It reaches a certain level from the 6th-8th week. It reaches a mature level during youth and remains at these levels between 35-40 years. After this period, the melatonin level goes into a downward trend. With old age, disturbances occur in the rhythm of the pineal gland and the decrease in melatonin secretion is now evident. In healthy elderly people, there is a possibility that this condition may not develop. One of the most important causes of anatomical and functional damage to organs with aging is a decrease in antioxidant capacity and damage caused by free radicals. This has been linked to a decrease in the level of the hormone melatonin with age. It is estimated that melatonin protects the brain from oxidative damage by stimulating antioxidant enzymes and also reduces lipid peroxidation. Most neurodegenerative distresses in the brain have been linked to free radicals, which occur with the reduction of melatonin as the culprit. It has been reported that this situation can be prevented by melatonin treatment (Martín Giménez et al. 2022).

2.4.5. The Role of Melatonin in Thermoregulation and Its Role in the Biological Clock

Melatonin plays a huge role in the regulation of human and animal body temperature. Melatonin lowers central body temperature while at the same time increasing peripheral skin temperature. Thus, it causes heat loss in the body. Body temperature is regulated in the preoptic part of the hypothalamus, which is recognized as the heat center, in the anterior part. Research has shown that the nerve cells in this center have melatonin receptors and that the hormone melatonin stimulates this center, causing a drop in body temperature. It is estimated that melatonin will contribute to exercise performance. This is because melatonin levels in the blood have been found to change during physical activity. In addition, it was found that plasma lactate levels decreased in rats injected with melatonin after exercise, but elevated liver and muscle glycogen levels. As a result of these results, it can be said that melatonin contributes to performance by preventing the body temperature from rising to dangerous levels during exercise.

In addition to all these functions, the main task of melatonin is to maintain the biological clock and regulate its rhythm. The only hormone whose job is known as the regulation of the biological clock is melatonin. In the event that melatonin is not adequate and balanced, "jet lag" disease is observed, which manifests itself with symptoms such as fatigue, indigestion, mental disorders, late reaction to events, and body aches for no reason. The hormone melatonin has been proposed for the prevention and treatment of this disease (Badia et al. 2020).

2.4.6. Use of Melatonin as a Contraceptive

High doses of melatonin intake have been reported to prevent luteinizing hormone (LH) from reaching its peak during the menstrual cycle and to cause follicle-stimulating hormone (FSH) levels to remain stable. This condition

inhibits ovulation and the elevation of progesterone in the luteal phase. However, the use of melatonin as a contraceptive is controversial because it increases the feeling of sleep. It may also be considered that its use in oral contraceptive form is not very reliable. Because the success of the drugs used with oral contraceptive targets should be close to 100% (Greendale et al. 2020).

2.4.7. Anticancer Activity of Melatonin

The hormone melatonin has been found to inhibit cell proliferation in cancerous tissues and has anti-estrogenic effects in breast tissue. Melatonin prevents the increase of cancerous cells, the development of tumors and reduces the amount of metastasis. With these effects, they are similar to chemotherapeutic substances. Moreover, melatonin levels are low in patients with prostate or breast cancer. Melatonin sulfatase lowers the expression of aromatase and 17-hydroxysteroid dehydrogenase enzymes. It also increases the expression of the enzyme sulfotransferase and anti-estrogenic activity, just like progesterone.

A melatonin hormone molecule has the property of being both a selective estrogen receptor modulator (SERM) and a selective estrogen enzyme modulator (SEEM). This feature is one of the main features sought in drugs used in breast cancer.

One study found that melatonin reduced tumors caused by chemicals in animals. Another study found that visually impaired people had a lower risk of developing cancer. Studies conducted in Sweden and Finland have also found that women with blindness have a lower risk of breast cancer than other normal women. A possible mechanism for this is increased secretion of melatonin in visually impaired people (Samec et al. 2021).

2.4.8. Effects of Melatonin on the Heart

It is thought that melatonin deficiency may increase hypoxia and oxidative damage. Therefore, it is estimated that melatonin intake may be important in heart disease caused by oxidative damage. It has also been found that melatonin hormone is more beneficial than ascorbic acid in cardiac arrhythmias. In an in vivo study by a research team, intravenous melatonin injection was found to prevent ventricular tachycardia, ventricular fibrillation, and early ventricular contraction. Another property of melatonin is that it is secreted during the night, reducing blood pressure and heart rate, thus contributing to the balancing of high blood pressure (Reiter et al. 2010).

