Unit 6:
Sensory receptors

Think and answer?

a. What is the function of sensory receptors?

b. What are the stimulus that the eye? And the ear?

c. What organ allows us to detect the taste of food? And its smell?

d. Name some of the receptors located in the skin?

UNIT OBJECTIVES

In this unit you will learn:

- The different types of sensory receptors that exist in the human body.
- The processes of sight and hearing.
- To understand the operation of balance sense.
- To relate the function of smell and taste.
- To distinguish the different receptors located in our skin.
- To appreciate the importance of healthy habits related to sensory organs.
- The main diseases and disorders of the sensory organs.

1. Sensory receptors

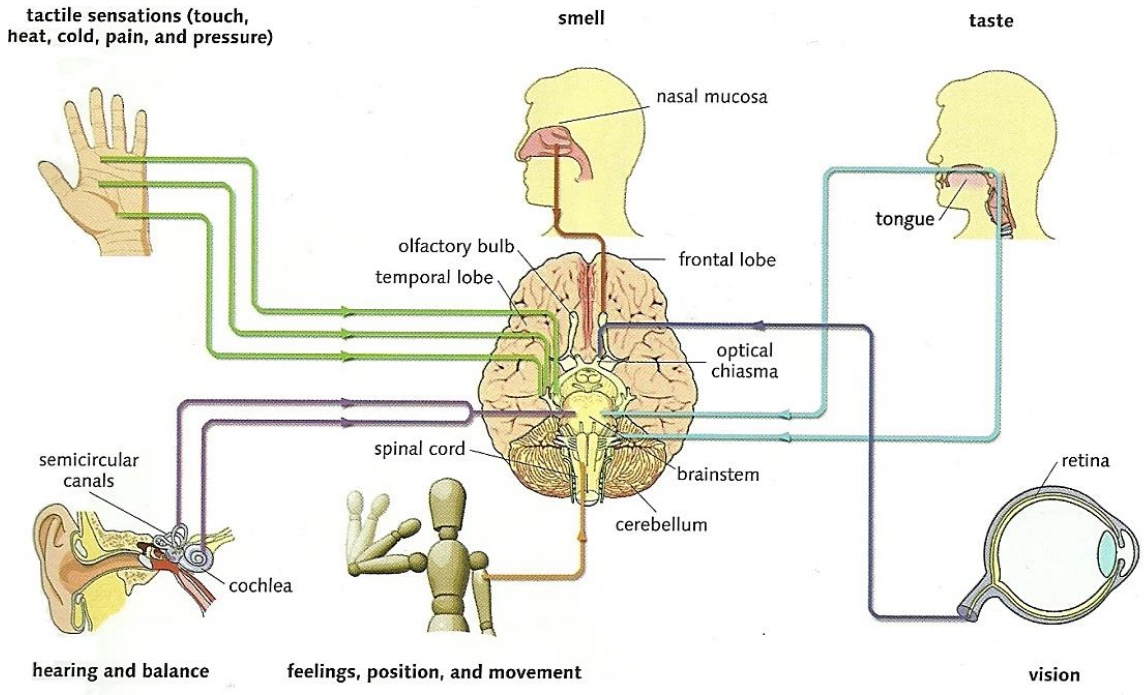
Sensory receptors are responsible for detecting changes (stimuli) in the world around us and converting them into nerve impulses. The nerve impulses then travel to a higher nerve centre where feeling starts. Sensory receptors can be quite simply groups of nerves or, more often, special cells, which join together to make up the sensory organs.

They can be classified according to the *type of stimuli* they receive:

- **Photoreceptors** detect *light* stimuli and are found in the eyes.
- **Mechanoreceptors** are stimulated by changes in movement, like *pressure*, *contact* or *sound waves*. These include receptors in skin, muscle, and the ears.
- **Chemoreceptors** pick up information from *chemical changes*. These include taste and smell receptors.
- **Thermoreceptors** detect changes in *temperature*. These include some skin receptors.
- **Nociceptors** are several kinds of receptors that detect *pain*. It includes every stimulus that potentially can produce damage, by their nature or intensity.

