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Module : 24 Introduction to Human Growth and Development

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Description of Module	
Subject Name	Anthropology
Paper Name	01 Physical/ Biological Anthropological
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Content:

- **Introduction**
- **Defining growth**
- **A Capsule history of Growth Studies**
- **Methods of Studying Growth**
  - ✓ Longitudinal method
  - ✓ Cross sectional method
  - ✓ Semi longitudinal or linked longitudinal method
  - ✓ Mixed longitudinal method
- **Phases of Growth**
  - ✓ Prenatal Growth
  - ✓ Postnatal Growth
  - ✓ Early Childhood
  - ✓ Middle Childhood
  - ✓ Late Childhood
  - ✓ Adolescence
  - ✓ Adulthood
- **Factors affecting growth**
  - ✓ Environmental Factors
  - ✓ Nutrition
  - ✓ Migration and Urbanization
  - ✓ Socio-Economic Status
  - ✓ Secular Trend
  - ✓ Endocrine factors

Learning Objectives:

- Defining Growth and Development
- Difference between Growth and Development
- History of Growth Studies
- Methods of studying Growth
- Phases of Growth
- Factors affecting Growth

Introduction

ñGrowth is the only evidence of lifeò was said by John Hery Cardinal Newman in the 19th century itself. It is not an elaboration of function, differentiation of tissues, nor the laying down of metabolic pathways as per Goss (1964) rather an increase or decrease of some measurable quantity continuing throughout. As the life of an organism is an on-going process, it must be thought of as an increase in some measurable dimension (Johnston 1978). It is a dynamic process beginning with the conjunction of two sets of genes in the fertilized ovum. It shows a basic underlying constancy and does not proceed in ñfits and startsò, except in terms of certain increments (Tanner, 1965).

The Encyclopedia Americana (1958) says that physical growth comprises all the morphologic modifications that characterize the life span of an organism. Modifications known to take place during human ontogeny include change in the (i) kind, (ii) number, (iii) size, (iv) shape, (v) position, (vi) pigmentation and (vii) texture of body components. In quantitative terms, growth is the increase in living substance or protoplasm and includes one or more of the following three processes: (i) Cell multiplication, (ii) cell enlargement, and (iii) incorporation of material taken from environment. It is the biological synthesis of living tissues, or protoplasm. Growth may be by cell enlargement (such as growth of nerve and muscle fibres), but it is mostly by cell division (Encyclopedia Britannica, 1962).

Goss (1978) has referred to two dimensions of development: the qualitative, which refers to the problem of cellular differentiation and the quantitative one, is growth and size determination. So development is growth coordinated towards the production of the complete organism from immature state to a highly organized, specialized and mature state. Development depends on the maturation and myelination of nervous system. So the sequence is same for all children but the rate may vary. Development ultimately is a product of contribution of Heredity and Environment. Maturity is the measure of functional capacity e.g., the development of motor skills of a child i.e., maturation of the skeletal and muscle systems.

Watson and Lowrey (1962) have described that both growth and development in a normal child parallels each other and any separation would be an artificial one. They restrict the term growth to mean an increase in physical size of the whole or any of its parts which could be therefore measured in terms of inches or centimeters and pounds or kilograms. Development on the other hand indicates an increase in skill and complexity of function. Maturation and differentiation are frequently used as synonyms for development. Used in this sense, it is evident that development is related to growth but is not the same.

Defining growth

Richards and kavanagh (1945) writes ñGrowth is a fundamental attribute of living organism, manifested by a change in size of the individual or in the number of organism in a unit of environmentò. Comas (1960) says that ñgrowth is the increase in size of the various parts and organs of the body and this increase is limited to pre-established constitutional hereditary factors and influenced by exogenous factorsò. Tanner (1978) has observed growth as ña product of the continuous and complex interaction of heredity and environment or between the genotype and the changing environment, an interaction which is sometimes more complex than simpleò.

