APPOLO STUDY CENTRE CHENNAI

APPOLO STUDY CENTRE

ENDOCRINE SYSTEM

Unit – 6

REACHING THE AGE OF ADOLESCENCE

Introduction

- Growing up is a natural process that takes place in all living organisms. All living organisms grow up to maturity which is the ability to respond to a particular environment. Maturity along with experiences produces a progressive series of changes in an organism. These series of changes are called development. Different phases of human development are called developmental stages. Human developmental stages include infancy, childhood, adolescence, adulthood, middle age and old age. Among all these stages, adolescence is the most crucial and significant period in an individual's life. It is the period of transition from childhood to adulthood. This period starts at the age of about 10 to 13 and ends at the age of 19 (commonly known as teenage). Almost all of you would have entered this period now. In this lesson you are going to study about the changes that take place in you (which are normal) as you enter the age of adolescence. You will also study about the reproductive phases of human life, reproductive health, nutritional needs of adolescents and personal hygiene during adolescence.

Adolescence and Puberty

- The term adolescence is derived from the Latin word 'adolescere' meaning 'to grow' or 'grow to maturity'. During this period changes occur in height, weight, sex organs, muscle mass as well as in brain structure and function. Biologically it is a physical transition marked by the onset of puberty and termination of physical growth in an individual.

Puberty

- Puberty is a period of few years in which rapid physical; physiological and psychological changes occur resulting in sexual maturity. We can predict the sequence of physical changes that will take place but the age of beginning of puberty varies from individual to individual. The average age for the onset of puberty is 10 or 11 for girls and 12 or 13 for boys. But, factors like genetic and biological influences, life events, socioeconomic status, nutrition and diet and the amount of body fat also affect the onset and progression of puberty.

- Hormones play an important role at the time of puberty. Changes in hormones during this period trigger physical and behavioural changes. Sex hormones secreted at the time of puberty activate the male and female sex glands to produce necessary secretions in the body. The male sex glands, testes release the testosterone and the female sex gland, the ovaries release the estrogen. These result in changes in the primary and secondary sexual characteristics of the male and female.

Body changes at Puberty

- Four important changes that occur during puberty transform the body of a child into that of an adult. These changes are:

    - Changes in body size
    - Changes in body proportion
    - Development of primary sex characteristics
    - Development of secondary sex characteristics

a. Changes in body size

- The first major change at the time of puberty is growth which is the increase in body height and weight. It usually begins at the age of 10 to 12 in girls and 12 to 13 in boys. It is almost complete at around 17 to 19 in girls and 19 to 20 in boys. During adolescence both boys and girls add around 23 cm to 26 cm in the height. In addition to height, they also experience significant increase in weight. But increase in weight is influenced by various factors like diet, exercise and life style. The average weight gain during this period is about 17

kg to 19 kg. During this period, increase in fat is seen in girls in contrast to muscle development in boys.

b. Changes in body proportion

- Certain body areas which are small proportionately grow big. This can be seen in feet and hands. During childhood, legs grow proportionately more than the trunk. But at the time of puberty trunk also lengthens. Also, trunk broadens at the hip and shoulder thus giving the adult proportion to the body

c. Primary sex characteristics

- Reproductive organs of boys and girls become fully functional at the time of puberty. In boys, testes grow larger followed by that length and size of the reproductive organ increase. Similarly, female reproductive organ also grows during puberty. Thus, the size of the uterus and the weight of the ovaries increase during this time.

Testes and ovaries are called primary sex organs of the male and female respectively.

Secondary Sex Characteristics

- Secondary sex characteristics are the physical features which distinguish male from female. After the progression of puberty, boys and girls become dissimilar in appearance. The secondary sex characters are regulated by the hormones the testosterone or androgen secreted by the testes of the males and estrogen secreted by the ovaries of the females. Androgens cause the growth of the larynx, muscle development, skeletal size and distribution of body and pubic hair, and stimulation of sweat glands. Estrogen and progesterone are the female sex hormones. Estrogen stimulates the development of the breast, the external genitalia, pubic and axillary hairs, and the distribution of body fats.

Secondary Sex Characteristics of Boys

- The following are the secondary sex characteristics of boys.

a. **Hair**
Immediately after the development of primary sex characteristics, pubic hair appears followed by axillary and facial hair.

b. **Skin**
The skin becomes coarse and the pores in the skin enlarge.

c. **Glands**
The oil producing glands in the skin enlarge and due to this acne may appear on the faces.

The secretions of sweat and sebaceous or subcutaneous glands (Oil glands) are very active during adolescence. Many adolescent boys and girls get pimples on face because of increased activity of these glands in the skin. Owing to extra secretions sometimes a distinctive odour is also produced from the bodies.

d. **Muscle**
The strength of the muscle increases and it gives shape to arms, legs and shoulders.

e. **Voice**
During this period voice changes occur and the voice becomes husky. Then its pitch drops and the volume increases.

Secondary Sex Characteristics of Girls

- Girls show the following secondary sex characteristics at the time of puberty.

a. Hips
Due to the enlargement of the pelvic bone and the development of subcutaneous fat, the hip becomes wider and rounder.

b. Breast
After the enlargement of hips, the breasts begin to develop during this time.

c. Hair
Pubic hair appears followed by axillary and body hair on the limbs.

d. Skin

The skin becomes coarser and the pores enlarge as in the case of boys.

e. Gland

Oil producing glands become active causing acne on the face.

f. Muscles

Increase in muscles takes place which gives shape to shoulders, arms and legs.

g. Voice

Voice becomes shrill and voice breaks are rare among girls.

