

# I.E.S. PLAYAMAR DEPARTAMENTO DE BIOLOGÍA Y GEOLOGÍA

## UNIT 5 THE NERVOUS AND ENDOCRINE SYSTEM.

### The coordination systems

People, as the rest of living beings, receive information and make responses through the interaction function. To make the interaction relation people need to have a coordination system which permits us to detect the changes that are being made in the environment, to analyse it, and to respond with the adequate response. It is possible thanks to:

The nervous and endocrine system.

### Elements that take part in the coordination

During the process which occurs since we receive a stimulus to when we elaborate a response, different elements take part in both coordination systems:

-Receptor

It is structure that notices the stimuli, and transmits them to the nervous centre. The sensory organs are receptors which receive stimuli from the outside of the organism. Stimulus is any change, both from the outside or inside of the organism, which is able to provoke a response from the organism. It can be pain, a sound, etc...

-Nervous centre

It is the organ responsible for receiving the information noticed by the receptors. Then the nervous system processes it, and elaborates and transmits a set of responses to the effector organs.

-Effector

It is the organ responsible for making the response. There are two types of effectors, which develop two types of different responses:

1. Muscle. It produces a motor response, which involves movement.

2. Gland. It produces a secretory response, which consists of the secretion of some glands.

### The neurons and nervous impulse.

The nervous system is a network of neurons. The neuron is a highly specialized cell.

Each neuron has got a cell body or soma.

Signals or impulses go into the cell body along one or more fibres called dendrites and leave through another fibre called an axon. There are three types of neurons: Motor, Sensory, and Association neurons

### The neuron

a) Cell body. The cell body or soma is the part of a neuron containing its nucleus and most of its cytoplasm with the organelles.

b) Dendrites. Dendrites are thin extensions of the cell body which carry nervous impulses towards the cell body.

c) Axon. It is a long and single thin nerve fibre that carries nervous impulses away from the cell body.

### Glial cells

The glial cells are stiffened cells which provide support and protection for neurons in the brain and peripheral nervous system.

The four main functions of glial cells are:

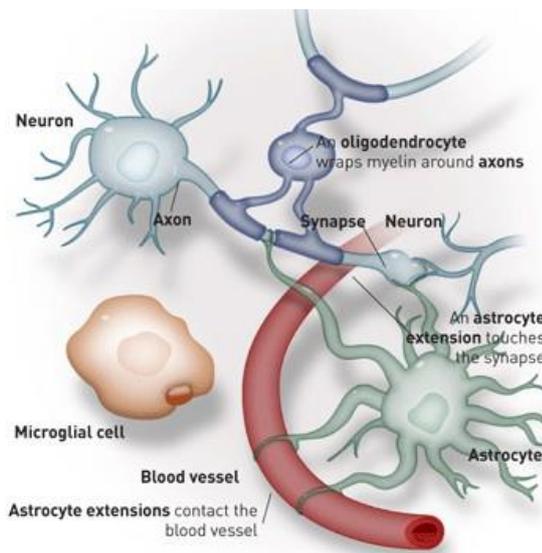
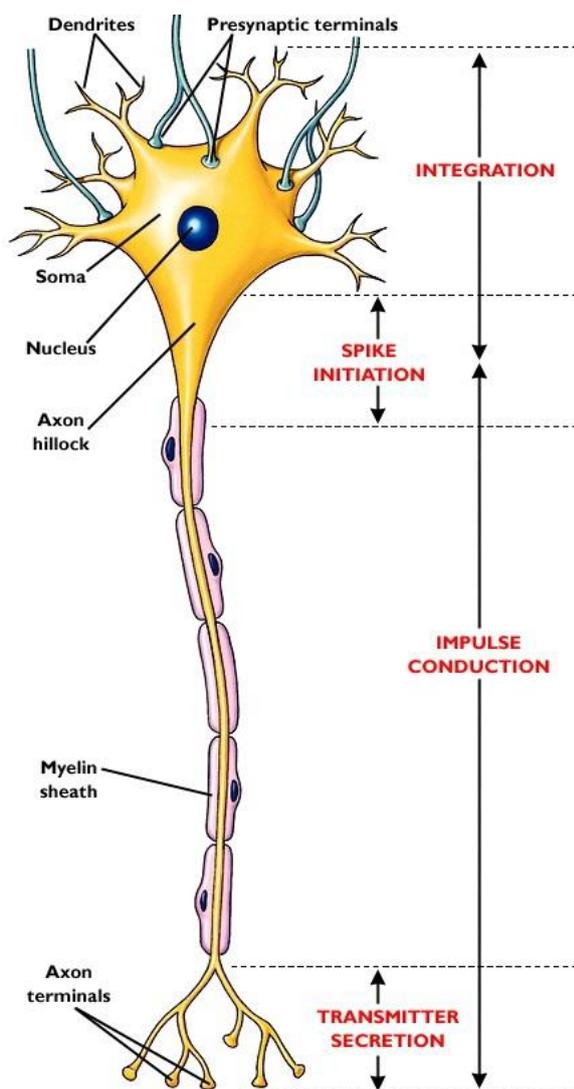
- To surround neurons and hold them in place

