Reaching the Age of Adolescence

Puberty and Adolescence

When Anjali visited her aunt after a gap of five years, she was amazed to see that her 13 year old cousin brother (Sameer) had become quite tall and had a hairy line above his lips. She observed various changes which had recently developed in him. **Do you know what these changes are and why they occur?** Let us explore.

The period of life when the body undergoes several changes to reach sexual maturity is called **Adolescence,** or Growing up stage of life.

The stage of adolescence usually begins at ages 13 – 14 for boys, and ages 10 – 12 for girls. However, this may vary from person to person. The occurrence of adolescent changes in the body marks the onset of **puberty**.The stage of puberty ends with the attainment of sexual maturity in an adolescent.

But what are these changes which occur in the body of an adolescent during this stage?

The changes which take place in the body of an adolescent are:

(I) Increase in height

One of the most obvious changes that you may have observed in an adolescent is a sudden increase in height. This occurs due to the elongation of bones of arms and legs.

Let us perform a fun activity to find out how tall your classmates will grow at the end of puberty.

Record the height of boys and girls in your class and calculate the height of your classmates at the end of the growing period using the given table.

Age in years	% of full height	
	Boys	Girls
8	72	77
9	75	81
10	78	84

11	81	88
12	84	91
13	88	95
14	92	98
15	95	99
16	98	99.5
17	99	100
18	100	100

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Use the given formula to calculate the full height (cm)

$$= \frac{\text{Present height (cm)}}{\text{\% of full height at this age}} X100$$

Let us take an example to understand how this formula can be used. Suppose Anjali's cousin (Sameer) is 152 cm tall at the age of 13.

Then,

Present height of Sameer (cm) = 152 cm

% of full height at the age of 13 = 88% (see table)

Applying the values to the given formula, we get

$$\frac{152}{88} \times 100 = 172.72 \text{ cm}$$

Therefore, Sameer's height at the age of 18 will be approximately 172 cm.

But does this formula give an exact measurement of height in all boys and girls?
No. The height of an individual is dependent on factors like genes inherited from parents. So, not all boys and girls will grow to a height determined using the given table.

Also, proper intake of various nutrients and consuming a balanced diet provides proper nourishment for the growth of our body. Therefore, it is essential for adolescents to eat a balanced diet and adopt healthy eating habits for proper growth and nourishment.

(II) Change in Body shape

Another major change which occurs in the body of an adolescent is the change in body shape. These changes are different for boys and girls. While in boys, the shoulders become broad and the chest becomes wide, in girls, the region below the waist becomes wider. Also, muscular development is more prominent in boys than in girls.

(III) Change in voice

You must have observed that the voice of some of your male classmates gradually becomes hoarse. This is also one of the changes associated with puberty. This occurs because at the time of puberty in boys, the voice box or the larynx begins to grow and protrude from the throat. This is called an Adam's apple. The enlargement of the larynx makes the voice low pitched and hoarse. In girls, the voice becomes high pitched.

(IV) Increased activity of the sweat glands and the sebaceous glands

You must have observed that a lot of teenagers face the problem of acne or pimples. Why is it so?

In adolescents, the secretion of the sweat glands and the sebaceous glands increase. This leads to the occurrence of acne and pimples.

(V) Development of sex organs

Attaining sexual maturity is the main aim of the adolescent stage. Therefore, various changes are observed in the sex organs of adolescents during puberty. In males, sex organs like the testes and the penis develop and the testes start producing sperms.

In girls, the ovaries enlarge and start producing mature eggs.

(VI) Reaching emotional, mental, and intellectual maturity

Apart from various physical changes, adolescents undergo various emotional, mental, and intellectual changes at the time of puberty. Their way of thinking starts to change and they become more independent and self conscious.

Secondary Sexual Characteristics

Have you ever wondered why only boys develop moustaches and girls do not?

At the time of puberty, both males and females acquire different body features which help in distinguishing them from each other. These specific features which differentiate boys from girls or males from females are called **secondary sex characteristics**.

Let us discuss about secondary sex characteristics in boys and girls.

