

Chapter - 2

Control and Coordination

What is control and coordination?

We analyse and recognise various events or stimuli and display only the correct response. proper control and coordination is necessary to carry out essential function of the life.

Brain is control centre of body.

control and coordination in animals is done with the help of two main systems:

(i) Nervous system

[Associated with nerves]

Eg. Coordination while walking

(ii) Endocrine system

[Associated with hormones]

Eg. Body preparing to react in stressful situation

Nervous system made up of Brain, spinal cord, Nerve

Human Nervous System

① Central Nervous system ② Peripheral nervous system
① Brain ② Spinal cord

The Brain and Spinal cord connected to all the sense organs and other parts of our body by millions of nerve.

Main terms

① Stimuli (plural) / Stimulus (singular)

Stimuli is the change, factor or agent in an internal or external environment which cause a change in activity or behaviour of an organism.

② Response :- It is the reaction towards a stimulus by an organism

** Nervous tissue cannot work alone in receiving the stimulus and responding to it. Therefore, it requires receptors and effectors **

③ Receptors :-

Receptors are the cells, tissues or organs that receive the stimulus and initiate the signalling process.

* Receptors are generally located in ear, nose, tongue, skin, eye etc. .

5 Basic sensory receptors in Humans.

① Chemoreceptors [Inner ears] sense of sound/body balance

② Photoreceptors [eyes] sense of sight

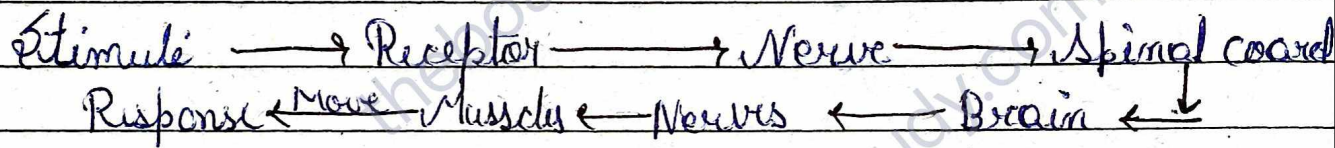
③ Olfactory receptors [Nose] sense of smell

④ Thermoreceptors [sense of touch/pain/heat]

⑤ Gustatory receptors [Tongue] Sense of taste

Effectors

Effectors are tissue, glands or muscles which act in response to stimulus received from the nervous system.

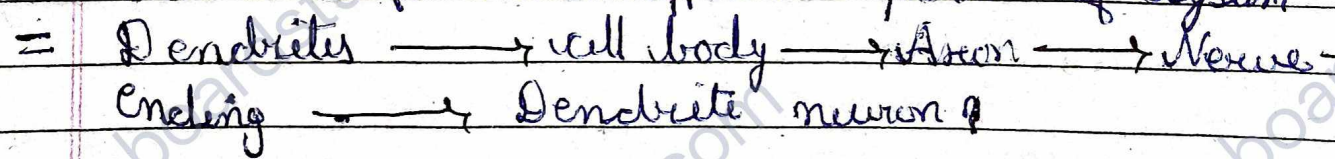


Neuron - Nervous tissue - Nerves

Nervous system is made of special cells called neurons. It is ~~longest~~ ^{longest} cell of our body.

Neuron / Nerve cell

Neuron is a highly specialized cell which is responsible for the transmission of signals and form the different parts of system



- Signals are in the form of electric impulses as they pass the message across the synapse from dendrites to nerve ending.
- + Dendrites :- Branched structure that collects information from previous neuron and passes on the cell body.
- + cell body :- It is the broad rounded part

of the neuron that contains the nucleus abundant cytoplasm (neuroplasm) and other organelles like mitochondria, golgi, vacuole etc.

Axon:- It is a long tube-like structure that carries information from the cell body to the nerve endings. Axon is covered by 1-2 sheaths called nerve fiber. A number of nerve fibers joined together to form a nerve.

Nerve ending:- The axon is branched terminally in muscle fibers, glands, other structure or forms synapse with the dendrites of other neurons.

