Endocrine System

Q. Define and classify hormones.
Hormone: A hormone is a chemical substance that is secreted into the internal body fluid by one cell or group of cells and has a physiological control effect on other cells of the body.
Classification:

1. **On the basis of chemical nature:**

    a. **Amine hormones:**
    T_3, T_4, Epi, Nor, Dop
    T_3: Triiodothyronine
    T_4: Thyroxine
    Epi: Epinephrine
    Nor: Norepinephrine
    Dop: Dopamine or prolactin inhibiting factor.

    b. **Steroid hormones:**
    টেস্ট পরীক্ষায় Corti, Aldo 125 পেয়ে ইষ্টনাম জপে

    Testosterone, Progesterone, Cortisol, Aldosterone, 1,25-Dihyroxycholecalciferol and Estrogen.

    c. **Peptide Hormones:** TSH, ADH, insulin etc.

2. **On the basis of site of action:**
    a. **Local Hormones:** Act locally near the site of secretion. Examples are gastrin, secretin etc.
    b. **General Hormones:** Secreted by a definite endocrine gland and act on distant cells. Examples are insulin and aldosterone.
    c. **Tropic Hormones:** Specialized type of general hormones secreted by one ecdocrine gland and acts on other glands to control their secretions. Examples are TSH, LH, ACTH etc.
3. **On the basis of location of receptor:**

    a. **In the cell membrane:**
        - Protein hormones
        - Peptide hormones and
        - Catecholamines
    b. **In the cytoplasm: Steroid hormones.**
    c. **In the nucleus: Thyroid hormones.**

4. **On the basis of mechanism of action:**
    a. **Group I Hormones:** They bind to intracellular receptors. They act by genetic transcription of DNA. **Examples are thyroid hormones, steroid hormones.**
    b. **Group II Hormones:** These are the hormones that bind to cell surface receptors. They act by second messengers. Examples are-
        - **Proteins and polypeptides**
        - **Glycoproteins and**
        - **Catecholamines**

Q. Give the general characteristics of protein and polypeptide hormones.
General characteristics of protein and polypeptide hormones:

1. Most of the hormones in the body are proteins and polypeptides.
2. These hormones range in size from small peptides with as few as 3 amino acids (e.g., Thyrotropin Releasing Hormone (TRH) to proteins with almost 200 amino acids, e.g., GH and prolactin).
3. They are synthesized on the rough endoplasmic reticulum of the different endocrine cells.
4. They are stored in secretory vesicles until needed.
5. They are usually synthesized first as larger biologically inactive proteins (preprohormones) and are cleaved to form smaller prohormones in the endoplasmic reticulum.
6. Enzymes in the vesicles cleave prohormones to produce smaller, biologically active hormones and inactive fragments.
7. Secretion of these hormones occur by exocytosis.
8. The stimulus for exocytosis is an increase in cytosolic calcium or c AMP concentration.

Functions of Oxytocin:

1. **Oxytocin causes contraction of pregnant uterus:** The hormone oxytocin, in accordance with its name, powerfully stimulates contraction of the pregnant uterus, especially towards the end of the gestation. Therefore, many obstetricians believe that this hormone is at least partially responsible for causing birth of the baby.
2. **Oxytocin aids in milk ejection by the breasts:** Oxytocin also plays an especially important role in lactation. In lactation, oxytocin causes milk to be secreted from the alveoli into the ducts of the breasts so that the baby can obtain it by sucking.