Secondary sex characteristics in boys

- Under the influence of hormones, larynx grows prominently, vocal cords become longer and thicker, causing the voice to become hoarse.
- Hair start growing in the frontal region of the genital area.
- Appearance of hair in other areas such as underarms, legs, chest, abdomen, face, etc.
- Enlargement of testicles followed by penis.
- More secretion of oil from the skin, resulting in the appearance of acne.
- Testes grow and start producing sperms.

Secondary sex characteristics in girls

- Increase in breast size and the darkening of the skin of nipples present at the tips of the breasts.
- Appearance of hair in the genital area.
- Appearance of hair in other areas such as underarms, hands, legs, etc.
- Increase in the size of uterus and ovary.
- Beginning of menstrual cycle.
- More secretion of oil from the skin, resulting in the appearance of acne.

But do you know that some secondary sex characteristics are common in both boys and girls?

These common changes are:

- Growth of hair in genital area and other parts.
- Growth of reproductive organs.

- More secretion of oil from skin, resulting in the formation of acne.

But what factors lead to the development of secondary sex characteristics in males and females?

The development of secondary sex characteristics is under the control of hormones in bodies of both males and females. In males, the hormone called testosterone secreted by the testes causes the growth of facial hair. Similarly, the hormone called estrogen secreted by the ovaries in females cause the development of breasts.

The production of the testosterone and the estrogen is under the control of another hormone secreted by the pituitary gland.

Endocrine Glands and their Functions

We salivate when we see delicious food; we feel tense or anxious while making important decisions; we digest different types of food that we ingest; children grow taller during the early years of their life; voices of boys crack during puberty; lactation begins during motherhood. **Do you know why these changes occur? How does the body control these functions? Is there another system governing these complex functions?** Let us explore.

Hormones

A hormone is a chemical messenger that regulates physiological processes in living organisms. It is secreted by a gland.

The regulation of the physiological processes, control and coordination by hormones is governed by the endocrine system. The nervous system, along with the **endocrine system** in our body, controls and coordinates the physiological processes.

Characteristics of hormones:

- Hormones act as chemical messengers.
- They are secreted by living cells/tissues or organs called **glands**.
- They are secreted in very small quantities by glands.
- They act upon specific cells, tissues, or organs called the **target sites**.
- They are generally slow in action, but have long lasting effects.
- They either accelerate or inhibit a reaction.

Glands

A cell, tissue, or an organ that secretes hormones required for a specific function is called a **gland**. You are familiar with the pancreas, pituitary gland, and thyroid gland. Glands are mainly divided into two broad categories -**endocrine and exocrine**.

Exocrine gland	Endocrine gland
These glands possess ducts (enclosed passage or channel for conveying a substance) for discharging their secretions into the body surface. The sebaceous glands present in the skin, salivary glands present in the buccal cavity, and gastric glands present in the walls of the stomach etc. are a few examples of exocrine glands.	These glands do not discharge their secretions through ducts. Hence, they are also known as ductless glands. They discharge their secretions directly into the bloodstream. Their secretions are known as **hormones**. The pituitary gland, thyroid gland, adrenal gland etc. are a few examples endocrine glands.

Do you know that the term 'hormone' was first introduced by Ernest Starling? Secretin was the first hormone to be discovered. Ernest Starling and William Bayliss are credited for its discovery.