Sensory receptor also can be classified according to the *origin of the stimuli*:

- **Internal receptors**. They perceive changes in the internal medium and organs. These receptors are scattered throughout the organism.
- **External receptors**. They capture stimuli from the external environment.



ACTIVITIES

1.1. Define:

a. Stimulus
b. Receptor
c. Response
d. Effector

1.2. Indicate what criteria we can use to classify the sensory receptors. Put examples.

1.3. Answer these questions:

a. Can any internal photoreceptor exist?
b. What kind of receptors are balance receptors?
c. Why are nociceptors known as polimodal receptors while thermoreceptors as monomodal?

2. The eye: sight

The **eye** is the organ of sight.

2.1. Parts of the eye

Each eye is made up of the **eyeball** and a series of **accessory structures**.

a) Eyeball

It is a hollow spherical organ, located in a cavity in the skull called the **ocular orbit** (or eye socket).

The eyeball walls are formed by three layers, that are, from the outside to the inside:

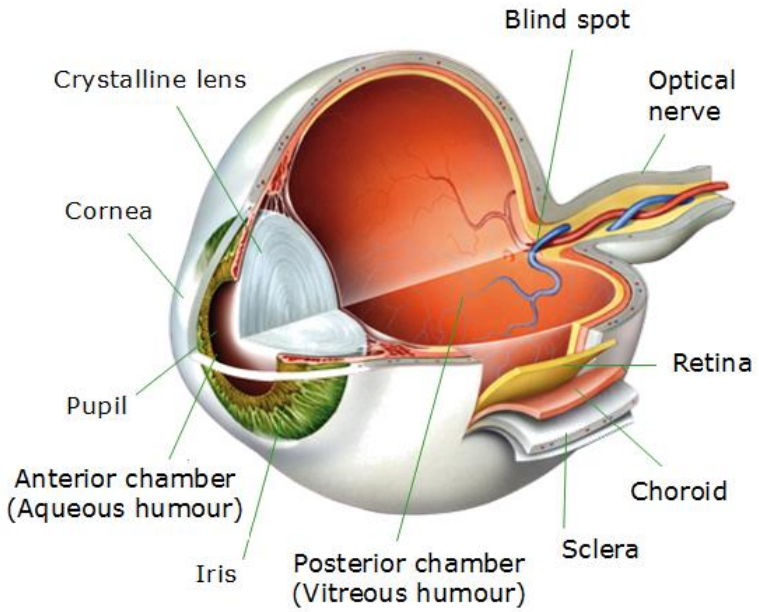
- The **sclera.** It is the outer part of the eyeball. It is white and opaque, but in the front it becomes transparent and forms the **cornea**. Covering the cornea, there is a layer of epithelium, the **conjunctiva**.
- The **choroid.** It is the middle layer of the eyeball. It is full of blood vessels that nourish the photoreceptors. It is black, although its frontal part, the **iris** (behind the cornea) is coloured (blue, brown, etc.). In the centre of the iris there is the **pupil**, an opening of variable diameter.
- The **retina.** It is the inner layer of the eyeball. It is made up by photoreceptors. These are specialised cells of two types: rods and cones.
  - **Rods** are cylindrical-shaped cells and can be stimulated by low intensity light, although they cannot distinguish colours.
  - **Cones** are conical-shaped cells and there are three types. They are less sensitive than rods and need high intensity light to be excited.
    Each one is able to perceive a colour (red, green, blue)

  There are two special points in the retina:

  - The **fovea**. It is an area, near the optical nerve, where exist a large number of cones and the sensitivity is maximum.
  - The **blind spot**. It is the part of the eyeball where the optical nerve emerges and where there are not photoreceptor cells.