Functions of Cortisol:

1. **On carbohydrate metabolism:**
    - Increases gluconeogenesis.
    - Increases glycogenesis.
    - Decreases glucose utilization.
    - Increases blood glucose concentration.
2. **On protein metabolism:**
    a. **In extrahepatic tissue:**
        - Decreases amino acid uptake.
        - Decreases protein synthesis.
        - Increases protein catabolism.
        - Increases amino acid mobilization from extrahepatic tissue into blood.

    b. **In liver:**
        - Increases amino acid uptake.
        - Increases protein synthesis.

    c. **In plasma:**
        - Increases plasma protein.
        - Increases plasma amino acid.
3. **On fat metabolism:**
    - Increases fatty acid mobilization from adipose tissue.
    - Increases fatty acid utilization for energy.
    - Increases ketone body formation.
    - Increases plasma fatty acid.
4. **Anti-inflammatory effect:**
    - Prevents development of inflammation.
    - Causes resolution of inflammation.
5. **Anti-allergic effect:** Inhibits release of mediators, e.g., histamine causing allergic reaction.
6. **Effect on blood cells:**
    - Increases eosinophil and basophil count.
    - Increases RBC, platelet and neutrophil count.
7. **Effect on immunity:** Decreases level of immunity by decreasing number of T cells and amount of antibodies.

Functions of Aldosterone:

1. **Aldosterone increases renal tubular reabsorption of sodium and secretion of potassium:**

Aldosterone increases reabsorption of sodium and simultaneously increases secretion of potassium by the renal tubular epithelial cells, especially in the *principal cells of the collecting tubules* and to a lesser extent, in the distal tubules and collecting ducts. Therefore, aldosterone causes sodium to be conserved in the extracellular fluid while increasing potassium excretion in the urine.

A high concentration of aldosterone in the plasma can transiently decrease the sodium loss into the urine to as little as a few milliequivalents a day. At the same time, potassium loss into the urine transiently increases severafold. Therefore, the net effect of excess aldosterone in the plasma is to increase the total quantity of sodium in the extracellular fluid while decreasing the potassium.

Conversely, total lack of aldosterone secretion can cause transient loss of 10 to 20 grams of sodium in the urine a day, an amount equal to one tenth to one fifth of all the sodium in the body. At the same time, potassium is conserved transiently in the extracellular fluid.

2. **Aldosterone stimulates sodium and potassium transport in the sweat glands, salivary glands and interstitial epithelial cells:**

Aldosterone has almost the same effects on sweat glands and salivary glands as it has on renal tubules. Both these glands form a primary secretion that contains large quantities of sodium chloride, but much of the sodium chloride, upon passing through the excretory ducts, is reabsorbed, whereas potassium and bicarbonate ions are secreted. Aldosterone greatly increases the reabsorption of sodium chloride and the secretion of potassium by

- Knee jerk
- Ankle jerk
- Biceps jerk

3. **Visceral reflex:** These are reflexes where at least a part of the reflex arch is formed by autonomic nerve. Examples:
    - Pupillary reflex
    - Micturition reflex
    - Baroreceptor reflex
    - Vomiting reflex
4. **Pathological reflex:** These are found only in the pathological conditions. Examples:
    - Babinski's sign

B. According to the number of synapses in the reflex arch:

1. **Monosynaptic reflex:** The reflexes having a single synapse between the afferent and efferent neurons ae called monosynaptic reflexes. The stretch reflexes are monosynaptic reflexes.
2. **Polysynaptic reflexes:** The reflexes having more than one synapses between the afferent and efferent neurons are called polysynaptic reflexes. The withdrawal reflex is a typical polysynaptic reflex.

C. Physiological classification:

1. Flexor reflex: e.g., withdrawal reflex.
2. Extensor reflex: e.g., stretch reflex.

D. Inborn or acquired:

1. Unconditioned reflex (inborn)
2. Conditional reflex (acquired): e.g., salivation in sight or smell of food.

E. Anatomical:

1. Segmental
2. Intersegmental
3. Suprasegmental

Q. Write down the functions of the following organs/parts of brain:

1. **Cerebral cortex**
2. **Thalamus**
3. **Hypothalamus**
4. **Cerebellum**
5. **Pons**
6. **Medulla oblongata**

Functions of cerebral cortex: The cerebral cortex is involved in several functions of the body including:

1. Determining the intelligence
2. Determining personality
3. Motor function
4. Planning and organization
5. Touch sensation
6. Processing sensory information
7. Language processing

Functions of thalamus:

1. **Relay center:** Thalamus forms the relay center for the sensations. Impulses of almost all the sensations reach the thalamic nuclei, particularly in the ventral posterolateral nucleus. After being processed in the thalamus, the impulses are carried to cerebral cortex through thalamocortical fibers.
2. **Center for processing sensory information:** Thalamus forms the major center for processing the sensory information. All the peripheral sensory impulses reaching thalamus are integrated and modified before being sent to specific areas of cerebral cortex. This function of thalamus is usually the processing of sensory information.