Importance of hormones

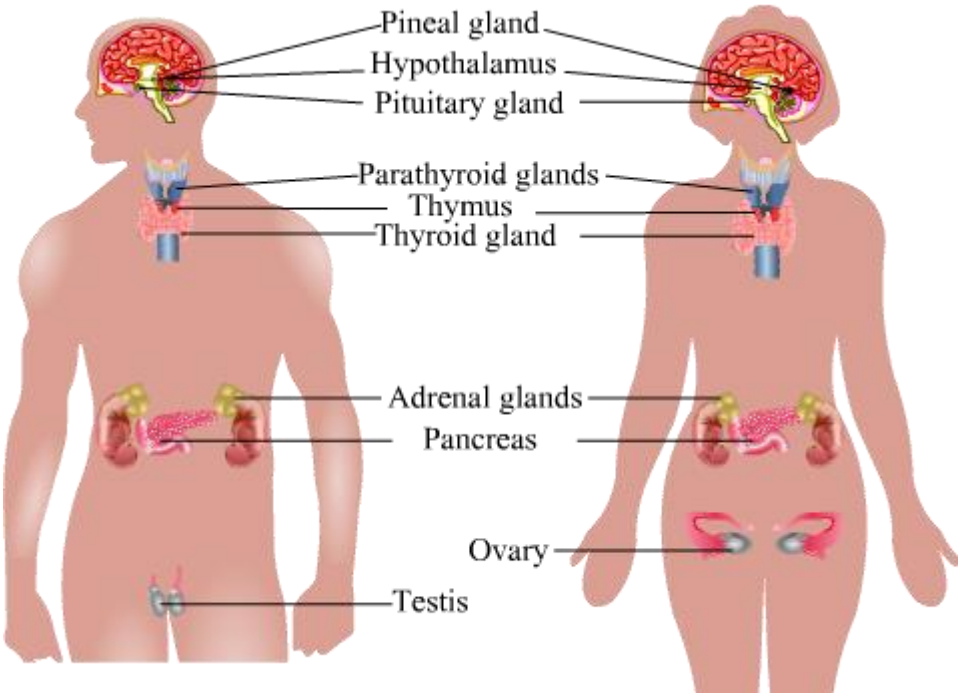
We have often heard people complaining that they suffer from sugar. Do you know which condition they are referring to? How do we treat this condition?

They are referring to the condition called **diabetes**. It is a chronic condition characterized by high levels of sugar (glucose) in the blood.

What is the reason for the increase of sugar in the blood? How are other activities such as sleep, hunger, stress, body temperature etc. regulated? Let us explore.

Hormones in the human body

There are different kinds of hormones found in the human body. However, we will discuss only a few.



Pituitary Gland

It is a tiny pea sized gland located near the hypothalamus of the brain. It is known as master gland as functions of many other endocrine glands are regulated by the pituitary gland. The gland is divided into two lobes- anterior lobe also called **adenohypophysis** and posterior lobe also called **neurohypophysis**.

Functions of the pituitary Gland

- It influences the secretion of other glands like thyroid gland, adrenal gland, mammary glands, gonads etc.
- It controls the excretion of water from kidneys and contraction of muscles of uterus.
- It also influences the development of testes and ovaries.
- It secretes the **growth hormone (GH)** that is involved in the growth and development of the human body.

The secretion of the growth hormone should be properly maintained in the body. Over secretion of the growth hormone prior to puberty (in children) results in abnormal growth of the body known as **gigantism**. This is characterised by the excessive growth and increase in height of the person. On the other hand, its low secretion results in retarded growth and this condition is called **dwarfism**.

The oversecretion of the growth hormone in the adults causes a disease called **acromegaly**. This results in the excessive growth of the bones especially in jaws, nose, hands and legs.

Thyroid Gland

The thyroid gland is situated close to the trachea in the neck. It secretes a hormone called thyroxin. It regulates carbohydrate, fat, and protein metabolism in our body. It indirectly affects the growth of the body by promoting growth and differentiation of tissues. Hence, it is also known as the personality hormone.

Thyroid disorders:

The deficiency (hypothyroidism) or excess secretion (hyperthyroidism) of this hormone results in certain disorders.

Hypothyroidism- The condition in which thyroid gland does not produce enough thyroxin to meet the normal requirements of the body. This condition causes abnormalities like simple goitre, myxoedema and cretinism.

Simple goitre- It is usually caused by deficiency of iodine in diet and results in swelling in the neck region due to enlargement of the thyroid gland. People living near coastal regions usually do not suffer from this disease as sea water and soil are rich in iodine. People suffering from goitre are suggested to increase their intake of iodine with food and water.

Myxoedema- It is mainly caused in adults due to under activity of the thyroid gland and symptoms include low metabolic rate, loss of mental and physical vigour, increase in weight, thickening of the skin and lower rate of heart beat. This condition is cured by giving proper doses of thyroxin to the person.