- To supply nutrients and oxygen to neurons
- To insulate one neuron from another
- To destroy pathogens and remove dead neurons

The main glial cells are:

-The Astrocytes which nourish the neurons.

-The Schwann cells which produce a white, fatty substance called myelin and surround the axon forming the myelin sheath. The nodes of Ranvier are the gaps formed between the myelin sheaths generated by different Schwann cells.

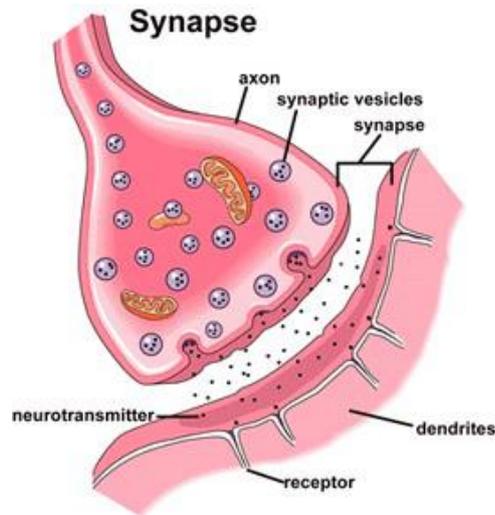
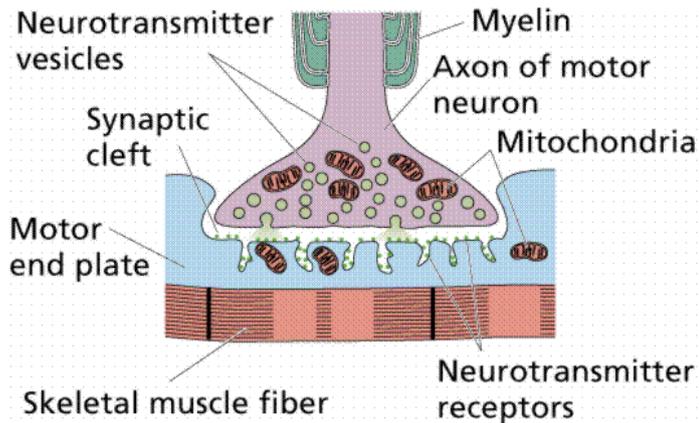


## THE SYNAPSE

The synapse is the tiny area where the branching ends of the axon of one neuron meet the dendrites of the next. When a signal or nervous impulse reaches the end of an axon, it can be passed on to the dendrites of the next across a gap called synapse.

When the nervous impulse reaches the end branch, a chemical called neurotransmitter is released into the minute gap, called synaptic cleft, found at the junction.

When a big quantity of this neurotransmitter has crossed the synaptic cleft and has reached the other side into the dendrite of the next neuron, an impulse starts up and is sent on along the dendrite.