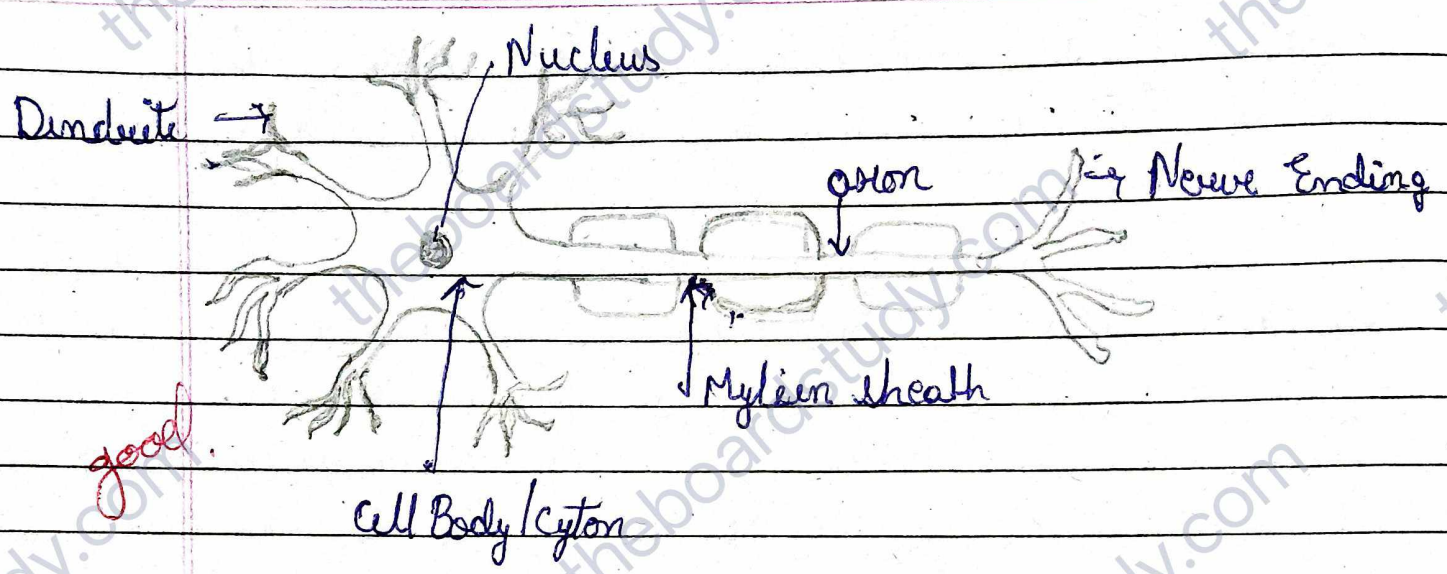
Synapse:- There is a gap between the nerve endings of one neuron and dendrite of the following neuron where signals are transmitted as chemical signals called neurotransmitters.

How are involuntary action and reflex action different from each other?

Involuntary action

Reflex Action.

- | | |
|---|---|
| ① Involuntary action are those do not require consciousness or thinking | Reflex action is an immediate response to stimulus. |
| ② It does not require a stimulus (thing that cause an action or response) | It require a stimulus. |
| ③ Involve that brain | does not involve the brain |
| ④ Controlled by the midbrain and medulla oblongata. | controlled by the spinal cord |
| ⑤ It is a relatively slow process | It is relatively fast process |



Nerve impulse :

Nerve impulses are progressive wave of electrical and chemical carried along nerves fibers. Nerve impulse are initiated at receptor cells as a result of stimuli from the environment.

How exactly do these signals pass through and between neurones?

Information is collected by the dendritic tips. The chemical reaction sets off electric impulse. Electric impulse pass from dendrite to cell body. Then passes from cell body to through the axon. Reaches nerve ending at the end of axon. Electric impulse sets off signals called neurotransmitters across the synapse. This again passes as electric signals in the next dendrite and so on.

Signals are in the form of chemicals called neurotransmitters during transmission of messages across the synapse.

Types of Neurons.

Sensory neurons

[Sense organ

Motor neurons

[Brain]

Interneuron/Relay neuron

[Spinal cord]

1. Sensory neurons: They carry information from the receptors in the sense organs to the brain. These are also called Afferent neurons.

Example: When we hear a sound the signal is carried from the eardrum to the brain.

2. Motor neurons: They carry information from the brain cells to the effector organ that need to respond according to the signal sensed.

These are ^{also} called Efferent neurons.

Ex:- The brain cells transmit signals to the muscle cells in the hand enabling us to remove our hand from hot surface.