Ensembling, it could be said that physical growth is the quantitative increase in size or mass which brings about irreversible changes in the body, its organs, in their size and form.

Growth is often used as a synonymous for development. ñDevelopmentò according to Todd ñis progress towards maturityò. It refers to a process of change in growth and capability over time, as function of both maturation and interaction with the environment

Difference between Growth and Development

Growth	Development
1. It refers to increase in size which is in physical terms	1. It is the overall change in shape or form and results in improved functioning.
2. Growth results in measurable changes and hence may be quantified.	2. Development is change or improvement in functioning and behaviour so it brings qualitative changes which are difficult to be measured directly.
3. Growth may or may not bring development.	3. Development may take place without growth.

It could therefore be said that

- Growth and development in children is a continuous and steady process.
- Growth pattern of every individual is unique
- Different parts of the body grow at different rates.

A Capsule history of Growth Studies

Before the 17th and 18th century mostly the artists started using accurate proportions of the human body in their drawings. The anatomical differences also started to depict in their work with children of normal proportions and growth pathologies.

In 1651 physician William Harvey helped establish that the embryo is not a preformed adult, rather that during development the human being passes through a series of embryological stages that are distinct in appearance from the form visible just before and after birth. Galen (c.AD 130 to c.AD 200) wrote about the appearance of the foetus in the later stages of pregnancy. The first accurate drawings of the foetus were made by Leonardo da Vinci (1452-1519), who dissected a seven month old foetus and stillborn, full-term infants. Other descriptions of foetal anatomy and physiology followed Leonardoôs work, notably by Vesalius in 1555 and Volcher Coiter in 1572.

The study of growth after birth began with the concept of infants and children as miniature adults who had to only increase in size during the growing years. By the late 15th century Leonardoôs drawings correctly rendered adult and child body proportions. Albrecht Diirer (1471-1528) devised a method of geometric transformations that he used to accurately render proportions of the human head and face (Bogin, 1991).

The first longitudinal study on human growth was made by Count Philibert Gueneau de Montbeillard of France upon his son. He measured the stature of his son every six months from 1759 on the behest of Buffon, who included the measurements and his commentary on them, in a Supplement to his Histoire Naturelle in 1777 (Tanner, 1981). Another 18th century longitudinal study of growth is that of the students of the Carlschule, conducted between the years 1772 and 1794 which included the sons of the nobility and of the bourgeoisie.

In 1835 Lambert Adolphe Quetelet published the first statistically complete study of the growth in height and weight of children. He was first to make use of the concept of ónormal curveôto describe the distribution of his growth measurements.

After this a vast number of growth studies were started to be made with the accumulation of dimensional data mostly from the schools, prisons, hospitals and military personals. Along with this several long term longitudinal studies also made its influx between 1927 and 1932 (Tanner 1981). These include the famous Fels Longitudinal Study, at the Fels Research Institute, Yellow Spring; the Bolton-Brush Study at Western Reserve University (Cleveland, Ohio), the Berkeley Growth study, Guidance study and Oakland Growth study at the Institute of Human Development of the University of California (Berkeley), the Child Research Council Study at the University of Colorado (Denver), and the Harvard School of Public Health Growth Study (Boston, Massachusetts) [Roche, 1992].

Buffon noted the seasonal variations in rate of growth, daily variation in stature with the data on montbeillardôs son.

With the studies of Boas involving his research into the methodology of growth studies demonstrating the importance of calculating growth velocities from individuals rather than from sample means, the modern era of growth measurement and analysis began.

Methods of Studying Growth

Growth among the children could be studied mainly by two methods:

Longitudinal method

1) In this method, the same subject or group of subjects is measured repeatedly from year to year.

2) Individual rates of growth and the timing of specific developmental events could be analyzed with data collected by this method.

3) Data may be analyzed for individual rates of growth and the timing of specific developmental events.