## THE NERVOUS SYSTEM

The nervous system receives information from the receptors, processes and coordinates it and elaborates responses that effectors execute.

There are two main parts: the central nervous system and the peripheral nervous system.

### Central nervous system (CNS)

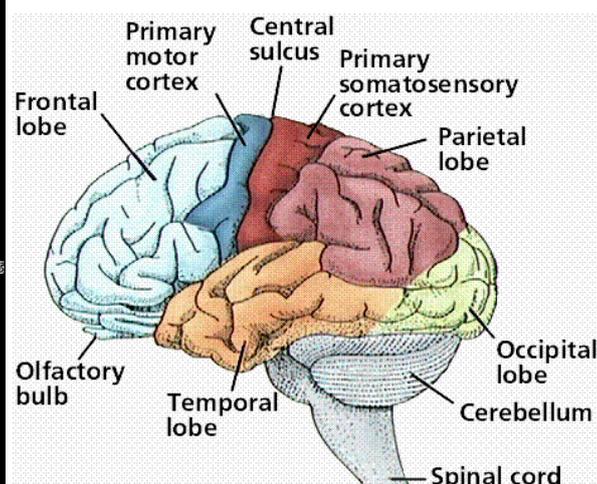
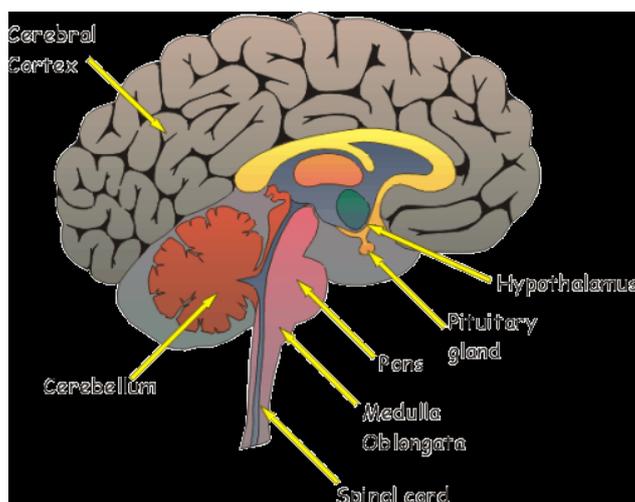
The CNS receives information from all over the body. It interprets this information and uses it to control the body's system. The CNS consists of the brain and the spinal cord.

### The brain

The brain is protected by the cranium. It interprets information from the sense organs. It also controls language, memory and thought. It is responsible for motor control, sleep, hunger, thirst, etc. The brain produces voluntary responses; these are responses we perform just thinking.

The brain has got three parts:

1. The forebrain. It is formed by two cerebral hemispheres (the right hemisphere and the left hemisphere) that are separated by a groove, the medial longitudinal fissure. The surface of both hemispheres is folded making the circumvolutions. The forebrain consists of the cerebral hemispheres, thalamus, hypothalamus, and limbic system.
2. The midbrain. It is located below the cerebral cortex, and above the hindbrain. So it is placed near the centre of the brain. It is associated with vision, hearing, motor control, sleep/wake, alertness, and temperature regulation.
3. The hindbrain. It controls basic movements that keep us alive. We perform them automatically, even when we are asleep. It includes the cerebellum, the pons and the medulla oblongata.