3. Interneuron - They carry information from the sensory neuron to motor neuron.

These are also called relay neurons.

* Voluntary action of nervous tissue is performed under the conscious direction of the brain.



Eg. picking up a pencil for writing, walking, and dancing.

- Involuntary action of nervous tissue is performed under the unconscious direction of the brain for controlling and coordinating the functioning of internal organs. Such as breathing, digestion, heart beating, eye reflexes etc. It also called Autonomic.

- Reflex action is the immediate response to harmful stimuli.

In other words special type of involuntary action which take place in our body without the involvement of Brain

* Spinal cord is involved.

The process of reflex action is like.

- The stimuli is sensed by the sensory receptors and sensory neurons generate impulses.
- These impulses reach the spinal cord.
- The relay neuron in the spinal cord passes signals between neurons.
- The motor neurons pass the signals for response to the organ that needs to respond to stimulus.

The information input also goes on to reach the brain. But it is not involved in reflex action.

The path travelled by an impulse during a reflex action is called a reflex arc.

Stimulus → receptors → Sensory neurons →
 relay neurons [in spinal cord] → motor neurons →
 effector → Response.

Reflex Arc flow chart

Neuromuscular junction (NMJ)

The neuromuscular junction (NMJ) is a synaptic connection between the axonal end of a motor nerve and a muscle (skeletal / smooth / cardiac) site of chemical communication between a nerve fiber and a muscle cell.

Breathing voluntary / involuntary?

if Involuntary it controlled brain → medulla [Respiratory Rhythm center]

if voluntary it controlled by brain → cerebrum

Nerves

Nerves are bundle of Nurons.

Nerves are two types -

- (1) Cerebral nerves
- (2) Spinal nerve

Cerebral nerve: Nerve which arise from brain are called - Cerebral nerves.

It has 12 pairs

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- Spinal nerves:- Nerves which arises from spinal cord are called spinal nerves.
 It has 31 pairs.

Human Brain

- # Brain is the main coordination and control center of the human body.
- # The brain coordinates the input and output signals through a complex design.
- # Human brain is divided into three parts:

Brain

Forebrain

Midbrain

Hindbrain

- # ~~By~~ The Brain have two parts. left brain and right brain.
- # The two parts of brain is connected by corpus callosum.

Forebrain

- Cerebrum:- The cerebrum is the largest part of the brain which is dome shaped in structure.
- It is divided into two hemispheres called cerebral hemispheres. The two cerebral hemisphere are connected to each other by a structure called corpus callosum.
- Each hemisphere of the cerebrum is further divided into four lobes.

- 1 Frontal lobe:- This part of the cerebrum controls muscular activities and voluntary movements.
- 2 Parietal lobe:- This part of the cerebrum controls general sensations such as taste, smell, pain, touch and temperature.
- 3 Temporal lobe:- This part of the cerebrum is concerned with sense of hearing.
- 4 Occipital lobe:- This part of cerebrum is concerned with sense of sight.

Functions of Forebrain

- 1 It receives information from sense organs like eyes, ears, skin, nose and tongue.
- 2 It interprets information and controls voluntary movement.
- 3 It changes our behavior on the basis of past experience and memories.
- 4 It maintains a balance between stimulus and response.
- 5 It regulates the sense of sight, hearing, smell, touch, temperature and pain.

Midbrain

- Smallest parts of the brain.
- It acts as a bridge and transmits signals from forebrain and hindbrain.
- It is mainly concerned with sense of sight and hearing. It involves in involuntary action.

Hind Brain

Hind brain of human beings consist of cerebellum, pons and medulla oblongata. involuntary action regulates.

Function of Hind Brain

1. The cerebellum coordinates the movement, balance of the body and maintains posture.
2. Pons is concerned with regulation of ~~the~~ breathing rate, sleep cycle.
3. Medulla oblongata regulates heart beat, blood pressure, coughing, sneezing, salivation and vomiting and rate of respiration.

How are nervous organs protected?