At puberty, the growth of the larynx is larger in boys than that of girls. The growing voice box in boys can be seen as a protruding part of the throat called Adam's apple, so that the voice becomes deep and harsh. This is caused mainly by male hormone (regulatory chemicals) during adolescence. As a result of this, muscles (chords) attached to the cartilage get loosened and thickened. When air passes through these loosened and thickened chords a hoarse sound is produced. In girls larynx is hardly visible from outside because of its small size and the voice becomes high pitched.

Secondary sex characteristics in boys and girls.

Girls	Boys
Height and weight increase	Height and weight increase.
Fatty and subcutaneous tissues develop	Muscles develop.
Hip broadens	Shoulder broadens.
Hair grows in arm pits and pubic area	Hair grows in the arm pits and pubic area, and facial hair also appears
Voice becomes shrill	Voice break takes place due to lengthening of vocal cord and enlarging of larynx.
Breast develops.	Size of the penis increases

Role of Hormones in Reproduction

- The primary hormones that regulate reproduction are the steroids such as androgens, estrogens and progesterone which have masculinizing, feminizing and gestational effects respectively. These hormones are secreted from the gonads which are regulated by the anterior pituitary (adenohypophysis). In male and female, reproductive behavior and reproduction are mainly under the control of LH (Luteinizing Hormone) and FSH (Follicle Stimulating Hormone). LH stimulates the testes to produce androgens, the male sex hormone. Sperms are then actively produced. In man sperm production starts at sexual puberty and may continue throughout his life.

Follicle Stimulating Hormone (FSH)

- FSH in the female influences the development of the Graafian follicle and secretion of estrogens. In the male it is necessary for the development of seminiferous tubules, and for spermatogenesis.

Luteinizing Hormone (LH)

- In the female, it is the hormone necessary for ovulation, and the secretion of the luteal hormone progesterone, and for the final maturation of the Graafian follicle. In the male it stimulates the interstitial (Leydig) cells of testes and the secretion of testosterone, and is referred to as the Interstitial Cell Stimulating Hormone (ICSH).

Estrogen is not a single hormone but a collection of related steroid hormones.

Prolactin (PRL) or Lactogenic Hormone

- The main function of this hormone is milk secretion during lactation.

Oxytocin Hormone

- Oxytocin causes expulsion of milk from the breast and it is also involved in the contraction of smooth muscles of uterus during child birth

Reproductive phase of life in Human

- Reproduction is more important for the continuation of human race. The phase in an individual's life during which there is production of gametes is called reproductive phase. In females, the reproductive phase of life begins at puberty (10 to 12 years of age) and generally lasts till the age of approximately 45 to 50 years, and in males, it is from the age of 13 to life long. The reproductive age may vary from person to person. The following are the reproductive phases in the life of a female

Menarche

- The first menstrual flow begins at puberty and is termed menarche. The ova begin to mature with the onset of puberty. It is the beginning of adolescence, during which mental and emotional maturation occurs and physical growth becomes pronounced.

Ovulation

- Ovulation occurs approximately 14 days before the next ovarian cycle commences. Thus in a 28 days cycle ovulation occurs about day 14. One ovum matures and is released by one of the ovaries once in about 28 to 30 days. The release of ovum from the ovary is called ovulation. During this period, the wall of the uterus becomes thick so as to receive the fertilized egg. This results in pregnancy.

Pregnancy

- After ovulation the ovum reaches the fallopian tube and fertilization takes place. The fertilized egg undergoes development and it is implanted in the uterus. The corpus luteum continues to grow and produces large amount of progesterone. This results in pregnancy. Normally, it lasts for 280 days, at the end of which parturition takes place.

Menstruation

- If the ovum is not fertilized, the corpus luteum begins to degenerate and the production of hormones progesterone and estrogen ceases. The unfertilized egg and the thickened lining of the uterus along with its blood vessels are shed off. This causes bleeding in woman's reproductive tract which is called

menstruation. Menstruation occurs once in about 28 to 30 days. It takes about 3 to 5 days. In some cases, initially menstrual cycle may be irregular. It takes some time to become regular. If it remains irregular for over a year, then it is better to consult a doctor.

Menopause

- Menopause marks the end of the reproductive phase of a woman's life. At 45 to 50 years of age, the menstrual cycle stops. Stoppage of menstruation is termed as 'menopause'. During menopause psychological symptoms such as anxiety, irritability, fatigue and loss of concentration may occur. Menopause may be induced by surgical removal of the ovaries, or by pelvic irradiation in a woman of any age.

Now-a-days girls attain puberty at very early age. This is due to food habits. As you eat lot of junk food, the body growth increases and it look like adults.

Menstrual Cycle

- The beginning of the menstrual cycle marks the onset of puberty in human females. The menstrual cycle begins with the casting off of endometrial lining of the uterus and bleeding. The casting of endometrium can be considered as periodic preparation for pregnancy. Menstruation occurs if an ovum released by the ovary of a woman is not fertilized during ovulation. This is described below.

1. When a girl reaches puberty at the age of about 10, the sex hormones released into her blood cause some of the ova (or egg cells) in her ovaries to become mature (or ripe).