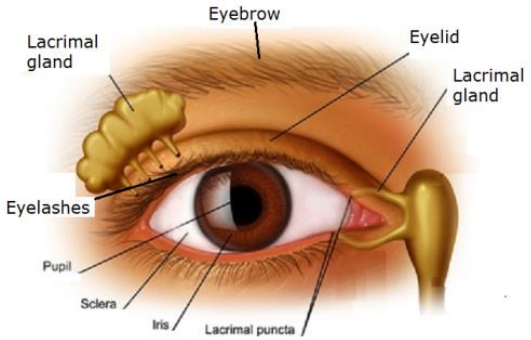
In the front part of the eyeball, there is the **crystalline lens**. It is located onto the inside, holding by the tiny muscles. It is a transparent, deformable and biconvex lens that separates two chambers:

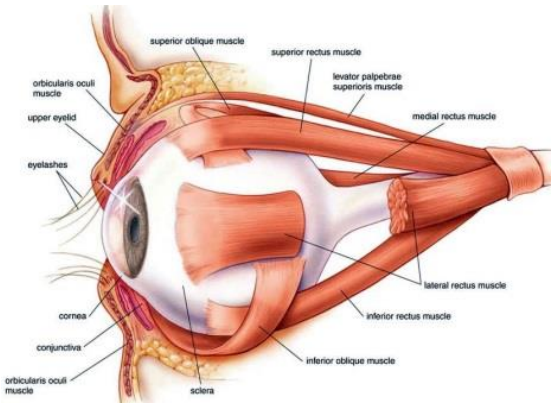
- The **anterior chamber** that is filled with a watery liquid (**aqueous humour**)
- The **posterior chamber** that is filled with a viscous transparent substance (**vitreous humour**)



b) Accessory structures of the eye (or appendages):

They protect the eye and allow its movement.
They are: **eyebrows**, **eyelashes**, **eyelids**, **lacrimal apparatus** and the **ocular muscles**.





2.2. How the eye works

Light crosses the eyeball, entering by the **cornea**. The cornea diverts and concentrates the light rays in a single point.

The **pupil** opens more or less depending on the intensity of light. It does this through the contraction and relaxation of very small muscles located in the iris (ciliary muscles).

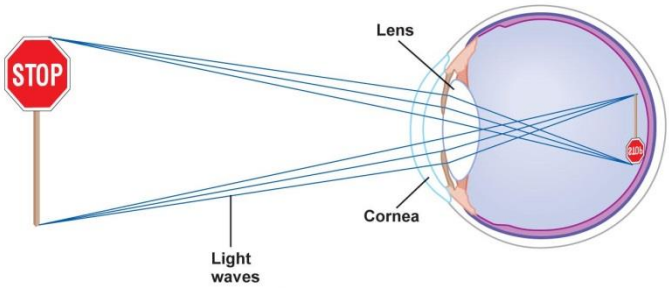
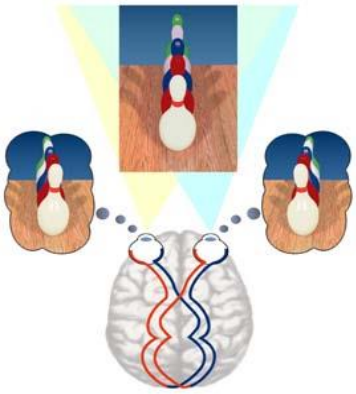


Image is focused thanks to the modification of the thickness of the **crystalline lens**. This process is called **accommodation**. The formed image onto the retina is inverted and smaller than the original object.

The **photoreceptors** are excited and convert the light in nerve impulses that are conducted by the **optical nerve** from the retina to the **cerebral cortex**.
There, the information is interpreted and the image is perceived.



Because of the position of our eyes, we can see the same image with both at the same time.
As a result, our vision is **binocular** and **stereoscopic**.
That means that we can perceive the distance, length, depth, width and position of the objects in the space.

ACTIVITIES

2.1. Indicate which is the function of:

a. Crystalline lens
b. Iris
c. Cones
d. Cornea

2.2. Answer these questions:

a. Why can we perceive objects in three-dimensional way?
b. Why cannot we distinguish the colour of objects with low light?
c. Why does the blind spot exist?
d. What is the function of eyebrows? And the function of tears?

2.3. Explain this sentence: "*It's the brain which can see, not the eyes*"

3. The ear

The **ear** is the organ of **hearing** and **balance**.