4) A birth to maturity study may take up to 20 years to complete with the help of this methodology**.**

The principal **drawback** of the comprehensive longitudinal study is

- The time it takes to complete and the relatively small number of subjects that can usually be followed.
- Longitudinal studies are by their nature costly and dependent upon the continuous cooperation of the subjects.

It is therefore essential that the highest of accuracy should be maintained in collecting and recording the data and the methods of analysis used should be those appropriate to the methods of study, yielding the maximum and accurate information covering individual growth.

Cross sectional method

1) In this method, the subjects are measured only once. Subjects of different ages are measured at a single point of time.

2) This method provides a general description of age-related growth changes.

3) A growth study could be completed within a very short span of time.

4) In a comparative survey of childrenôs growth in different populations, the concern is more with the means and variations of group of children than with the growth patterns of individuals. Therefore the information is usually from cross-sectional studies.

5) Cross sectional methods are adequate for studying distributions of various measurements in different individuals at different ages and for constructing standards of growth attained e.g. height and weight standards. In these circumstances the relative ease and rapidity with which results may be obtained from a large number of cases makes cross-section methods preferable to longitudinal one.

6) Cross-sectional methods are also obligatory in circumstances where continuity is not possible, e.g. autopsy studies on internal organs (Tanner, 1960).

7) From a cross sectional study, the centiles of distribution could be calculated which are often used as the basis for population standards. A larger number of subjects are necessary for creating effective standards.

There are **limitations** to the usefulness of even large- scale cross-sectional studies.

- They tell us nothing about individual increments from one year to the next i.e., about individual rate of growth.
- Though they give us an estimate of the mean rate of growth of a population, they tell us nothing about the variability around the mean. Since this method mixes data of early, average and late maturing children, it results in a mean velocity curve that underestimates the actual velocity of growth of all children during the adolescent spurt.
- In a clinical context, it is required to compare a given individuals velocity or rate of growth with standards for velocity at his age.

Semi longitudinal or linked longitudinal method

Longitudinal and cross-sectional studies are complementary and both are required for a full understanding of the growth process. For some purpose a good design is that of linked-longitudinal studies, i.e. studies covering the ages 0-6, 5-11, 10-16 and 15-21. Efficient sampling of the population is crucial to obtain smooth joints in the data

Mixed longitudinal method

Maximum information could be extracted from a mixture of longitudinal and cross-sectional data (Tanner, 1951). It is called mixed longitudinal studies, in which children have the liberty to enter and leave at different ages, giving various degrees of longitudinality.

Phases of Growth

The beginning of life from the single celled stage proceeds with many irreversible changes taking place scientifically called growth and development till the death of that single cell in the form of multicellular biologically complex being. This whole lengthy course could be broadly divided into two phases:

(i) Prenatal (before birth, which takes place within the motherôs womb) and

(ii) Postnatal (after birth)

Prenatal Growth

The course of pregnancy is divided into three trimesters. During the first trimester, the multiplication of a single cell, the fertilized ovum into millions of new cells takes place. While dividing distinct groups of cells begin to form having different rates of cell division. Eventually they form different kinds of tissue ï endoderm, mesoderm and ectoderm. After the tissues are formed, the first trimester is taken up with organogenesis i.e., the formation of organs. By the eighth week the embryo is recognizable human.

By the start of second trimester, the embryo is a foetus as the differentiation of cells tissue and organ is complete. The embryo grows slowly in length reaching about 1.0 to 1.5 mm at 18 days during the first trimester. AT eight weeks after conception the crown-rump length is about 30 mm (Meire, 1986). By the fourth month it is about 205 mm, by the fifth month 254 mm and by the sixth month is between 356 and 381 mm (about 70% of average birth length (Timiras, 1972). Weight increase is less rapid, at eight weeks the embryo weighs 2.0 to 2.7grams (OôRahilly and Mueller, 1986), at six months the foetus weighs only 700gms (Timiras, 1972). Growth rate increases during the last trimester, when development and maturation of the circulatory, respiratory and digestive system occurs preparing the foetus for the postnatal life.