2. Usually one mature ovum (or egg) is released from one of the ovaries into the oviduct once in every 28 days. This is called ovulation.

3. Before ovulation (or release of ovum), the inner wall of uterus becomes thick and spongy, and full of tiny blood vessels (or blood capillaries). It prepares itself to receive the fertilized ovum.

4. If the ovum does not get fertilized then the thick and soft inner lining of uterus is no longer needed and hence it breaks. So, the thick and soft inner

lining of uterus along with the blood vessels and the dead ovum comes out of the vagina in the form of a bleeding called menstruation.

5. Menstruation usually occurs 14 days after ovulation and usually lasts for about 3 to 5 days.

6. After menstruation is over, the inner lining of the uterus starts building up again so that it may become ready to receive the next ovum.

7. If the ovum does not get fertilized even now, then menstruation takes place again. This cycle of menstruation is repeated again and again in women after every 28 days. The menstrual cycle is controlled by hormones.

- Menstruation stops temporarily when the ovum gets fertilized and the women gets pregnant. This is because, in this case the thick and soft lining of the uterus containing lot of blood vessels is needed for the growth and development of the fertilized ovum to form a baby. Menstruation restarts after the birth of the baby. Menstruation also stops due to nutritional deficiencies, low body weight, stress, eating disorder, excessive weight gain etc.

Reproductive Health

- The physical and mental well-being of an individual is regarded as an individual's health. The World Health Organisation (WHO) has defined the reproductive health as the total well-being of behavioural, emotional, physical and social aspects of adolescence. To keep the body healthy, every human being, at any age, needs to have a diet, exercise and personal hygiene. The following are some of the measures that girls and boys need to take.

Cleanliness

1. Have a bath once or twice a day, paying special attention to underarms, groins and genitals.

2. Change the underwear daily. It should be made of cotton and washed and cleaned everyday.

3. For teenagers, the increased activity of sweat glands sometimes enhances body odour. If cleanliness is not maintained there are chances of having fungal, bacterial and other infections.

Menstrual Hygiene

- Girls should take special care of cleanliness during the time of menstrual cycle. Making use of disposable napkins or tampons may reduce chances of infections. First of all, girls should realize that menstruation is as natural as any regular physiological activities like breathing, drinking, eating, urinating and defecation. Girls are advised to use sanitary napkins or tampons rather than cloth. It should be changed frequently depending upon the menstrual flow. If a cloth is being used repeatedly, it should be cleaned with soap and hot water and dried in sunlight for reuse.

Sleep is vital to the well-being of adolescents. It can even help you to come out of the stress you experience during this period. During this period about 8 to 10 hours of sleep each night is necessary. But most teens do not get enough sleep.

Physical Exercise

- Walking and playing in fresh air keeps the body fit and healthy. All young boys and girls should take a walk, exercise and play outdoor games. Physical activity leads to the conditions of better health, sound sleep and thereby mental peace. Mental peace promotes happiness in day to day existence.

Nutritional needs of Adolescents

- Adolescence is a stage of rapid growth and development. Hence a diet with proper calories and other nutrients is needed for proper growth and physical activity. Balanced diet is very much important during adolescence. Balanced diet includes proteins, carbohydrates, fats and vitamins in requisite proportions. Our Indian meal of roti / rice, dal (pulses), milk, fruits and vegetables forms a balanced food.

- The nutritional deficiencies during this period not only retard the physical growth, but also impair the intellectual development and may also delay sexual maturation. A very good amount of proteins and carbohydrates is necessary during this growth period. Apart from that, adolescents need the following dietary components.

Minerals

- Since there is an increase in skeletal mass and blood volume during adolescence, the body needs calcium, phosphorus and iron.

Calcium

- Calcium intake needs to be increased to prevent osteoporosis in later life. It is present in milk and milk products or other equivalents.

Iodine

- It helps to prevent thyroid gland related diseases.

Iron

- Iron builds blood and iron-rich foods such as green leafy vegetables, jaggery, meat, dates, fish, chicken, citrus, Indian gooseberry (Nelli) and whole pulses are good for adolescents. Lack of iron in the diet results in anemia. To make up for the loss of iron, adolescents need to have a diet rich in iron. In boys, iron deficiency occurs due to muscle spurt whereas in girls it occurs due to menstruation in addition to the muscular growth.

Women should take in more iron in their diet regularly to make up for the loss of blood during menstruation.

Personal hygiene for Adolescence

- During adolescence, growing children need special attention towards diet, exercise and personal hygiene. Personal hygiene is a clear indicator of man's personality. Personal hygiene starts from the hair tip and ends down at the toes. Personal hygiene habits for the adolescence are as follows.

1. Shower or bath daily.
2. Always wash your hands before and after meals.
3. Keep fingernails clean and dipped.
4. Wash your teeth and mouth before and after each meal.
5. Avoid touching your face, nose or mouth while preparing food.
6. Avoid coughing or sneezing around food and close your mouth by using hand kerchief while you cough in public places.
7. If you want to taste the food, use a clean spoon.
8. Change your clothes regularly and wash them cleanly, especially undergarments.
9. Do not defecate in open field. Use clean toilets for defecation.
10. If you are not well, avoid self-medication, consult a doc

11th Zoology

Chapter – Chemical Coordination & Integration

Introduction

- While hearing your test marks, some may have anxiety and some may hesitate to hear and some may be worried. Do you know the reasons for such immediate changes? While seeing any unexpected happenings, we get goose bumps. Do you know the reason, why? These are all due to the biochemical changes happening in our body, Which are created by the endocrine system. The above mentioned biochemical changes are due to the hormone adrenalin (flight, fright and fight hormone).