Cretinism- It is found in children born with improperly functioning thyroid gland. Its symptoms include stunted growth, retarded mental development, bow legs, defective teeth, protrusion of the tongue and loose skin. These effects can be prevented by providing proper treatment in time.

Hyperthyroidism- It is caused due to the excess secretion of thyroxin. It results in high metabolism, protrusion of the eye balls, high BP, nervous tension, irritability, profuse swelling, weight loss and fatigue. This can also be cured by giving proper treatment in time.

Thyroxine hormone not only plays an important role in humans but also in frogs. It is required for the completion of life cycle of frogs. The process of conversion of larva into an adult is called metamorphosis. This process is controlled by the thyroxine hormone in frogs. In the absence of this hormone, tadpoles cannot develop into adult frogs.

Parathyroid Gland

There are four parathyroid glands present on back side of thyroid glands that secrete parathyroid hormone or parathormone (PTH). This hormone regulates the level of calcium ions in the bloodstream.

The deficiency of this hormone results in the painful muscle cramps. On the other hand its over secretion removes calcium from the bones making them soft and spongy.

Adrenal Glands

The adrenal (suprarenal glands) gland, is situated at the anterior part of the kidneys. Each adrenal gland consists of two parts- **outer cortex** and **inner medulla.**

Adrenal cortex secretes two hormones- **Aldosterone** and **cortisol** while adrenal medulla secretes hormone- **adrenaline (epinephrine) and noradrenaline (norepinephrine).**

In case of danger, emergency, or stress, **adrenaline** is secreted in large quantities to prepare the body to face the situation. For this reason, it is also known as 'emergency hormone'. This hormone is secreted even in normal situations, but in small quantities.

Adrenaline is secreted directly into the blood and is transported to different parts of the body. The specific tissues/organs on which this hormone acts also includes the heart. This results in faster heartbeats. Hence, more oxygen is supplied to the muscles. The breathing rate also increases due to contractions of the diaphragm and rib muscles.

Pancreas

Pancreas is a mixed gland i.e. both exocrine and endocrine in function. The cells of pancreas which are endocrine in function are known as **islets of Langerhans** and secrete two hormones- **insulin** and **glucagon.**

Insulin regulates the blood sugar level in the human body. It increases the permeability of the cell membrane for glucose and accelerates the passage of glucose into the cells from the bloodstream.

In case of deficiency of insulin, the level of glucose in blood increases and is excreted through urine. This condition is known as **diabetes mellitus.** Other symptoms of the disease include frequent urination and thirst. The treatment of diabetes mellitus includes oral pills or injections of insulin.

Glucagon is antagonistic hormone to insulin and is secreted when blood glucose levels are low. It helps in conversion of glycogen into glucose. This glucose is released into the blood and supplied to the tissues.

Gonads

Gonads (testes and ovaries) are both involved in producing gametes and are also endocrine (produce hormones) in function. Testes secrete **testosterone** and ovaries secrete the hormones **estrogen** and **progesterone**. These are also known as male sex hormones and female sex hormones respectively.

Testosterone is responsible for the growth and development of male secondary sexual characters.

Deficiency of testosterone results in under-sexed individuals whose masculine characters are not properly developed.

Estrogen is responsible for the development of secondary sexual characters in females like development of mammary glands etc.

Deficiency of estrogen causes infertility.

Progesterone helps in regulation of menstrual cycle and maintaining pregnancy.

The human body contains 30 amazing hormones, which regulate activities such as sleeping, body temperature, hunger, and managing stress.

Process Of Hormonal Action

Endocrine glands are ductless glands, which release their secretions called **hormones** into the bloodstream. **But how do these hormones work? And how do they bring about changes in the body?** Let us find out.