Q. List the cranial and spinal nerves.

Cranial nerves: Thee are 12 pairs of cranial nerves. They are given below:

Name	Specific function
I. Olfactory	Smell
II. Optic	Vision
III. Oculomotor	Motor to four of six extrinsic eye muscles and upper eyelid; parasympathetic: constricts pupil, thickens lens.
IV. Trochlear	Motor to one extrinsic eye muscle.
V. Trigeminal	Sensory to face and teeth; motor to muscles of mastication (chewing).
VI. Abducens	Motor to one extrinsic eye muscle
VII. Facial	Sensory: taste; motor to muscle of facial expression; parasympathetic to salivary and tear glands.
VIII. Vestibulocochlear	Hearing and balance.
IX. Glossopharyngeal	Sensory: taste and touch to back tongue; motor to pharyngeal muscles; parasympathetic to salivary glands.
X. Vegas	Sensory to pharynx, larynx and viscera; motor to palate, pharynx and larynx; parasympathetic to viscera of thorax and abdomen.
XI. Accessory	Motor to tow neck and upper muscles.
XII. Hypoglossal	Motor to tongue muscles.

Spinal nerves: There are 31 pairs of spinal nerves. They are given below: **(CTLSC=8 12 5 5 1)**

Name	Number
Cervical	8
Thoracic	12
Lumber	5
Sacral	5
Coccygeal	1

	• Voice becomes deeper.
4. Hair growth	• Beard appears. • Hair line on scalp recedes anterolaterally. • Pubic hair grows with male pattern (triangle with apex up). • Hair appears in the axillas, on the chest and around the anus. • General body hair increases.
5. Mental	• More aggressive. • Active attitude. • Interest in opposite sex develops.
6. Body conformation	• Shoulders broaden. • Muscles enlarge.
7. Skin	• Sebaceous gland secretion thickens and increases (predisposing to acne).

Q. What are the secondary sex characteristics of female?

Secondary sex characteristics of female:

Traits	Secondary sex characteristics
1. External genitalia	• Deposition of fat in the mons pubis. • Enlargement of labia majora. • Enlargement of labia minora.
2. Internal genitalia	• Enlargement of uterus, ovary and vagina. • Proliferation endometrial stroma. • Stratification of vaginal epithelium. • Follicular growth in ovary.
3. Breast	• Enlargement of breast • Deposition of fat in breast.
4. Menstruation	• Onset of menstruation.
5. Voice	• Larynx remains [illegible] in size. • Voice remains high-pitched.
6. Hair growth	• Growth of pubic and axillary hair. • Less body hair and more scalp hair.
7. Body conformation	• Narrow shoulder and broad hip. • Thighs converge and arms diverge. • Wide carrying angle.
8. Fat distribution	• Occurs in the breasts, buttocks and thighs.
9. Skin	• Skin becomes soft, smooth and thicker. • Increased secretion of subcutaneous gland causes formation of acne.
10. Mental	• Active attitude. • Interest in opposite sex.

Q. Write down the histology of the following organs:

1. **Ovary**
2. **Fallopian tube**
3. **Uterus**

Histology of the ovary: Each ovary consists of the following parts:

1. **Germinal epithelium:** The germinal epithelium is a layer of simple epithelium (low cuboidal or squamous) that covers the surface of the ovary. We now know that the term germinal epithelium in humans is not accurate because this layer does not give rise to ova; the name came about because, at one time, people believed that it did. We have since learned that the cells that produce ova arise from the yolk sac and migrate to the ovaries during embryonic development.
2. **Tunica albuginea:** The tunica albuginea is a whitish capsule of dense irregular connective tissue located immediately deep to the germinal epithelium.

tubular follicles of endometrium are open. Endometrium also contains connective tissue in which the uterine galnds are present. Uterine glands are lined by ciliated columnar epithelial cells.