2.4.9. Antioxidant Property of Melatonin

Melatonin hormone has been proven to be a very important antioxidant by in vivo and in vitro studies. The antioxidant property of melatonin is that it protects DNA, which is very important for the life cycle, against oxidative damage and prevents tumor formation. Melatonin is a powerful free radical scavenger. It also acts by activating pathways that remove toxic and chemical substances. Thanks to these properties, carcinogenic substances cannot bind to DNA and the resulting harmful components do not accumulate in the cell. In cases where there is DNA damage, melatonin is also reported to promote the repair of this damage.

Melatonin neutralizes and removes the most harmful OH radical. The methoxy and acetyl groups of melatonin in the side chain of the indole nucleus are involved in the removal of these OH radicals. An indolyl cation radical is formed by the reaction of melatonin with the OH radical. Melatonin exerts its effect by retaining the superoxide (O_2-) radical in the environment. It also inhibits the superoxide radical by amplifying the mRNA of superoxide dismutase (SOD). In addition, melatonin has been found to stimulate the activities of peroxidase (POD), glutathione reductase (GR), and glucose-6-phosphate dehydrogenase enzymes. Melatonin also exerts an antioxidant effect by reducing the intracellular concentration of hydrogen peroxide (H_2O_2) (Chrustek, et al. 2021).

Additionally, although vitamin E cannot cross the blood-brain barrier, melatonin does, so it is considered an excellent antioxidant.

In addition, it has been found that melatonin, a natural antioxidant, has a 5-fold higher ability to neutralize the OH radical than glutathione and 2 times higher than vitamin E.

2.4.10. The Role of Melatonin in Psychiatry

It has been reported that the basis of psychiatric disorders is functional disorders of the pineal gland and depression is associated with low melatonin levels (Macchi et al. 2004). Likewise, disorders in the release of melatonin have been identified in patients diagnosed with bipolar disorder and schizophrenia. The fact that many antidepressant medications raise melatonin by raising norepinephrine and serotonin levels is considered evidence of a link between depression and melatonin. In the studies conducted, it was found that melatonin levels were low at night in depression patients. The use of melatonin in the treatment of patients with depression has been reported to cause the regulation of sleep rhythm and the reduction of symptoms of depression in patients. However, it is believed that the use of melatonin preparations throughout the day, such as antidepressant drugs, can worsen the picture, so melatonin should be used taking into account the circadian rhythm (Moon et al. 2022)

As a result of the studies carried out, the melatonin hormone in patients diagnosed with bipolar disorder was generally shown to decrease. In patients with schizophrenia, melatonin circadian rhythm disturbances and low serum melatonin levels have been found. It is estimated that the use of melatonin in schizophrenia patients can be a solution to sleep problems without disrupting the circadian rhythm and causing side effects. In a study of OCD patients, serum melatonin levels were found to be lower than in other people Panic attack patients have also been found to have low melatonin levels at night (Janicak et al. 2011)

3. Conclusıon

The miraculous chemicals in our brain are hormones that affect our body's homeostasis, metabolic processes in the body, cognitive activities in our brain, our psychological mood during the day, and our daily social life. We must know how the release of these hormones is, what depends on them, and what their deficiency or excess leads to, and we must organize our lives according to these miraculous chemicals so that we can protect the physiological and mental health of our body. In conclusion, the miraculous chemicals in our brain, namely hormones, play pivotal roles in maintaining the homeostasis of our body, regulating metabolic processes, influencing cognitive activities, shaping our psychological mood, and orchestrating our daily social interactions. Understanding the mechanisms underlying the release of these hormones, their dependencies, and the consequences of their deficiency or excess is essential. By aligning our lifestyles with the functions of these miraculous chemicals, we can safeguard both the physiological and mental well-being of our bodies. Moving forward, it is imperative to prioritize education and awareness regarding the significance of these hormones, fostering a proactive approach toward holistic health maintenance.

Conflict of interest: none

Financial support: none

Ethics statement: none

Acknowledgements: This study was prepared by my student Muhammed Can Uysal from Agri İbrahim Cecen University Faculty of Pharmacy research project thesis.

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