Endocrine glands and hormones

- Physiological functions of our human body is regulated and coordinated by both neural and endocrine systems. The endocrine system influences the metabolic activities by means of **hormones** (hormone means *to excite*) which are chemical messengers released into the blood and circulated as chemical signals and acts specifically on certain organs or tissues called target organs or target tissues. Hormones may speed up or slow down or alter the activity of the target organs. The hormones secreted do not remain permanently in the blood but are converted by the liver into inactive compounds and excreted by the kidneys.

- Hormones are chemical messengers because they act as organic catalysts and coenzymes to perform specific functions in the target organs. The target organs contain receptor molecules either on the surface or within the cell. Although different hormones come in contacts with cells, only the cells that contain receptor molecules specific for the hormones are physiologically activated. A single hormones may have multiple effects on a single target tissue or different target tissue.

- Many hormones exhibit long term changes like growth, puberty and pregnancy. Hormones often influence many organs and organ systems at the same time. Serious deficiency or excess secretion of hormones leads to disorders. Hormones coordinate different physical, physiological, mental

activities and maintain homeostasis. Hormones are composed of water soluble proteins or peptides or amines or fat soluble steroids.

Human endocrine system

- There are two glandular systems such as the exocrine glands and the endocrine glands. The exocrine glands secrete enzymes, saliva and sweat and have ducts that carry their substances to the membrane surfaces. Example: salivary gland and gastric gland. The endocrine glands, called ductless glands produce hormones and lack ducts; they release their hormone to the surrounding tissue fluid. The hormones circulate around the body and eventually reach the target organs. Endocrine glands (Figure: 11. 1) include the pituitary, thyroid, parathyroid, pineal, adrenal, thymus and are also known as exclusive endocrine glands. The hypothalamus along with its neural function also produces hormones and is considered as a neuro endocrine gland. In addition several organs such as pancreas, gastro intestinal tract epithelium, kidney, heart, gonads and placenta are also have endocrine tissues and are known as partial endocrine glands.

Hypothalamus

- Hypothalamus is a small cone shaped structure that projects downward from the brain ending into the pituitary stalk. It interlinks both the nervous system and endocrine system. Though pituitary gland is known as master endocrine glands that controls the other endocrine glands, but it is, in turn controlled by the hypothalamus. Hypothalamus contains groups of neurosecretory cells. It produces neurotransmitters which regulate the secretions of the pituitary (Figure11. 2). The hormones produced by the hypothalamus act either as a releasing hormone or as an inhibitory hormone. In the basal region of the brain, the hypothalamic hypophyseal portal blood vessel connects hypothalamus and anterior pituitary. It allows hypothalamic hormones to control anterior pituitary secretion. The posterior pituitary is connected with hypothalamus by a nerve bundle called hypothalamic hypophyseal axis. It produces nerve signal that control the posterior pituitary secretion. Hypothalamus maintains homeostasis, blood pressure, body temperature, cardio and fluid electrolyte balance of the body. As the part of limbic system it influences various emotional responses.

Chemical nature of hormones

Class	Chemical properties	Example
Amines	Small, water soluble derived from tyrosine or tryptophan	Adrenalin, nor adrenalin, melatonin and thyroid hormone
Protein/Peptides	Water soluble	Insulin, glucagon and pituitary hormones
Steroids	Derived from cholesterol, mostly lipid soluble	Cortisol, aldosterone, testosterone, oestrogen, progesterone.

The major hypothalamic hormones and their functions

S.No.	Hormones	Functions
1.	Thyrotropin releasing hormone (TRH)	**Stimulates the secretion of TSH**
2.	Gonadotropin releasing hormone (GnRH)	Stimulates the secretion of FSH
3.	Corticotropin releasing hormone (CRH	Stimulates the secretion of ACTH
4.	Growth hormone releasing hormone (GHRH)	Stimulates the secretion of GH
5.	Prolactin releasing hormone (PRH)	Stimulates the secretion of Prolactin
6.	Luteinizing hormone releasing hormone (LHRH)	Stimulates the secretion of LH
7.	MSH releasing hormone	Stimulates the secretion of MSH
8.	Growth hormone-inhibiting hormone (GHIH)	Inhibits the secretion of GH
9.	Prolactin inhibiting hormone (PIH)	Inhibits the secretion of Prolactin
10.	MSH inhibiting hormone	Inhibits the secretion of MSH

Pituitary gland or Hypophysis

- The pituitary gland (means to grow under) is ovoid in shape and is located in the sella turcica, a bony cavity of the sphenoid bone at the base of brain

and connected to the hypothalamic region of the brain by a stalk called infundibulum. It is about one centimetre in diameter and 0.5 gm in weight. The pituitary consists of two lobes, anterior glandular adenohypophysis and posterior neural neurohypophysis. The anterior lobe originates from the embryonic invagination of pharyngeal epithelium called Rathke's pouch and the posterior lobe is originates from the base of the brain as an outgrowth of hypothalamus. Anatomically the adenohypophysis has three lobes or zones namely pars intermedia, pars distalis and pars tuberalis. The neurohypophysis is otherwise known as pars nervosa. The anterior lobe of pituitary secretes six tropic hormones such as growth hormone (GH), thyroid stimulating hormone (TSH), adreno corticotropic hormone (ACTH), follicle stimulating hormone (FSH), luteinizing hormone (LH), luteotropic hormone (LTH) and melanocyte stimulating hormone (MSH) (in lower animals only). The posterior lobe of pituitary secretes the hormones namely vasopressin and oxytocin.