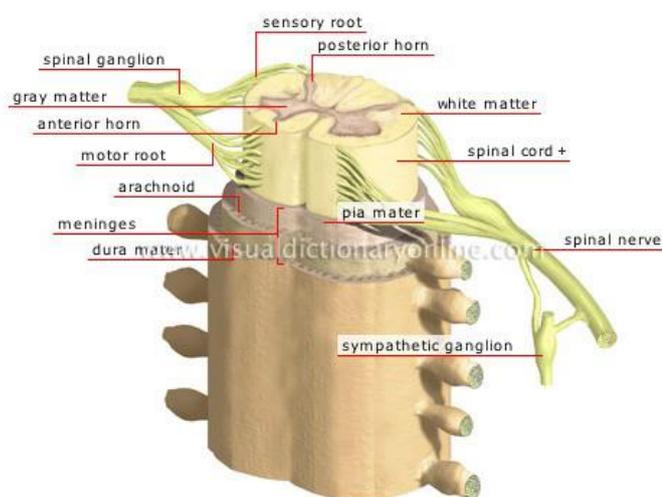
-The cerebellum. It is the largest part of the hindbrain. It is responsible for keeping our balance, and the fine control of muscle movements.

-The medulla oblongata. It is the lower half of the hindbrain, which continues with the spinal cord, the upper half being the pons. The medulla oblongata contains the cardiac, respiratory, vomiting, and vasomotor centres and so deals with the autonomic (involuntary) functions, of breathing, heart rate, and blood pressure.

## The spinal cord

The spinal cord is a long, thin, tubular bundle of nervous tissue and support cells that extends from the brain. It passes through the hollow channels of bones called vertebrae.

The spinal cord is protected by the vertebral column, and by three membranes called meninges. It is divided into 31 different segments. In cross-section, the peripheral region of the cord contains neuronal white matter tracts containing sensory and motor neurons. Inside this peripheral region is the grey, butterfly-shaped central region made up of cell bodies. The spinal cord sends signals to and from the brain. The spinal cord sends orders so that the effectors carry out involuntary responses or reflexes.



## Peripheral nervous system (PNS)

The PNS is the part of the nervous system consisting of the nerves and ganglia outside of the brain and spinal cord. The PNS includes twelve pairs of cranial nerves, and thirty one pairs of spinal nerves, which voluntary movements and sensations.

The PNS connects the sense organs to the central nervous system, and the central nervous system to the effectors; for example, the muscles.

The peripheral nervous system is divided into the somatic nervous system and the autonomic nervous system.

1.The somatic nervous system. It controls the body movements (skeletal muscles which are voluntarily controlled).

2.The autonomic nervous system. It controls involuntary and unconscious body functions as the heartbeat of which we are not aware. The brain has not got control over it, although some of these functions can be influenced by a voluntary and conscious activity.

The autonomic nervous system consists of two subsystems:

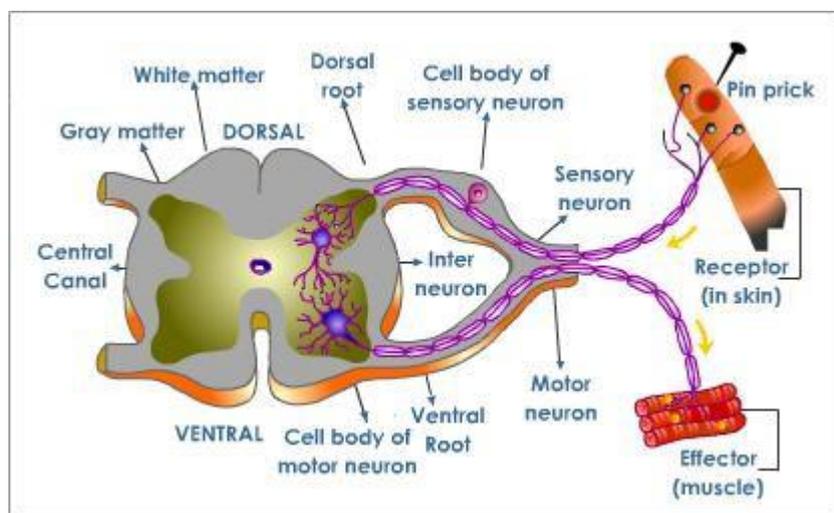
a)The sympathetic autonomic nervous system.The sympathetic prepares the body for situations of activity.

b)The parasympathetic autonomic nervous system. The parasympathetic prepares it for situations of rest.