Each ear is located in a cavity in the temporary bones of the skull. It can be distinguish three parts in the ear: the **outer ear**, the **middle ear** and the **inner ear**.

- Outer ear

It is formed by the **pinna** (auricle) and the **ear canal**. Inside the ear canal there are glands that produce cerumen. It is a sticky substance that avoids the entrance of strange particles to the ear. The ear canal ends in the **tympanic membrane** (eardrum).

- Middle ear

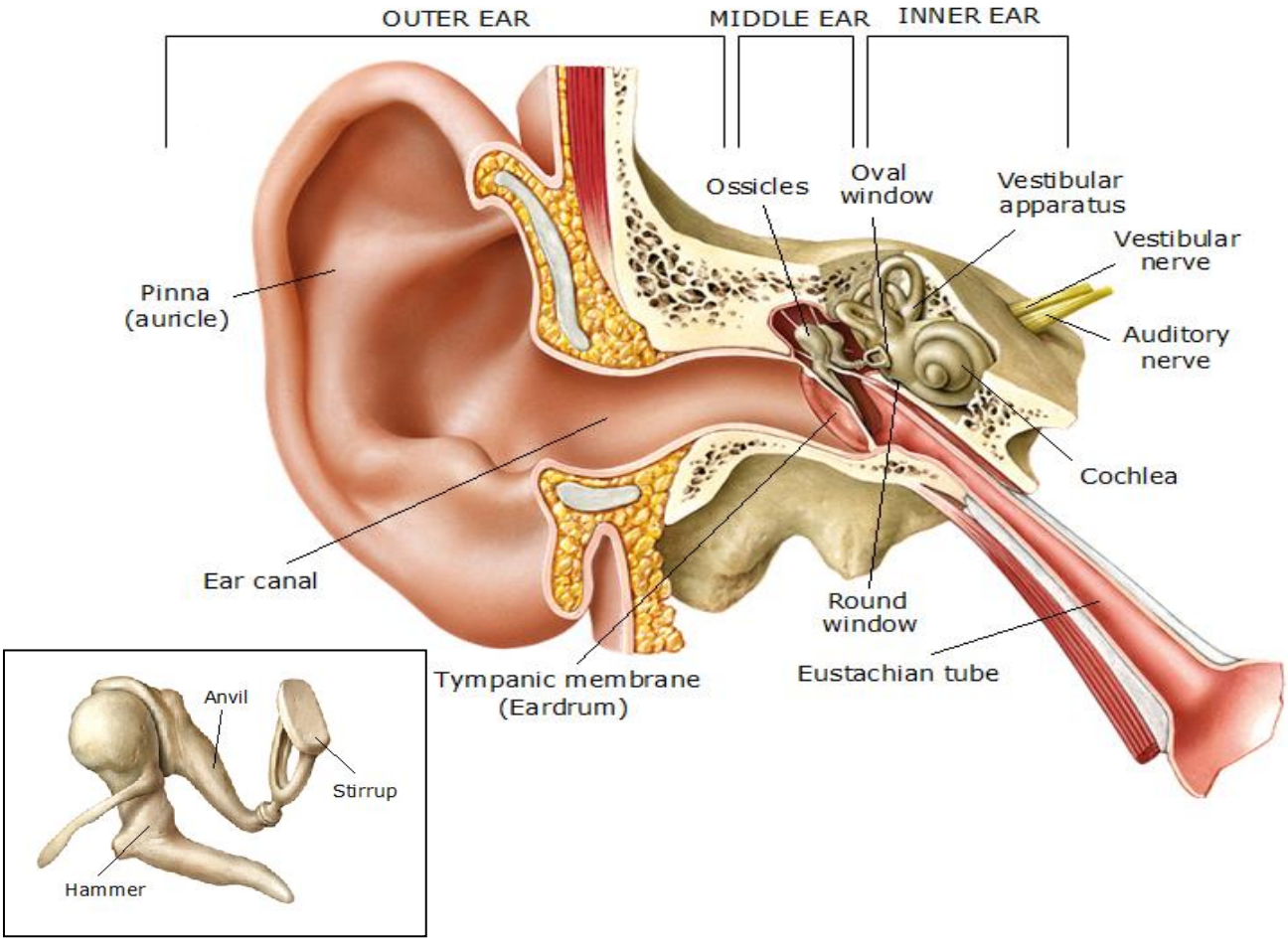
It starts in the eardrum and reaches two small membranes, the **oval window** and the **round window**. Connected among them and with the eardrum and the oval window there are three little bones called the **ossicles**. They are the **hammer**, the **anvil** and the **stirrup**.