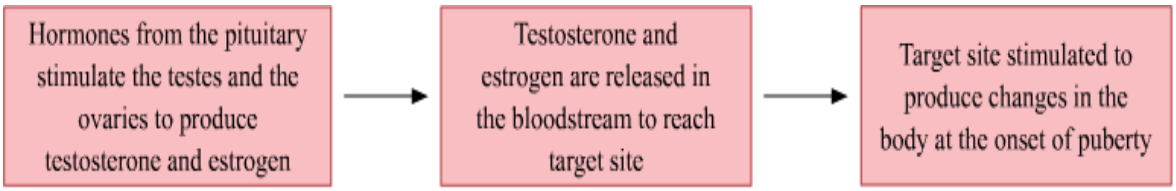
All endocrine glands release their hormonal secretions into blood. These hormones, on reaching a particular site in the body called the **target site**, bring about necessary changes to maintain proper functioning of the body.

Let us take examples of hormones **testosterone** and **estrogen** to understand the process of hormonal action.

Hormones known as testosterone and estrogen are produced by the testes and the ovaries respectively. The production of these hormones is under the control of hormones from the anterior pituitary gland.

Hormones released from the anterior pituitary stimulate the testes to produce testosterone, and the ovaries to produce estrogen which is released into the bloodstream. From the bloodstream, testosterones and estrogen reach their respective target sites, where they stimulate various changes in the body at the onset of puberty.

The process can be explained using the given flow chart:



Reproductive Phases In Humans

At the time of puberty, adolescents attain reproductive maturity and their reproductive organs like the testes in males and the ovaries in females start producing gametes. **But do you know that males and females have different reproductive phases of life?** Let us explore.

The reproductive phase in males lasts much longer than in females. Males produce sperms throughout their life. But, this is not the same for females.

In females, the reproductive phase starts at ages 10 – 12 and lasts till ages 45 – 50 years. During this period, a mature egg or an ovum is released once in a period of 28 – 30 days by each ovary alternatively. The uterus also undergoes changes during this period. The wall of the uterus becomes thick, so that the developing embryo can attach itself to the uterus. If the embryo attaches to the wall of the uterus, pregnancy occurs.

But what happens in the absence of fertilization?

The ovum remains available for fertilization only for a single day. When fertilization does not take place, the ovum and the thickened lining of the uterus are shed off along with the blood vessels. This leads to the process of bleeding in woman, which is known as **menstruation**.

When a woman first starts her menstrual cycle at the onset of puberty, it is known as **menarche**.

But do women undergo menstruation throughout their life? No. Menstruation stops at an age of 45-50 years in women. This stage is known as **menopause.** After this stage a women can no longer reproduce.

Do You Know?

By the time a woman enters puberty, she has between 300,000 to 500,000 eggs in her ovaries. But only 400 to 500 eggs ripen into mature eggs during her life.

Sex Determination

Have you ever thought how a baby boy or a baby girl is born? What directs the zygote to form a baby boy or a baby girl? What determines the sex of a child? Let us explore.

The answer to these questions lie in thread-like structures called **chromosomes**. These chromosomes are present in the nucleus of all cells. Thus, they are also present in the zygote. They carry the instruction for determining the sex of the baby.

But how many chromosomes do humans have and do all of them determine the sex of a child?

All human beings have 23 pairs of chromosomes out of which two chromosomes are sex chromosomes. These sex chromosomes are responsible for determining the sex of a child. Let us study how sex is determined in human beings.

Hence, the sex of a child is dependent on the father as the sperm containing **X** or **Y** chromosomes decides whether the child will be a male or female.

Environmental factors (**Non-genetic sex determination**):

In some animals such as turtles, lizards, crocodiles, and a few snakes, the sex of the progeny depends upon the incubation temperature of the eggs.

For example, in certain turtles, the eggs hatch to produce male and female organisms, when incubated at low and high temperatures respectively.

Other type of sex determination: Some snails can change their sex. Snails start development as males and later change their sex to females.

Absence of sex determination system: Earthworms are hermaphrodites. They do not have separate sexes as males and females.

Some interesting facts:

- Do you know that in birds, males have same sex chromosomes (ZZ) and females have different sex chromosomes (ZW)? This system of sex determination is reversed compared to the system found in humans.
- In fruit fly (*Drosophila*), sex chromosomes are not present. Sex is determined by the ratio of the number of X chromosomes to autosomes.