Postnatal Growth

Prenatal and postnatal growth and development are one continuous process, but the incident of birth and beginning of extra-uterine existence is an important dividing point.

Life after birth has been divided into different periods of growth differently by the various researches.

The stage of growth gives by Watson and Lowrey (1962) are:

Growth Period	Approximate Age
Prenatal	From 0 to 280 days
Ovum	From 0 to 14 days
Embryo	From 14 days to 9 weeks
Foetus	From 9 weeks to birth
Premature infant	From 27 to 37 weeks
Birth	Average 280 days
Neonate	First 4 weeks after birth
Infancy	First year
Early Childhood (preschool)	From 1 to 6 years
Later childhood (pre -pubertal)	From 6 to 10 years
Adolescence	Girls, 8 or 10 to 18 years Boys, 10 or 12 to 20 years
Puberty (average)	Girls, 13 years Boys, 15 years

Timiras (1972) has described the stages in the life cycle as:

Neonatal period	-	Birth to 28 days
Infancy	-	2 months to 24 months
Early childhood	-	2^{nd} to 6^{th} year
Middle childhood	-	7^{th} to 10^{th} year (approx.)

Late childhood	-	10th year to puberty, which typically occurs between 12 and 15 in girls and 13 to 16 years in boys.
Adolescence	-	The six years following puberty.
Adulthood		
Prime and transition	-	Between 20 years and end of child bearing years.
Old age and senescence	-	From end of child bearing years to death.
Death		

R.E. Scammon (1942) has proposed another classification:

Prenatal	Ovum	The first two weeks
	Embryo	From 2 to 8 weeks
	Foetus	From 2 to 10 lunar months
Postnatal childhood	Infancy	Neonatal (The first two weeks)
		Infancy (From 2 weeks to 1 year)
	Childhood	Early (from 1 to 6 years)
		Middle (from 6 to 9 or 10 years)
		Late -Boys (from 9-10 to 13-16 years) Girls (from 9-10 to 12-15 years)
	Puberty	Boys (around 14 years)
		Girls (around 13 years)
	Adolescence	Boys (from 14 to 20 years)
		Girls (from 13 to 18 or 20 years)
	Maturity	From 18-20 to 60 years
	Senility	After 60 years

Each growth period is characterized by its own tempo of growth. Bogin (1991) says the approximate divisions between periods are:

Infancy ï Birth to three years of age,

Childhood ï three to 12 years of age and

Adolescence ï 12 to 18 years of age.

Early Childhood

Increase in height takes place up to 44% during the first year for boys and 40% for girls. Weight increase is established at 143% in the male and 157% in the female (Comas, 1960). Head height is approximate 1/4th of the total stature. The spinal column at birth has a single dorsal curvature with anterior concavity. The legs lengthen almost double their length by the age of three but the arms do not

double their length until the age of five. Thorax is small in comparison with the abdomen and waist does not exist. Another characteristic of early infancy is general chubbiness with relatively large dimensions of the trunk and head.

http://memegenerator.net

Middle Childhood

This stage is characterized by the persistence of rounded infantile form and by a growth in width rather than in length or height. All deciduous teeth have erupted. The rounded body form of infancy persists. It is between 2½ to 6-7 years.

Late Childhood

This period is from the 7th year to the first signs of puberty i.e., approximately up to 11 years of age in girls and 12 years in boys. There is a crisis of rapid linear growth of the body particularly of the lower

limbs. Individual becomes thinner and the trunk loses its predominance and appears smaller with respect to the legs. Sexual morphological differentiation begins during this period.

Adolescence

During this period the future adult biotype are set Adolescence in girls usually starts and ends two years before boys. It is from 11-12 to 15-16 in girls and from 12-13 to 17-18 years in boys. This period is characterized by the maturity of the genital organs and the appearance of secondary sex characters and modifications in body proportions. The annual mean increment in stature is 7 cms in boys from 14 to 15 years, but only 3 cms between 16 and 17 years (Comas, 1960).