Hormones of Adenohypophysis

i) Growth hormone (GH):

- It is also known as somatotropic hormone (STH) or Somatotropin. It is a peptide hormone. Growth hormone promotes growth of all the tissues and metabolic process of the body. It influences the metabolism of carbohydrates, proteins and lipids and increases the rate of protein biosynthesis in the cells. It stimulates chondrogenesis (cartilage formation), osteogenesis (bone formation) and helps in the retention of minerals like nitrogen, potassium, phosphorus, sodium etc., in the body. GH increases the release of fatty acid from adipose tissue and decreases the rate of glucose utilization for energy by the cells. Thus it conserves glucose for glucose dependent tissues, such as the brain.

ii) Thyroid stimulating hormone (TSH) or thyrotropin:

- TSH is a glycoprotein hormone, which stimulates the thyroid gland to secrete Tri-iodothyronine (T3) and thyroxine (T4). TSH secretion is regulated by negative feedback mechanism. It's release from the anterior pituitary is induced by the thyrotropin releasing hormone (TRH). When thyroxine level in the blood increases, TRH acts on both the pituitary and hypothalamus to inhibit TSH secretion.

iii) Adreno cortico tropic hormone(ACTH):

- ACTH is a peptide hormone that stimulates the adrenal cortex to secrete glucocorticoids and mineralocorticoids. It stimulates melanin synthesis in melanocytes, induces the release of fatty acids from adipose tissues and stimulates insulin secretion. ACTH secretion is regulated by negative feedback mechanism.

iv) Follicle stimulating hormone (FSH):

- FSH is a glycoprotein hormone which regulates the functions of the gonads (ovary and testis). In males, FSH along with androgens acts on the germinal epithelium of seminiferous tubules and stimulates the production and release of sperms (spermatogenesis). In females, FSH acts on the ovaries and brings about the development and maturation of graffian follicles.

v) Luteinizing hormone (LH):

- LH is a glycoprotein hormone which is also known as interstitial cell stimulating hormone (ICSH). In males, ICSH acts on the interstitial cells of testis to produce the male sex hormone, testosterone. In females, LH along with FSH matures the ovarian follicles. LH independently induces ovulation, maintains the corpus luteum and promotes synthesis and release of ovarian hormones. FSH and LH are collectively referred as gonadotropins. FSH and LH are not produced during childhood. The secretion of FSH and LH starts only during pre pubertal period.

vi) Luteotropic hormone (LTH):

- LTH is also called luteotropin or lactogenic hormone or prolactin or mammotropin. It is a protein hormone which stimulates milk secretion after the child birth in females. High prolactin secretion during lactation suppresses LH secretion and ovulation since it induces the corpus luteum hence named as luteo tropic hormone.

Hormones of neurohypophysis.

i) Vasopressin or antidiuretic hormone (ADH) :

- ADH is a peptide hormone which promotes reabsorption of water and electrolytes by distal tubules of nephron and thereby reduces loss of water through urine. Hence it is called as anti diuretic hormone. It also causes constriction of blood vessels when released in large amount and increases blood pressure. ADH deficiency causes Diabetes insipidus which induces the production of large amount of urine.

ii) Oxytocin (means quick birth):

- It is a peptide hormone which stimulates vigorous contraction of the smooth muscles of uterus during child birth and ejection of milk from the mammary glands.

Pineal gland

- In human, the pineal gland or epiphysis cerebri or conarium is located behind the third ventricle of brain and is formed of parenchymal cells and interstitial cells. It secretes the hormone, melatonin, which plays a central role in the regulation of circadian rhythm of our body and maintains the normal sleep wake cycle. It also regulates the timing of sexual maturation of gonads. In addition melatonin also influences metabolism, pigmentation, menstrual cycle and defence mechanism of our body.

Iodine is required for formation of thyroxine:
To produce normal quantities of thyroxine, about 1mg/week of iodine is required. To prevent iodine deficiency common table salt is iodised with 1 part sodium iodide to every 1,00,000 parts of sodium chloride

Thyroid gland

- The butterfly shaped thyroid gland is a bilobed gland located below the larynx on each side of upper trachea. It is the largest endocrine gland in the body. Its two lateral lobes are connected by a median tissue mass called isthmus. Each lobe is made up of many lobules .The lobules consist of follicles called acini (acinus in singular). Each acinus is lined with glandular, cuboidal or squamous epithelial cells. The lumen of acinus is filled with colloid, a thick glycoprotein mixture consisting of thyroglobulin molecules.