The round window connects with the **Eustachian tube**. It is a canal that connects the middle ear with the pharynx and makes possible to equalize the pressure to both sides of the eardrum.

- Inner ear

This is the deepest part of the ear. It is made up of **labyrinthine membranes**. These form two complicated cavities in the temporal bone, one inside the other. There is a fluid called **perilymph** between the two labyrinth cavities and within the cavities there is other liquid, the **endolymph**.

- The first part of the labyrinth is the **cochlea**, which is responsible for picking up sounds. Here there are mechanoreceptor cells that form the **organ of Corti**.
- The other part is the **vestibular apparatus**, responsible for balance. It is formed by the **semicircular cannals** and two vesicles, the **utricle** and the **saccule**. Inside of them, there are also mechanoreceptor cells.



3.1. Hearing

The **pinna** catches the sounds and amplifies them. The sound waves are transmitted through the ear canal and provoke the vibration of the **eardrum**.

This vibration is transferred to the **ossicles** that amplify it even more.

From the oval window, the vibration passes to the liquids that fill the **cochlea**. The **organ of Corti**, runs through its inside. It consists of thousands of sensory hair cells, attached to a membrane. Tiny sensory hairs emerge from each sensory hair cell (mechanoreceptor) and pierce into a second, gel-like membrane above. Whenever the fluids in your cochlea are in motion, the first membrane vibrates and squashes the sensory hairs against the second membrane. The movement of your sensory hairs is then translated into nerve impulses.

From here, the nerve impulse travels through the **auditory nerve** to the brain where the information is interpreted.

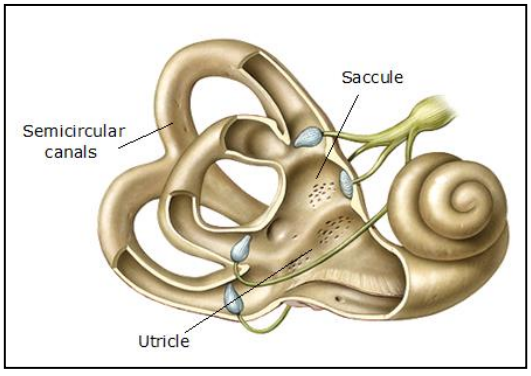
Because we have two ears, we are able to **locate** the source of a sound. If a sound comes from the right, for instance, it will reach your right ear slightly sooner than your left ear. Or it will be slightly louder in your right ear. As a result, you will recognise the sound as coming from your right.

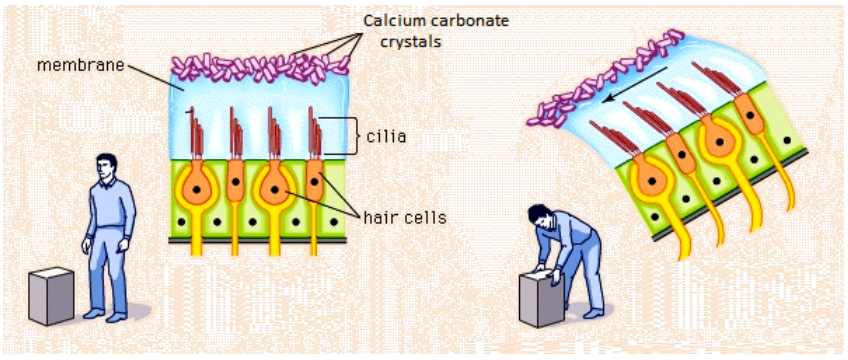
3.2. Balance

The sense of balance tells us

- the **position** of our body (utricle and saccule) → Static equilibrium
- the **movements** we make (semicircular canals) → Dynamic equilibrium

When we move, the liquid that fill in the **vestibular apparatus** moves too and it moves the cilia of the mechanoreceptors that cover the walls of the vesicles and semicircular canals. These cells change this movement into nerve impulse that is transmitted through the vestibular nerve to the brain and the cerebellum.