Importance Of Personal Health, Hygiene And Nutrition During Adolescence

The body of an adolescent undergoes a number of changes. Thus, it is important for adolescents to take care of their nutritional requirements, personal hygiene, and health. Let us explore what adolescents should do to take care of all these aspects.

Nutritional requirement in adolescents

You must have heard your parents advising you to eat a balanced diet containing all the nutrients instead of fast food like burgers, patties, chips, cold drinks etc. **Why do you think they advise you to do so?**

Consuming a balanced diet, containing all food nutrients in balanced proportions is very essential during the stage of adolescence. An adolescent's diet should include carbohydrates, fats, proteins, vitamins, and minerals in adequate amounts. This is because bones and muscles need proteins and calcium to grow at the time of puberty.

Some food sources like fruits and vegetables should also be included in the diet as they contain lots of vitamins and minerals. *Amla* is the richest source of vitamin C, while all green leafy vegetables are rich in iron which helps increase the production of blood in body.

Food items like chips, cold drinks, and snacks should be avoided, or their consumption should be restricted as they are good in taste only and are poor in nutrient content.

Maintaining personal hygiene

At the time of puberty, the activity of the sweat glands increases considerably. Therefore, it is necessary for an adolescent to have a bath daily to protect the body form bacterial infections. Also, girls should maintain personal hygiene at the time of menstruation to avoid various infections.

Maintaining personal health

Adolescents should do regular physical exercise to keep their body fit and healthy. They should play outdoor games and should keep themselves active.

Drugs

Drug abuse has become increasingly common in adolescents during the recent years. Drugs are chemical substances that bring about physical, mental, emotional and behavioural changes in the users. Many of these drugs are addictive and once addicted, it becomes difficult for the user to get out of this addiction. The use of drugs for purposes other than medical reasons is known as **drug abuse**.
Drugs affect the health of the user and damage many vital organs such as lungs, heart, liver and the nervous system and may even lead to death.

Some of the drugs are alcohol, nicotine (present in cigarettes), *gutka*, *pan masala*, cocaine and marijuana.

AIDS

The sharing of injection needles to inject these drugs is also responsible for the spread of a diseases known as **AIDS** (Acquired Immuno Deficiency Syndrome). AIDS is caused by a virus known as human immunodeficiency virus (HIV). It is one of the most dangerous diseases and is not completely curable. It poses a major threat to public health.
AIDS is transmitted through the following means:

- Sharing of injection needle contaminated with the virus
- Unsafe sexual contact with infected person
- From infected mother to the baby

Stress

Stress is a state of mental or emotional strain which results from adverse circumstances. It is a common phenomena among the adolescents because of all the physiological and mental changes they undergo during puberty. Whenever one become stressed, the body reacts by releasing some hormones. These hormones result in various physical changes, such as increased heart beat, increased breathing rate, and release of a large amount of energy. Stress also results in alteration in attention and thought processes. This may result in decline in physical health and may also induce depression.

The key to manage stress lies in adopting a healthy lifestyle. There are a number of approaches that can prove helpful in stress management. Some of them are as follows:

- taking proper sleep
- regular exercise and yoga
- keeping a positive attitude
- practising deep breathing and meditation
- practising hobbies of your interest

AIDS: Modes of Transmission

Historical background of AIDS

AIDS is believed to exist from long time but it came to light only in 1980's. The first cases of AIDS were recognized in U.S.A in the year 1981. It was associated with two diseases namely pneumonia and skin cancer. This disease was first observed mainly in homosexual men and drug addicts. Later, it was observed in the children and adults who received infected blood.

Discovery of AIDS Virus

The AIDS virus was first discovered by the team of French scientists lead by **Luc Montagnier** in **1983**. In **1984**, the American virologist named **Robert Charles Gallo** gave the first report on the virus causing AIDS. The name HIV was suggested by the **International committee on the nomenclature of viruses.**

In India, the first AIDS patient was identified in Chennai in the year 1987.