- Hormones of the thyroid gland are often called the major metabolic hormones. The follicular cells of thyroid gland secrete two hormones namely

tri-iodothyronine (T3) and thyroxine or tetra- iodothyronine (T4). The parafollicular cells or 'C' cells of thyroid gland secrete a hormone called thyrocalcitonin. Iodine is essential for the normal synthesis of thyroid hormones. Thyroid releasing hormone from the hypothalamus stimulates the adenohypophysis to secrete TSH, which inturn stimulates the thyroid gland to secrete the thyroid hormones. Thyroid hormones show a negative feedback effect on the hypothalamus and pituitary (Figure11. 4).

Functions of thyroxine or tetraiodothyronine(T4):

- Thyroxine regulates the basal metabolic rate (BMR) and body heat production. It stimulates protein synthesis and promotes growth. It is essential for the development of skeletal and nervous system. Thyroxine playsan important role in maintaining blood pressure. It reduces serum cholesterol levels, Optimum levels of thyroxine in blood is necessary for gonadial functions.

Functions of thyrocalcitonin (TCT):

- TCT is a polypeptide hormone, which regulates the blood calcium and phosphate levels. It reduces the blood calcium level and opposes the effects of parathyroid hormone.

Parathyroid gland

- In human, four tiny parathyroid glands are found in the posterior wall of the thyroid glands. This gland is composed of two types of cells, the chief cells and oxyphilcells. The chief cells secrete parathyroidhormone (PTH) and the functions ofoxyphil cells are not known.

Parathyroid hormone or Parathormone (PTH)

- PTH is a hypercalcemic hormone. It is a peptide hormone involved in controlling the calcium and phosphate homeostasis. Th e secretion of PTH is controlled by calcium level in the blood. It increases the blood calcium level by stimulating osteoclasts to dissolve the bone matrix. As a result calcium and phosphate are released into the blood. PTH enhances the reabsorption of calcium and excretion of phosphates by the renal tubules and promotes activation of vitamin D to increase calcium absorption by intestinal mucosal cells.

Thymus gland

- Thymus gland is partially an endocrine and partially a lymphoid organ. It is a bilobed structure located just above the heart and aorta, behind the sternum. It is covered by fi brous capsule and anatomically it is divisible into an outer cortex and an inner medulla. It secretes four hormones such as thymulin, thymosin, thymopoietin and thymic humoral factor (THF). Th e primary function of thymus is the production of immuno competent 'T' lymphocytes whichprovides cell mediated immunity.

Adrenal gland

- A pair of adrenal glands are located at the **anterior end of the kidneys, hence also** called suprarenal glands. Anatomically the outer region is the cortex and the innerregion is the medulla. Histologically the adrenal cortex has three distinct zones, zona glomerulosa, zona fasciculata and zona reticularis. Zona glomerulosa an outer thin layer constitutes about 15% of adrenal cortex, and secretes mineralocorticoids Zona fasciculata, the middle widest constitutes about 75% of adrenal cortex and secretes glucocorticoids such as cortisol, corticosterone and trace amounts of adrenal androgen and oestrogen. Zona reticularis, an inner zone of adrenal cortex constitute about 10% of adrenal cortex and secretes the adrenal androgen, trace amount of oestrogen and glucocorticoids. Adrenal medulla: It is the central part of adrenal gland and is composed of ovoid and columnar cells, which are found around the network of blood capillaries. Adrenalin (epinephrine) and nor adrenalin (nor epinephrine) are the two hormones secreted by the adrenal medulla. Both adrenalin and nor adrenalin are catecholamines.

Function of adrenal hormones:

- **Glucocorticoids** stimulate gluconeogenesis, lipolysis and proteolysis (the life saving activity). Cortisol is a glucocorticoid involved in maintaining cardio vascular and kidney functions. It produces anti-inflammatory reaction and suppresses the immune response. It stimulates the RBC production. It is also known as stress combat hormone. Mineralocorticoids regulates water and electrolyte balance of our body. Aldosterone stimulates the reabsorption of sodium and water and eliminates potassium and phosphate through excretion, thus it helps in maintaining electrolytes, osmotic pressure and blood pressure. Adrenal androgen plays a role in hair growth in axial region, pubis and face during puberty.

- The adrenal medulla secretes the hormones adrenalin and noradrenalin and are referred as "3F hormones" (fight, flight and fright hormones). Adrenalin increases the release of fatty acids from fat cells. During emergency it increases heart beat rate and blood pressure. It stimulates the smooth muscles of cutaneous and visceral arteries to decrease blood flow. It increase blood flow to the skeletal muscles thereby increases the metabolic rate of skeletal muscles, cardiac muscles and nervous tissue.

Pancreas

- Pancreas is a composite gland which performs both exocrine and endocrine functions. it is located just below the stomach as a leaf like structure. The pancreas is composed of two major tissues such the acini and islets of Langerhans. Acini secretes digestive enzymes and the islets of Langerhans secretes hormones like insulin and glucagon. Human pancreas has one to two million islets of Langerhans. In each islet about 60% cells are beta cells, 25% cells are alpha cells and 10% cells are delta cells. The alpha cells secrete glucagon, the beta cells secrete insulin and delta cells secrete somatostatin.

Insulin:

- Insulin is a peptide hormone and plays an important role in glucose homeostasis. It's main effect is to lower blood glucose levels by increasing the uptake of glucose into the body cells, especially muscle and fat cells. Insulin also inhibits the breakdown of glycogen to glucose, the conversion of amino acids or fats to glucose, so insulin is rightly called a hypoglycemic hormone.