Both of them have got antagonistic effects. Each organ of the body is controlled by two different nerves of the autonomic nervous system, one branch from the sympathetic and other from the parasympathetic. Both subsystems have opposite but complementary functions.

### The reflex arc

The nervous system allows very quick responses because it uses nervous impulses. Reflex actions are automatic; it means that they are involuntary actions which are done without thinking, so they are even quicker. Reflex actions save your body from injury, such as when you pull off your hand from a hot object. The muscles respond by contracting and the glands by secreting.



### The mental health

The mental disorders are caused by the interaction of physical, psychological and environmental causes. They include thought, emotional, and behaviour alterations.

#### Physical or organic disorders

They can be produced by very different causes:

- Infectious diseases. The poliomyelitis or meningitis are caused by pathogenic agents and are harmful to the nervous system.
- Obstruction or Break down of cerebral arteries. These cause the death of neurons due to the lack of blood flow.
- Blows. These can cause injuries in the medulla and provoke paralysis in the rear limbs (paraplegia) or in the all the limbs (tetraplegia).
- Neurodegenerative diseases. Alzheimer or Parkinson are the diseases with biggest impact in our society.

They are characterized by the appearance of multiple symptoms, due to the progressive lack of the functions of the CNS. The causes of these diseases are already unknown, although they are mainly linked to ageing and genetic factors. They are the third problem of health in Spain, after cardiovascular diseases and cancer.

#### Alzheimer

It is produced by the neuron degeneration of the cerebral cortex. The Alzheimer is irreversible and starts with memory, orientation, and reasoning ability mild loss, which gradually gets worse. In advanced stages, language difficulties, inability of keeping instructions, and behaviour and personality changes, are produced. The cause of this disease is unknown, although it is thought that it is due to a combination of genetic and environmental factors which act at the same time. Generally it affects old people, although it can appear in early ages. Nowadays this disease has not got a cure, but there are some medicines which control some of their symptoms.

#### Parkinson

It is produced by the degeneration or death of the neurons, of the cerebral areas which are in charge of the control and coordination of movements and position. The more frequent symptoms are; muscular rigidity, walking difficulties, hands, arms and legs shivering, and alterations in movement coordination. When these symptoms get worse, the patients can have walking, and talking difficulties. Nowadays the cause of this disease is unknown, but it seems that some genetic factors and toxic chemicals in the environment can influence. Generally it affects old people, although it can appear in early ages.

### **Nervous system healthy habits**

It is important to keep some healthy habits so that the nervous system can work properly, such as:

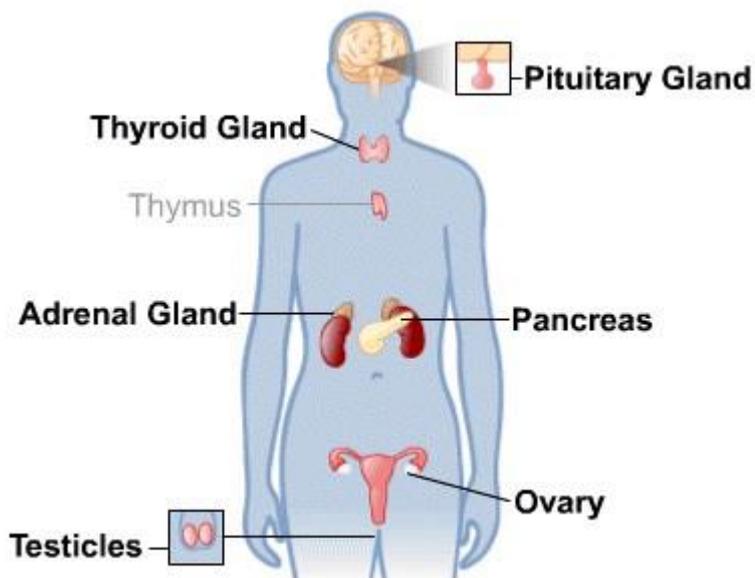
- To keep a balanced feeding which provides the adequate nutrients.
- To keep an ordered life, with regulates schedules which allows us to have time to rest and spare time.
- To do physical exercise, resting a little bit during the day and sleeping, at least, eight hours by night.
- To do mental activities regularly.
- To avoid conditions and activities which can harm the nervous system.
- To take protection measures in order to avoid injuries due to accidents. For example, to use the helmet when you drive a bike or a motorbike, or to use the seatbelt when you get into a car.
- To avoid the consumption of tobacco, alcohol or other drugs which affect the proper work of the nervous system. These substances can cause serious mental diseases or even death.