Q. What is ovulation? Describe the process of ovulation.

Ovulation: Ovulation is the process by which the graafian follicle in the ovary ruptures and the ovum is released into the abdominal cavity. Prior to ovulation, large amount of LH secretion occurs which is called LH serge.

The high levels of estrogens during the last part of the preovulatory phase exert a positive feedback effect on the cells that secrete LH and gonadotropin releasing hormone (GnRH) and cause ovulation as follows:

1. A high concentrations of estrogens stimulate more frequent release of GnRH from the hypothalamus. It also directly stimulates gonadotrophs in the anterior pituitary to secrete LH.
2. GnRH promotes the release of FSH and additional LH by the anterior pituitary.
3. LH causes rupture of the mature (graafian) follicle and expulsion of a secondary oocyte about 9 hours after the peak of the LH serge. The ovulated oocyte and its corona radiata cells are usually swept into the uterine tube.

Function: Formation of urine by-

5. Glomerular filtration.
6. Tubular reabsorption of wanted substances.
7. Tubular secretion.
8. Excretion of unwanted substances.

Neuron: Neuron is the structural and functional unit of the nervous system.

Structure: A typical neuron cell is composed of the following parts:

4. A cell body
5. Dendrites and
6. Axons

They are described below:

4. **Cell body:** Each neuron cell body contains a single nucleus. As with any other cell, the nucleus of the neuron is the source of information for gene expression. Extensive rough endoplasmic reticulum (rough ER), a Golgi apparatus and mitochondria surround the nucleus. Large numbers of neurofilaments (intermediate filaments) and microtubules organize the cytoplasm into distinct areas.
5. **Dendrites:** Dendrites (trees) are short, often highly branching cytoplasmic extensions that are trapped from their bases at the neuron cell body to their tips. Most dendrites are extensions of the neuron cell body, but dendritic structures also project from the peripheral ends of some sensory axons. Dendrites usually receive information from other neurons or from sensory receptors and transmit the information towards the neuron cell body.
6. **Axons:** Each neuron has an axon, a single long cell process extending from the neuron cell body. The area where the axon leaves the neuron cell body is called the axon hillock. Each axon has a uniform diameter and may vary in length from a few millimeters to more than a meter. Axons of sensory neurons conduct action potentials towards the CNS and axons of motor neurons conduct action potentials away from the CNS. Axons also conduct action potentials from one part of the brain or spinal cord to another part. An axon may remain unbranched or may branch to form collateral axons. Axons can be surrounded by a highly specialized insulating layer of cells called myelin sheath.

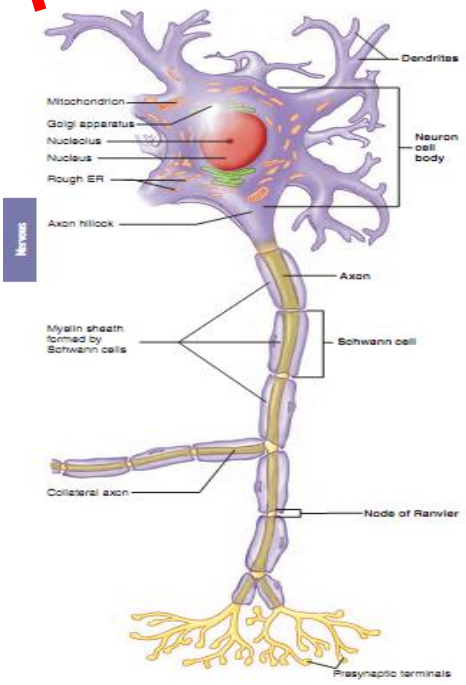

Fig: A typical neuron

- **Potassium:** 109 mg/dl
- **Protein:** 5.04 mg/dl
- **Urea:** 45 mg/dl

Time span of sperm development:

- It takes about 70 – 74 days to develop from spermatogonia to spermatozoa.
- It takes another 14 days to travel through epididymis to the ejaculatory duct.
- Illness and exposure to toxic agents can have a delayed effect on quality of sperm produced.