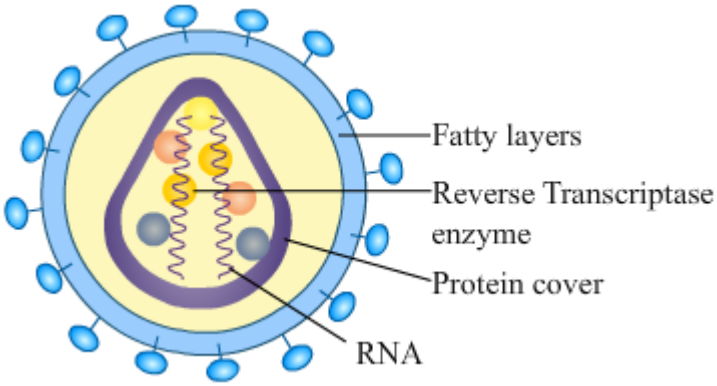
Do you know what AIDS is?

AIDS or Acquired Immunodeficiency syndrome is a viral disease, caused by the deadly virus (HIV). It is a disease in which the body's ability to fight against disease causing pathogens gets reduced and the body becomes prone to various diseases.

AIDS is regarded as a syndrome rather than a particular type of disease because AIDS patients show several symptoms which occur at a particular time.

Structure of HIV

Human Immunodeficiency virus (HIV) is spherical in shape and contains RNA as its genetic material. Externally, the virus is covered by the double layered membrane made up of fatty substances. Inside the fatty membrane a core of proteins is found that surrounds the viral RNA along with the enzyme reverse transcriptase. This enzyme helps the virus in the synthesis of DNA from RNA in the host cell.



HIV belongs to the retrovirus family and is capable of synthesizing DNA from viral RNA in the host cell. It is difficult to develop vaccine to control the disease as virus synthesises new DNA inside the host cell. It adapts itself so well in the body cells that our immune system fails to recognise it as foreign particle. Hence, symptoms take longer time even years to appear in the infected patient. Ultimately, the virus destroys the immune system and person becomes prone to secondary infections like tuberculosis, pneumonia, etc and finally leads to death.

Do you know which cells are normally affected by HIV virus?

The HIV virus normally attacks the white blood cells (lymphocytes) of our body. These cells include T lymphocytes which provide the protection to our body against infection. The HIV first destroys the T helper cells (or CD4 cells), breaking down the immune system. The patient is exposed to various contagious diseases and finally dies.

Do you know that AIDS can spread from one person to another? Let us find out the methods by which AIDS can spread.

- AIDS can be transmitted by sharing contaminated needles while injecting drugs.
- AIDS can be transmitted by having sexual contact with an infected person.
- AIDS can be transmitted by transfusion of infected blood.
- AIDS can also be transmitted from an infected mother to the child through pregnancy or breast feeding.

Some Interesting Facts:

- **The AIDS virus does not spread through touching or eating with an infected person or sharing public bathrooms, swimming pools or by the bite of mosquitoes or other insects.**
- **AIDS is a disease in which the body's ability to fight against diseases gets reduced and the body becomes prone to various diseases.**

Symptoms of AIDS

The first symptoms appear two to three weeks after the entry of the AIDS virus into the body of a person. These symptoms include, fever, headache, pain in joints, ulcers in mouth and throat. Although no signs appear externally, the virus keeps multiplying in the body and immune system keeps getting weak.

After the full establishment of the disease, the swelling of lymph nodes appears in the neck and axilla and patient may show following conditions:

1. Fever and body ache for long time

2. Total loss of immunity

3. Considerable weight loss

4. Skin itching and burning sensation of respiratory tract, cough with sputum are observed.

5. Sweating profusely during night.

6. White patches in mouth and ulcers in the oesophagus.

7. Giddiness, diarrhoea, inflammation of endocrine glands.

Few secondary infections that occur in AIDS patient are:

- Tuberculosis
- Pneumonia
- Herpes
- Meningitis
- Skin cancer

Precautionary measures

1. Avoid sexual contact with infected persons

2. Ensure use of disposable syringes

3. Screening blood from blood banks

4. A mother infected by AIDS should avoid breast feeding her child.

Tests to detect the HIV

Some of the important tests used to detect HIV in the blood include

- PCR (Polymerase Chain Reaction)
- ELISA- Enzyme linked Immuno Sorbent Assay
- Western Blot