### **THE ENDOCRINE COORDINATION**

Endocrine coordination is a mechanism which regulates the actions of many of the body organs, in a slow but prolonged manner. This system is related with the nervous system and they depend on each other. Sometimes the nervous system stimulates or inhibits the secretion of hormones, and sometimes the hormones stimulate or inhibit the action of the nervous system.

The endocrine system is made up of a set of glands distributed through the whole body. They are called endocrine glands or internal secretion glands, due to the fact that they release their secretion products directly to the blood.

The endocrine glands are made up of specialized secretor cells, which make chemicals called hormones. After hormones are made, they are poured into the blood and carried to the whole body through the blood vessels. Nevertheless, they only act in some cells or organs, called target cells or target organs.



## **The endocrine system**

The endocrine system is composed of a series of endocrine glands that produce and secrete hormones.

The endocrine glands

Endocrine glands are highly structured organs. The smallest blood vessels, the capillaries, run through these glands. Hormones are secreted into the capillaries

### **The Pituitary Gland**

It is a small, pea-sized gland located in the base of the brain. This produces many important hormones which tend to control other glands, as a rule.

-Oxycotin. It activates the uterus contractions during labour and stimulates milk production in the mammary glands.

-Growth hormone (GH). It stimulates the growing of bones.

-LH and FSH. They act over the sexual glands regulating their activity.

-Anti-diuretic hormone (ADH). It has anti-diuretic action that prevents the production of diluted urine.

-Thyroid stimulating hormone (TSH). It is a pituitary hormone that stimulates the thyroid gland to produce thyroxine.

### **The Thyroid**

It is located in the neck, in front of the trachea and below the larynx. This produces:

-Thyroxine. This hormone regulates the organism metabolism and helps the development of the nervous system.

-Calcitonine. This hormone decreases the calcium levels in blood, favouring its store in bones.

### **Adrenal Gland**

The adrenal glands (also known as supra-renal glands) are located on the top of the kidneys. They are mainly responsible for releasing hormones in response to stress.

-Adrenaline. It prepares the body with the well known fight or flight reaction by increasing; blood glucose, heart rate, breathing rate, and diversion of blood from the skin to muscles.

-Cortisol. It stimulates the glucose production and the fat break down.

### **Pancreas**

The pancreas is an organ located behind the stomach. It is involved in the body's ability to control glucose level in the blood. Inside the pancreas there are tiny structures called Islet of Lagerhans which secrete hormones into the blood. The Islets of Lagerhans are composed of several cell types. One type, Beta cells release insulin after every meal. Insulin, along with glucose passes into the blood stream and travels through the entire body. When you are doing strong exercise and blood glucose levels fall too low, the Islet of Lagerhans also produces glucagon. Glucagon causes the liver to convert stored glycogen into glucose, which is released into the bloodstream.

### **Testes**

They produce testosterone which promotes all male secondary sexual characteristics at puberty:

-Extra hair in some places

-Changes in body proportions.

-Sperm production.