ACTIVITIES

3.1. Indicate which is the function of:

a. Pinna (auricle)
b. Ossicles
c. Semicircular canals
d. Organ of Corti

3.2. Answer these questions:

a. Why can we know where a sound came from?
b. Why are the receptor cells of the ear classified as mechanoreceptors?
c. Why does the Eustaquian tube exist?
d. What is the function of cerumen?

4. Chemoreceptors

Our senses of taste and smell are located in the **tongue** and the **nose** respectively.

Chemoreceptors send signals to the brain. The signals are processed as a sensation of smell or taste.

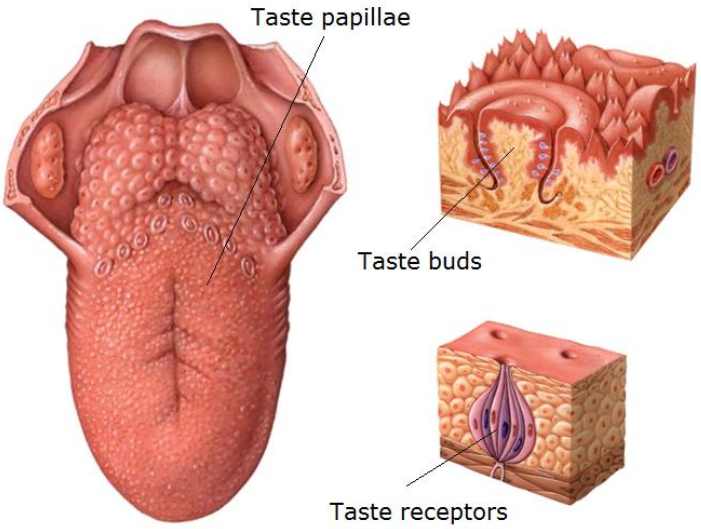
The sense of taste depends largely on what a person can smell. For example, if you have a cold, food seems to have no taste.

3.1. Taste

The sense of taste enables the body to detect **flavours**. There are four basic tastes: sweet, salty, sour and bitter. Nowadays, a fifth is also recognised: umami or savoury.

Chemoreceptors respond to chemicals dissolved in saliva. They are located mainly on the tongue.

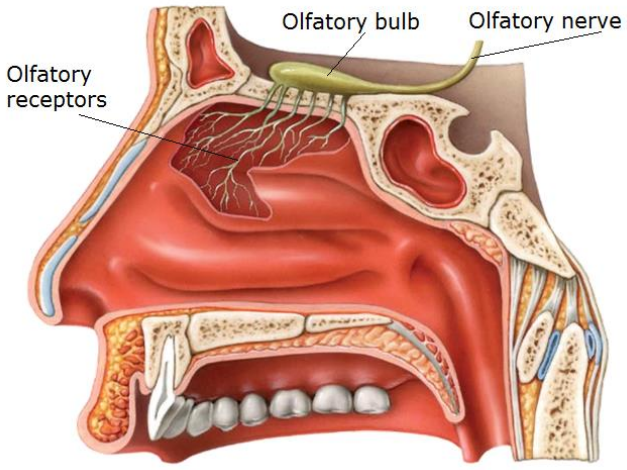
They are clustered in **taste buds** that group together to form **taste papillae** that covered the surface of the tongue.



3.2. Smell

The sense of smell enables the body to detect chemical molecules in the air. The molecules are detected by chemoreceptors in the nasal cavity. The sensations they receive are called **smells.** There are seven basic smells but they can combine increasing enormously the variety of smells we can distinguish.

The inside of the nasal cavity is lined by the **pituitary membrane**, a mucosa in which we can distinguish two different regions:



- **Respiratory mucous membrane.** This membrane has blood vessels that warm inhaled air and hairs that trap dust particles.