→ Protection of brain:

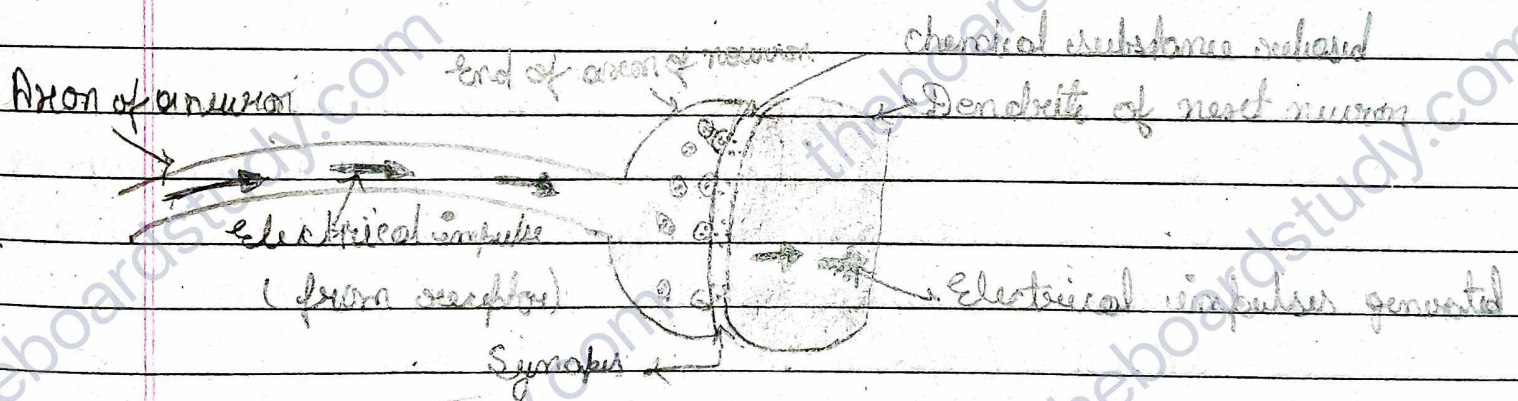
- The brain is placed in bony ~~case~~ called cranium and is a part of skull.
- Brain is wrapped in three separate membrane called meninges.
- The space present between these layers is filled with ~~cerebro~~ cerebro spinal fluid CSF.
- This fluid-filled balloon acts as a shock absorber / spring / cushion and protects the brain from injuries and shocks.

How are Nervous organs protected?

→ Protection of spinal cord:

- Like brain, spinal cord is also wrapped in meninges. The spinal cord is protected by the vertebral column or backbone.
- The vertebral column is formed by 33 individual bones called vertebrae.

* Signal Transfer between one neuron to another neuron.



Peripheral Nerve system

- * All the nerves of the body together make up the peripheral nervous system (PNS).
- # The Three types of nerves which make up the peripheral nervous system are spinal nerve, cranial nerve and visceral nerves.
- # Visceral nerves are a special kind of nerves which mostly arise from the spinal cord (though some also arise from the brain).

Control and coordination in plants.

The plants coordinate their behaviour against environmental changes by using hormones.
 Plants have no nervous system, so plants use only hormones for coordination.

Plants Movements

The plants movements made in response to external stimuli fall into two main categories: Tropism and Nastic.

Tropism (or Tropic movements)

A growth movement of a plant part in response to an external stimulus in which the direction of stimulus determines the direction of response is called Tropism.

- # It is a directional movement
- # The growth of plant part is towards the stimulus it is called positive tropism
- # The growth of plant part is away from the stimulus it is called negative tropism.

Types of Tropism

Stimulus

Light

Gravity

Chemical

Water

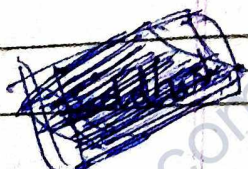
Types of Tropism

Phototropism

Geotropism

Chemotropism

Hydrotropism



Touch

Thigmotropism

(i) The Movement of light plant part in response to light is called phototropism.
shoot Positively, root Negatively

(ii) The movement of plant part in response to gravity is called geotropism.
Shoot Negatively, root positively.

(iii) The movement of plant part in response to chemical stimulus is called chemotropism.
Ex:- The growth of pollen tube towards the ovule during the process of fertilisation in a flower.

(iv) The movement of plant part in response to water is called hydrotropism.
shoot Negatively roots positively

(v) The Directional growth movement of a plant part in response to the touch of an object is called Thigmotropism.
roots negatively shoots positively

Nasties (or Nastic movements)

The movement of a plant part in response to an external stimulus in which the direction of response is not determined by the direction of stimulus.