### **Ovaries**

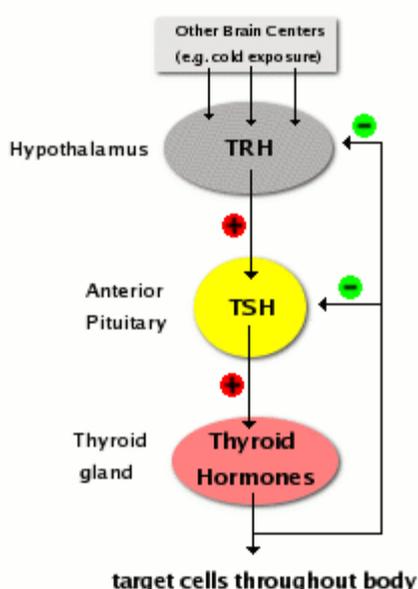
They produce oestrogen which promotes all female secondary sexual characteristics at puberty

- Extra hair in some places
- Changes in body proportions.
- Ovules production.

### The functioning of the endocrine system

Hormones act in small amounts, and when they finish their function they are eliminated. The excess or deficit in the amount of hormone present in blood can cause different diseases. Due to this fact, the endocrine glands do not secrete hormones constantly. There is a mechanism which stops their production. Usually it is the own amount of the hormone in blood or the action of such hormone which stops its release.

This mechanism of regulation is called feedback. It is controlled by the Central Nervous System through the hypothalamus and the pituitary gland, and it allows maintaining the proper hormone level in blood while the stimulus, which has caused it, lasts.



### Hormones and Nerves

Hormones and nerves do similar jobs, but there are important differences.

Nerves	Hormones
<ul style="list-style-type: none"> <li>• Very fast message.</li> <li>• Act for a very short time.</li> <li>• Act on a very precise area.</li> <li>• Immediate reaction.</li> </ul>	<ul style="list-style-type: none"> <li>• Slower message.</li> <li>• Act for a long time.</li> <li>• Act in a more general way.</li> <li>• Longer-term reaction.</li> </ul>

### ENDOCRINE SYSTEM DISEASES

In a healthy person, each hormone is made in the amount that the organism needs. Nevertheless, due to different factors, this amount can be over or below its regular level. This fact provokes important disorders. In this case, they are called hyper function and hypo function. The main diseases in relation to the endocrine system are:

#### Diabetes

The pancreas stops making enough insulin. Diabetes is a disease in which the pancreas does not produce enough insulin. The result is that a person's blood sugar can rise to a level that can kill them.

## Thyroid diseases

They are due to an alteration in the production of thyroid hormone, by excess or by deficit, which is called hyperthyroidism and hypothyroidism.

-Hyperthyroidism. It is the hyper function, or excessive production of thyroid hormones, leads to an increase of the metabolism, nervousness, irritability, hyperactivity and loss of weight. It is usually accompanied by an increase of the volume of the thyroid, which is manifested with a swollen of the neck (goitre).

-Hypothyroidism. It is the hypo function, or low production of thyroid hormones, produces a slowing down of the most important functions of the organism.

## Pituitary gland diseases

They are caused by problems in the production of growth hormone in the development phase of a person.

-Dwarfism. It is caused by the hypo function of the pituitary gland which provokes a low production of growth hormone. The consequence is that an individual person is short in height.

-Gigantism. It is caused by the hyper function of the pituitary gland which provokes overproduction of growth hormone. It is a condition characterized by excessive growth, and height significantly above average.

## ACTIVITIES

1. What are the systems of coordination? What are their functions?
2. What structures are in charge of receiving stimuli?
3. Name the types of effectors in order to the response which they produce.
4. What is the nervous impulse? Where is it made?
5. Draw a neuron and label the different parts.
6. What are the differences between the dendrites and the axon?
7. The myelin is a substance which provides special characteristics to the nervous cells.
  - a) What are these characteristics?
  - b) What kind of substance is the myelin?
  - c) What cells does the myelin make?
8. Elaborate a diagram with the components of the nervous system.
9. What is a hormone? Where are the hormones made?
10. Give four details to compare nerves with hormones.
11. What is a target cell or a target organ?
12. Name the hormones which are made in the pancreas and which are their function.
13. What is the hormone which stimulates the growing of our body? What is the gland which produces it?
14. What are the hormones released by the male and female gonads? What is the function that they have?
15. Describe the mechanism of negative feedback.