- **Olfactory mucous membrane.** This is the upper part of the nasal membrane. It contains the olfactory receptors. These chemoreceptors converge in the **olfactory bulb**. When stimulated by chemicals, these receptors transmit impulses along the **olfactory nerve** to the brain.

ACTIVITIES

4.1. Answer these questions:

a. Why do we often lose our sense of smell when we have a cold?
b. Why can we detect so many different flavours if there are only four types of taste receptors?
c. What is the role of saliva in the detection of flavours?

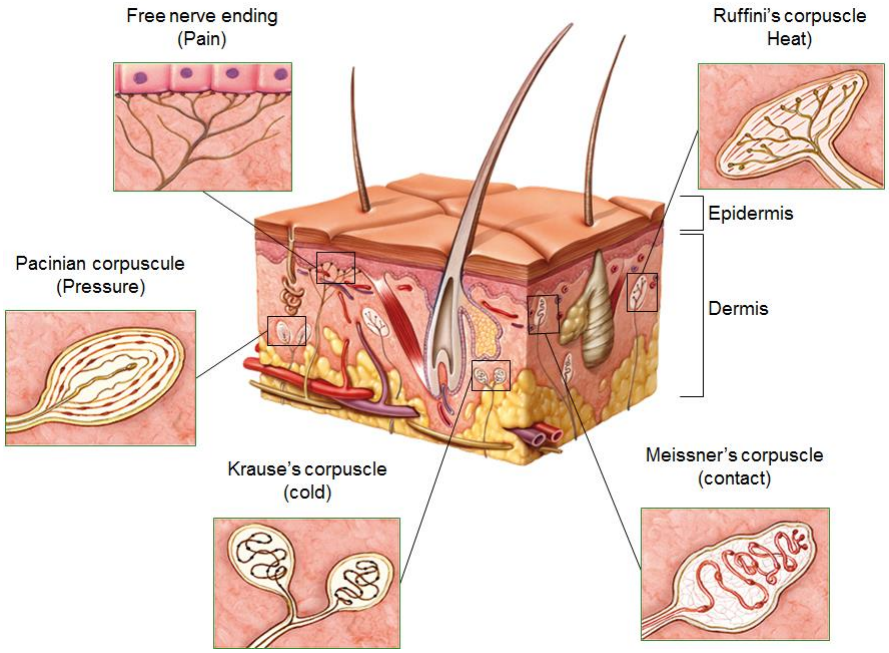
5. The skin: touch.

The skin is the organ responsible for most of our **sense of touch**. There are different types of receptors on the skin that capture different types of stimuli. Their distribution is not uniform. Depending on the area there are more or less receptors and some types are more abundant than others.

The skin consists of three layers: the epidermis, dermis and hypodermis.

- **Epidermis.** This is the outer layer, formed of epithelial tissue. The outermost cells are dead. These cells are always dividing and moving up to the surface where they are constantly renewed. As they ascend, they accumulate keratin and die.
- **Dermis.** This is an inner layer formed of connective tissue. The dermis contains blood capillaries and sensory receptors. These receptors can be:
  - **Free nerve endings**, such as pain receptors and receptors for light pressure, hair movement, etc.
  - **Encapsulates nerve endings** (corpuscles). The dendrites of these receptors are surrounded by connective tissue. They are mechanoreceptors that detect touch and deep pressure and thermoreceptors. There several types of tactile corpuscles such as Merkel's discs, Meissner's corpuscles, Krause's corpuscles, Ruffini corpuscles and Pacinian corpuscles.

  The dermis also contains **hair follicles** and **sweat glands.** Each hair follicle is attached to a **sebaceous gland** and an **arrector pili muscle,** which can make the hair stand on end. The sweat glands secrete sweat to eliminate wastes and help regulate body temperature.



- **Hypodermis.** This is the deepest layer. This is mainly formed of adipose cells, so it has a protective and thermoregulatory function.

ACTIVITIES

5.1. Answer these questions:

a. Why do you think hands have more sensory receptors than the back?
b. What types of receptors detect temperature? And pain? How are they different?
c. Name the functions of the skin.