Glucagon:

- Glucagon is a polypeptidehormone. It is a potent hyperglycaemichormone that acts on the liver andpromotes the breakdown of glycogen to glucose (Glygogenolysis), synthesis of glucose from lactic acid and from non-carbohydrate molecules (Gluconeogenesis). Glucagon releases glucose from the liver cells, increasing the blood glucose levels. Since glucagon reduces the cellular uptake and utilization of glucose it is called a hyperglycemic hormone. Prolonged hyperglycemia leadsto the disorder called diabetes mellitus.

GonadsTestis:

- A pair of testis is present in the scrotal sac of males. The testis functionsas a sex organ and also as an endocrine gland. The testis is composed ofseminiferous tubules and interstitial cellsor Leydig cells. The Leydig cells secrete several male sex hormones, collectively called androgens, mainly testosterone. Functions of testosterone: Under the influence of FSH and LH, testosterone initiates maturation of male reproductive organs, and the appearance of secondary sexual characters, muscular growth, growth of facial and axillary hair, masculine voice and male sexual behaviour. It enhances the total bone matrix and plays a stimulating role in the process of spermatogenesis.

Ovary:

- Females have a pair of ovaries located in the pelvic region of the abdomen. The ovary is composed of ovarian follicles and stromal tissues. It produces the eggs or ova. The ovaries secrete the steroid hormones oestrogen and progesterone. Oestrogen is responsible for the maturation of reproductive organs and the development of secondary sexual characters at puberty. Along with progesterone, oestrogens promotes breast development and initiate the cyclic changes during menstrual cycle. Progesterone prepares the uterus for implantation of the fertilized ovum. It decreases the uterine contraction during pregnancy and stimulates the development of mammary glands and milk secretion. It is responsible for premenstrual changes in the uterus and is essential for the formation of placenta.

Hormones of heart, kidney and gastro intestinal tract

- Some tissues of the heart, kidney and gastro intestinal tract acts as partial endocrine glands. In the heart, cardiocytes on the atrial wall's secretes an important peptide hormone called atrial natriuretic factor (ANF). When blood pressure is increased, ANF is secreted and causes dilation of the blood vessels to reduce the blood pressure.

- In kidneys, hormones such as renin, erythropoietin and calcitriol are secreted. Renin is secreted by juxta glomerular cells (JGA), which increases blood pressure when angiotensin is formed in blood. Erythropoietin is also secreted by the JGA cells of the kidney and stimulates erythropoiesis (formation of RBC) in bone marrow. Calcitriol is sercreted by proximal

tubules of nephron. It is an active form of vitamin D3 which promotes calcium and phosphorus absorption from intestine and accelerates bone formation. Gastro intestinal tract hormones Group of specialized endocrine cells present in gastro-intestinal tract secretes hormones such as gastrin, cholecystokinin (CCK), secretin and gastric inhibitory peptides (GIP). Gastrin acts on the gastric glands and stimulates the secretion of HCl and pepsinogen. Cholecystokinin (CCK) is secreted by duodenum in response to the presence of fat and acid in the diet. It acts on the gall bladder to release bile into duodenum and stimulates the secretion of pancreatic enzymes and its discharge. Secretin acts on acini cells of pancreas to secrete bicarbonate ions and water to neutralize the acidity. Gastric inhibitory peptide (GIP) inhibits gastric secretion and motility.

Hypo and Hyper activity of endocrine glands and related disorders

- The hyper secretion and hypo secretion of hormones leads to several disorders Dwarfism is due to hyposecretion of growth hormone (GH) in children, skeletal growth and sexual maturity is arrested. They attain a maximum height of 4 feet only.

- Gigantism is due to hypersecretion of growth hormone (GH) in children. Overgrowth of skeletal structure occurs (up to 8 feet) and the visceral growth is not appropriate with that of limbs.

- Acromegaly is due to excessive secretion of growth hormone in adults. Over growth of hand bones, feet bones, jaw bones, malfunctioning of gonads, enlargement ofviscera, tongue, lungs, heart, liver, spleen and endocrine gland like thyroid, adrenal etc., are the symptoms of acromegaly.

- In infants, hypothyroidism causes cretinism. A cretin shows retarded skeletal growth, absence of sexual maturity, retarded mental ability, thick wrinkled skin, protruded enlarged tongue, bloated face, thick and short limbs occurs. The other symptoms are low BMR, slow pulse rate, subnormal body temperature and elevated blood cholesterol levels.

- Hyposecretion of thyroid in adults causes myxodema. It is otherwise called Gull's disease. This disease is characterised by decreased mental activity, memory loss, slowness of movement, speech, and general weakness of body,

dry coarse skin, scarce hair, puffy appearance, disturbed sexual function, low BMR, poor appetite, and subnormal body temperature. Grave's disease also called as thyrotoxicosis or exophthalmic goitre. This disease is caused due to hyper secretion of thyroid. It is characterised by enlargement of thyroid gland, increased BMR (50% - 100%), elevated respiratory and excretory rates, increased heart beat, high BP, increased body temperature, protrusion of eyeball and weakness of eye muscles and weight loss. (Figure 11.13)

- Simple goitre is also known as Endemicgoitre. It is caused due to hyposecretion of thyroxine. The symptoms includes enlargement of thyroid gland, fall in serum thyroxine level, increased TSH secretion.