Q. What is the sperm count required for maintain male fertility?

Sperm count required for maintain male fertility:

- Normal sperm count: 40 – 100 million/mL. To maintain fertility, sperm count should be as a minimum 20 million/mL.
- Sperm mortality: For normal fertility, 40-100% spermatozoa must be motile.
- Sperm morphology: For normal fertility, 75-100% sperm must show normal morphology.

Importance of sperm count: Normal sperm count is needed for a sperm to able to fertilize the ovum. Male infertility is most commonly caused by low sperm count.

Q. Write down the overall functions of hormones.

Hormones have the following effects on the body:

- Stimulation or inhibition of growth
- Wake-sleep cycle and other circadian rhythms
- Mood swings
- Induction or suppression of apoptosis (programmed cell death)
- Activation or inhibition of the immune system
- Regulation of metabolism
- Preparation of the body for mating, fighting, fleeing, and other activity
- Preparation of the body for a new phase of life, such as puberty, parenting, and menopause
- Control of the reproductive cycle
- Hunger cravings

A hormone may also regulate the production and release of other hormones. Hormone signals control the internal environment of the body through homeostasis.

Q. Name the functionally important areas of the cerebral cortex.

Functionally important areas of cerebral cortex:

1. **Lobes:**
   - Frontal lobes: Contains the primary motor cortex and involved in speaking and muscle movements and in making plans and judgements. They also perform the executive function.
   - Parietal lobes: They contain the primary somatosensory cortex.
   - Occipital lobes: They include the visual areas, which receive visual information from the opposite visual field.
   - Temporal lobes: Include the auditory areas, each of which receives auditory information primarily from the opposite ear.
2. **Association areas:** Association areas are involved with more complex functions such as learning, discussion making and complex movements such as writing.
3. **Broca's area:** It is the motor speech area and is involved in translating thoughts into speech. Impulses from this area control the muscles of the larynx, pharynx and mouth that enable us to speak.
4. **Wernicke's area:** It is an area of the left temporal lobe and it is involved in language comprehension and expression.
5. **Aphasia:** It is important to language, usually caused by left hemisphere damage either to Broca's area and Wernicke's area.

Q. What are the hormones of placenta?

1. The fluid allows the baby to move around while it is developing. This movement allows for bone and muscle development.
2. The fetus breaths the fluid in and out, allowing it to practice breathing and to aid in lung development.
3. The fluid also helps to keep the fetus nice and warm by keeping heat in it. It also helps to keep the temperature constant.
4. The fluid offers protection from any blows that may come to the uterus area. It may cushion the blow if the mother falls.
5. When the fetus swallows the amniotic fluid, it is practicing using and developing the digestive system.
6. It keeps the umbilical cord from being squeezed too hard. A big squeeze would cut off the nutritional supply from mother to the baby.
7. The amniotic fluid also acts as a lubricant. The fetus' growing baby parts are very fragile and could grow together, such as in the case of webbed fingers or toes.

Laboratory importance of amniotic fluid:

1. **Genetic disease, chromosome abnormalities and birth defects:**
    - If a genetic disorder or chromosomal abnormality is detected, then the baby will most likely have the associated condition. It is important to note that such findings many not predict the severity if the condition.
    - Not every chromosomal abnormality is detected through the test. Thus, the test does not guarantee the absence of an inherited disorder in the fetus. Also, a genetic testing is usually performed for common mutation types.
2. **Fetal lung maturity:**
    - Low levels of surfactants (soapy substance that lowers pressure on the lungs) are indicative that the fetus's lung have not yet matured. Measures may be then taken to promote lung maturity, delay delivery and prepare to treat the baby, as soon as it is born, if necessary.
    - The healthcare provider monitors the level of surfactants. When their level are high enough, the physicians may decide to deliver the baby safely, without an increased risk of complication.