Nastic movement.

Some Example of Nastic Movement

- (i) The folding of the leaves of a sensitive plant (*Mimosa pudica*) on touching is a -
- (ii) The opening up of petals of dandelion flowers in morning in bright light and closing in the evening when the light fades
- (iii) The closing of the petals of moonflower in the morning in bright light and opening at night when the light fades

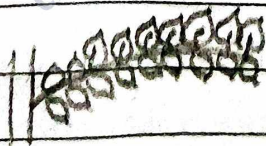
In all the example growth is not involved

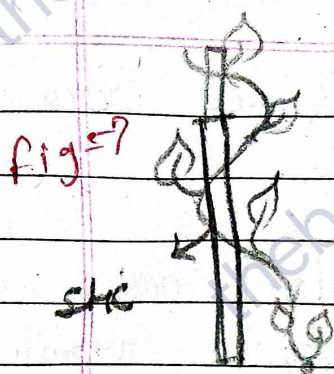
Thigmonasty

The non-directional movement of a plant part in response to the touch of an object is called Thigmonasty

Example:- The folding of leaves of a sensitive plant on touching

The folding of a sensitive plant on touching is due to the sudden loss of water from pad-like swelling called pulvini present at the base of all leaves of the sensitive plant which make the pulvini lose their firmness causing the leaves to droop and fall.





Photomasty

The non directional movement of any plant part (usually petals of flowers) in response to light is called photomasty.

The opening and closing of flowers in response to light (or photomasty) are growth movements.

Ex The moon flower closes the petals during the day time when there is bright light. It opens the petals at dusk (or night) when it gets dark and there is no light.

- # petal opens their inner surface more grow than their smaller outer surface.
- petal closes their outer surface more grow than their inner surface.

Plant Hormones [or Phytohormones]

The function of control and coordination in plant is performed by the chemical substances called plant hormones.

* The plant hormone is also known as Growth hormone.

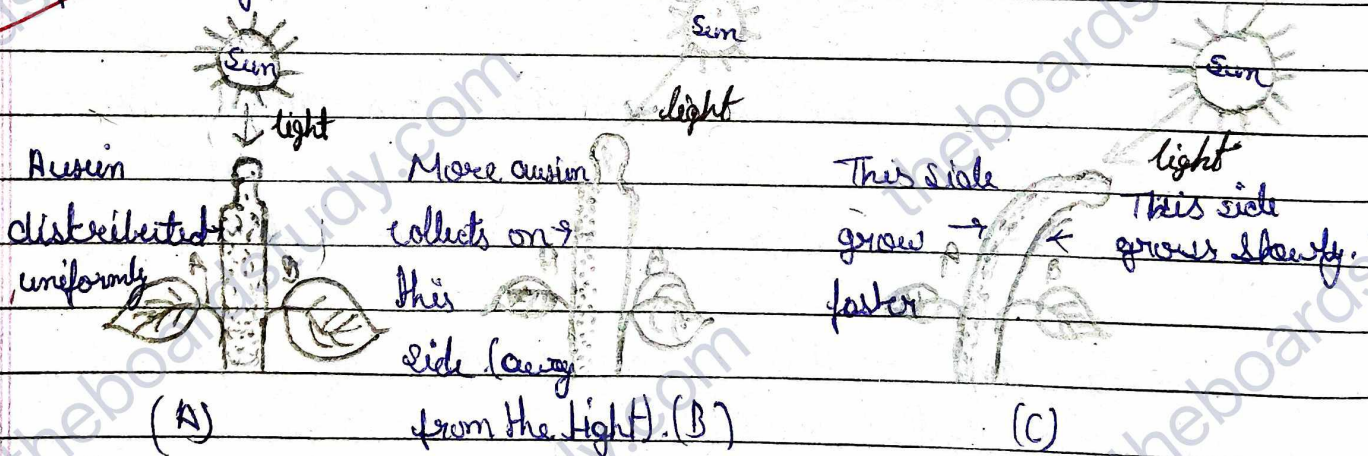
There are four major types of plant hormones :-

1. Auxins
2. Gibberellins
3. Cytokinins
4. Abscissic Acid (ABA)
5. Ethylene → Growth inhibitor

* Auxins, gibberellins and cytokinins are promote growth of plant.

* Abscissic acid inhibits (or prevents) the growth.