- Tetany is caused due to the hyposecretion of parathyroid hormone (PTH). Due to hyposecretion of PTH serum calcium level decreases (Hypocalcemia), as a result serum phosphate level increases. Calcium and Generalized convulsion, locking of jaws increased heart beat rate, increased body temperature, muscular spasm are the major symptoms of tetany.

- Hyperparathyroidism is caused due to excess PTH in blood. Demineralisation of bone, cyst formation, softening of bone, loss of muscle tone, general weakness, renal disorders are the symptoms of hyperparathyroidism.

- Addison's disease is caused due to hyposecretion of glucocorticoids and mineralocorticoids from the adrenal cortex. Muscular weakness, low BP., loss of appetite, vomiting, hyper pigmentation of skin, low metabolic rate, subnormal temperature, reduced blood volume, weight loss are the symptoms that occur in Addison's disease (Figure 11.15). Reduced aldosterone secretion increases urinary excretion of Na Cl. and water and decreases potassium excretion leading to dehydration.

- Cushing's syndrome is caused due to excess secretion of cortisol. Obesity of the face and trunk, redness of face, hand, feet, thin skin, excessive hair growth, loss of minerals from bone (osteoporosis) systolic hypertension are features of Cushing's syndrome. Suppression of sexual function like atrophy of gonads are the other symptoms of Cushing's syndrome.

Avoid use of synthetic soft drinks
The branded soft drinks damage our endocrine system. While consumingsoft drinks, the sugar level increasesin blood which leads to elevatedinsulin secretion to reduce the blood glucose level. The elevated insulin level diminishes immunity and causeobesity, cardio-vascular disorders etc.

- Hypoglycaemia is due to increasedsecretion of insulin thereby blood glucose level decreases. In this disorder blood glucose level lowers than normal fasting index. Increased heartbeat, weakness, Nervousness , headache, confusion, lack of co-ordination, slurred speech, serious brain defects like epilepsy and coma occurs.

- Hyperglycaemia is otherwise known as Diabetes mellitus. It is caused due to reduced secretion of insulin. As the result, blood glucose level is elevated. Diabetes mellitus is of two types, Type I Diabetes and Type II Diabetes. Type I diabetes is also known Insulin dependent diabetes, caused by the lack of insulin secretion due to illness or viral infections. Type II diabetes is also known as Non- Insulin dependent diabetes, caused due to reduced sensitivity to insulin, often called as insulin resistance. Symptoms of diabetes includes, polyurea (excessive urination), polyphagia (excessive intake of food), polydipsia (excessive consumption liquids due to thirst), ketosis (breakdown of fat into glucose results in accumulation of ketone bodies) in blood. Gluconeogenesis (Conversion of non- carbohydrate form like amino acids and fat into glucose) also occur in diabetes.

- **Diabates insipidus** is caused due to hyposecretion of vasopressin (ADH) from neurohypophysis. The symptom includes frequent urination (polyurea) and excessive consumption of liquids due to thirst (polydipsia).

Mechanism of hormone action

- Hormones circulate in the blood but their concentration can increase or decrease based on the requirement of the body. This is controlled by feedback mechanisms. These mechanisms control the secretion of endocrine glands by stimulating the hypothalamus, pituitary or both, which inturn governs the secretion of a particular hormone. In positive feedback, the

secretion of the hormone increases where as in negative feedback further secretion of hormone slows down. Feedback mechanisms are the key factors for maintaining homeostasis in our body.

- Hormones are classified into three major groups as peptide hormones, steroid hormones and amino acid derived hormones based on their chemical structure.

- Peptide hormones cannot cross the phospolipid cell membrane and bind to the receptors on the exterior cell surface. They are are transported to the golgi, which is the site of modification. It acts as a **first messenger** in the cell. Hormones on binding to their receptors do not enter the target cell but generate the production of **second messengers** such as cyclic AMP (c AMP), which in turn regulates cellular metabolism. This is catalyzed by the enzyme **adenylate cyclase**. The interaction between the hormone at the surface and the effect brought out by cAMP within the cell is known as signaling cascade. At each step there is a possibility of amplification

1. One hormone molecule may bind to multiple receptor molecules before it is degraded.

2. Each receptor may activate several adenylate cyclases each of which make much c AMP.

3. Thus there is more signal after each step.

- The actions of cAMP are terminated by phosphodiesterases. The effect of peptide hormones like insulin, glucagon, somatotropin are usually short lived because they work through second messenger system.

- Steroid hormones can easily cross the cell membrane, and bind to their receptors, which are intracellular or intranuclear. Upon binding to the receptors, they pair up with another receptor – hormone complex (dimerize).This dimer can then bind to DNA and alter its transcription.

- The effect of steroid hormones such as aldosterone, oestrogen, FSH are long lived, as they alter the amount of mRNA and protein in a cell.

- Amino acid derived hormones are derived from one or two aminoacid with a few additional modifications. Thyroid hormone is synthesised from tyrosine and includes the addition of several iodine atoms. Epinephrine an amino acid derivative may function through second messenger system like peptide hormones or they may actually enter the cell and function like steroid hormones.

Avoid use of steroid components

The abuse of anabolic steroids can cause serious health problems like high BP, heart diseases, liver damage, cancer, stroke and blood clots. Other side effects of steroid use includes nausea, vomiting, ligament and tendon injuries, head ache, joint pain, muscle cramps, diarrhoea, sleep problem etc.