Adulthood

The attainment of adult stature is one of the hallmarks used to mark the transition from adolescence to adulthood. Height growth stops when the long bones lose their ability to increase in length. Reproductive maturity is another hallmark of adulthood (Bogin, 1991). There is a lack of precisely timed or sequenced physiological events. Most tissues lose the ability to grow by hyperplasia but many may grow by hypertrophy. Homeostasis or stability and resistance to pathological influences is another feature of adulthood

http://www.mizostory.org

Old age and senescence follow the prime years of adulthood. The pattern of decline varies between individuals, so there is no biological or genetic plan for the ageing process.

Factors affecting growth

The body proportion differences between geographic populations are usually explained in terms of genetic model. Studying the variations between populations, another approach is also prevalent i.e. comparing children and adults of different national or geographic backgrounds living in the same or very similar environments. Genes do not directly cause growth and development, rather the expression is mediated by several biological systems operating within an environment appropriate for growth.

Growth and development therefore depends on the following factors:

1) Hereditary factors
2) Environmental factors
    a. Physical environmental factors
    b. Social environmental factors
3) Endocrine factors

Growth depending on hereditary factors is indicated by the differences found in the amount and / or rate of growth between children and adults of different national or geographic backgrounds living in the same or very similar environments. The genetical control of body shape is much more rigorous than that of size (Tanner, 1978).

Familial correlations have been used to examine the hereditary component of variation in many body measurements (Little *et al*., 1987). Studies focusing on this are many, among them on populations of European ancestry are (Tanner and Israelsohn 1963; Bielicki and Welon, 1966; Susanne 1975 and Mueller, 1977) and of non-European ancestry (Martorell *et al*., 1977; Mueller, 1977; Roberts *et al*., 1978; Mueller and Malina, 1980 and Mueller and Pollitt, 1983).

A difference in height and weight velocity between the early, average and late maturers has been found by Hägg and Taranger (1991). Thus final height varying significantly between the late maturing boys and the other two maturing groups of boys averaging 6.5 cms and 4.2 cms respectively.

Twin studies offer a more direct methodology for delineating the influence of heredity on growth. This genetical control operates throughout the whole period of growth; skeletal maturity shows a close correspondence at all ages in identical twins. The time of eruption of the teeth, both deciduous and permanent and also the sequence in which they calcify and erupt, is largely determined by heredity (Tanner, 1964). Robson (1978) estimated that genetic factors account for about 34 per cent of the variance is due to fetal genotype. Thus, the higher than expected concordance in the birth weight of DZ twins is likely to be due to the shared maternal environment, which sets some common limits to the

growth of both twins. Similar long-term differences in growth between MZ twins of markedly different birth weight have also been reported by Falkner (1978).

Theoretically the familial correlations show a measure of genetic similarity but are also equally a measure of environment. This was well demonstrated by Mueller and Pollitt (1983). Roberts *et al*., (1978) emphasized that differences between generations, and between older and younger siblings in the intensity of environmental stresses would tend to lower familial correlations and heritability estimates.

Hereditary diseases and chromosomal aberrations may affect growth. Turnerôs syndrome, Klinefelterôs syndrome and other x chromosomal abnormalities affects the growth of stature.

In general a particular environment may prove highly suitable for a child with certain genes and highly unsuitable for a child with others. Thus as per Tanner (1964) it is very difficult to specify quantitatively the relative importance of heredity and environment in controlling growth and physique under any given circumstances.

Environmental Factors

Prenatal Growth An inhibiting effect on fetal growth is exerted by illness in the mother, malnutrition, therapeutic drug treatment, alcohol and other social drug addiction and cigarette smoking. Environmental conditions account for about 60% of the variability of birth weight and genetic factors for the remaining 40% (Polani 1974). Environmental factors among others also include maternal age, order of birth and crowding within the uterus (Giovannelli *et al*., 1989).