1. Auxins are the plant hormone which promote cell enlargement and cell differentiation and fruit growth.



2. Gibberellins (Gibberellic acid) - It is synthesised in the areas of rapid cell division, such as in fruits and seeds.

* It increases the length of grapes stalks & promotes growth in stems and fruit.

3. **Cytokinins** - It is synthesized in the root apices, developing shoot buds, young fruits.

- * It promotes cell division in plant along with auxins. It helps to produce new leaves & chloroplasts in leaves, promotes opening of stomata and fruit growth.

4. **Ethylene** (only gaseous phytohormone) It is synthesized in large amounts by tissue under going senescence and ripening fruits.

- * It promotes root growth and root hair formation.
- * It helps to produce new leaves, chloroplasts in leaves. It helps in breaking the dormancy in buds and seeds.

5. **Abscissic Acid or ABA** :- (Stress hormone or dormin). It inhibits plant growth and seed germination. It causes the closing of stomata and thus effect wilting of leaves and falling of leaves, senescence in leaves.

Hormones in Animals

Endocrine glands lack ducts and are hence ductless glands. They secrete chemical substance called Hormones.

Types of Gland

- ① **Endocrine gland** :- These are ductless glands. Their secretions are directly released into the blood which carries them to various parts of the body.

2. Exocrine glands: The secretions of exocrine glands are carried through the ducts.

3. Heterocrine glands: They have both endocrine and exocrine function. They are also known as mixed gland.

Characteristics of Hormones.

- * They are the secretions of endocrine glands.
- * They are produced at a place and act on target organs.
- * They are specific in function.
- * They are poured directly into the bloodstream.

* Endocrine glands present in the human body are as follows:

1. Hypothalamus: It is the basal part of diencephalon (forebrain) and it regulates wide spectrum of body functions. It is known as master of master gland (Pituitary gland).

Types: 1) Releasing hormones. 2) Inhibiting hormones.

2. Pituitary gland (Master gland)

- * It secretes many hormones.
- * Found in below the Hypothalamus in Brain.
- * Its one type of hormone is Growth hormone (GH); This promotes and regulates the growth of the body. Its deficiency during childhood lead to

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dwarfism (stunted growth) and oversecretion leads to gigantism (abnormal growth of body).

3. Thyroid :- The Thyroid gland consists of two lobes joined which are located on either side of the trachea. Both the lobes are interconnected with a connective tissue called isthmus.

Thyroid gland secretes Thyroxine Hormone.

(i) Thyroxine :- It is the principal hormone & its main role is to increase the metabolic rate of the organs and tissue of the whole body.

* Iodine is essential for the normal rate of hormone synthesis.

* Iodine deficiency causes enlargement of the thyroid glands commonly called simple goitre.

* It is present on neck.

5. Parathyroid Gland [below]

There are small pea shaped glands. They lie on the back side of the thyroid gland.

* The function of parathormone is to regulate calcium and phosphate level in the blood.

6. Thymus Gland [found on chest]

It secretes a peptide hormone called thymosin.

* It plays a role in the development of the immune system of the body. Thymus gland is large in young children but shrinks after puberty.

7 Pancreas & [mixed gland]

It is the only heterocrine gland in the human body.

* It act as both exocrine & endocrine.

* Exocrine because it secrete pancreatic juice.

* Endocrine because it secrete insulin hormone.

functions of insulin hormone is to lower the blood sugar level.

* Deficiency of insulin hormone in the body causes a disease known as diabetes.

8 Adrenal Glands: [Emergency glands]

There are two adrenal glands which are located on the top of two kidneys. The adrenal glands secrete adrenalin hormone.

The function of adrenalin hormone is to regulate heart rate, breathing rate, blood pressure and carbohydrate metabolism.

9. Testis [Male] Te

* Testis make male sex hormones called testosterone.

* Its function is control the development of male sex organs and male features such as deeper voice, moustache, beard and more body hair.

* The testis also make the male gametes called sperm.

10 Ovary [female]

* Ovary make female hormone called oestrogen [Puberty]

and progesterone [Pregnancy]

- * Oestrogen hormone is to control the development of female sex organs, and female features such as feminine voice, soft skin and mammary glands. [To be given].
- * Progesterone hormone is to control uterus changes in menstrual cycle. It is also help in maintenance of pregnancy & make the female gametes called Ova or (egg).

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