Postnatal Growth

Altitude

High altitude environment, that is at an altitude of 3000mts above sea level or higher imposes a number of stresses like hypoxia, cold, high solar radiation, low humidity, high winds and rough terrain. Since these stresses could not be overcome by any cultural or behavioural adaptation, according to Muller et al., (1978) it results in differences in growth. They have found that among high attitude population in tropical areas of the world, growth in linearity appears to be depressed while expansive growth of chest is to be expected. Final size is considerably more gene influenced as altitude effects are greater in children than adults.

Climate

A relatively large body volume and small surface area (i.e. relatively short extremities in proportion to trunk size) is the body type best suited for heat retention in cold environments. In hot environments, a thin subcutaneous layer of fat would help minimize heat retention (Bogin, 1991). For healthy

individuals, winter is season of minimum weight gain for children and the time of maximum weight loss for adults. It occurs simultaneously with maximum height gains (Bogin, 1979). It is suggested that seasonal periodicity in sunlight may act on human endocrine system so as to synchronize changes in growth regulating hormone activity with changes in sunlight availability or intensity.

Season of year

Growth in height is on average found to be fastest in spring and growth in weight fastest in spring and growth in weight is fastest in the autumn. Tanner (1964) says that individual children differ both in the time which they show a seasonal trend, which may be because of variation in endocrine reactivity.

Nutrition

The effect of micro-socio cultural factors associated with economic conditions was studied by Bharati and Basu (1990) on the Mahishya caste population of West Bengal. They found an increase in the anthropometric measurements with the improvement in economic conditions in both sexes.

Therefore, it could be seen that some of the socio-economic and socio cultural factors which forms a part of the micro environmental surroundings of the people sometimes affect the individual directly and others exert their influence through intermediate mechanisms, e.g., nutrition.

Environmental stress, particularly nutritional deficiencies and associated infections, reduces childhood growth rates and delays maturation (Eveleth and Tanner, 1976). Preschool children are more sensitive to environmental insults than school children (Scrimshaw and Behar, 1965; Stini, 1971; Yarbrough *et al*., 1975). The quantities of nutrients and their proportions within the diet interact with other variables such as physical activity and health status to regulate, to a significant extent, the rate of growth. Essential nutrients are defined as those that people cannot produce naturally from simpler elements and if eliminated from diet of an otherwise healthy, well-fed individual will result in growth failure. The exact nature of the nutritional ecosystem differs markedly from one society and one socioeconomic level to another. The level of nutrition in a community, especially of its vulnerable young child population may be considered as being due to the numerous interacting ecological forces which Jelliffe (1968) has shown in the expression:

$$\text{Community level of nutrition} = \frac{\text{Education level} \times \text{Economic level} \times \text{Aspect of health [conditioning infections/ preventive services]}}{\text{Population size}}$$

Each of the components of the expression affects the community nutrition level directly and via the other factors indicated. The factors that influence the level of nutrition directly also include the agronomic factors, medical, sanitation and cultural factors.

Physical growth involves minimally two components -- status (size attained and rate (tempo). Growth rate reflects current nutritional status, while growth status is more related to nutritional history (Buschang and Malina, 1983).

Migration and Urbanization

Since migration redistributes the genetic, physiological, morphological and socio cultural differences found in human populations, some effects are likely on growth and development of migrants and the recipient populations (Bogin, 1991).

Mascie-Taylor (1984) reviewed geographic and social mobility in England and found that the effects of selection are additive; migrants tended to be the taller individuals of any geographic area and the taller individuals within any social class. Higher socio-economic status can, by itself, lead to increased body size and rate of maturation. To Mac Beth (1984) differences in socio economic status confound any unique biological differences between migrants and sedentes. Further confounding the fact that there is greater tendency for tall individuals to achieve higher socio-economic status (Tanner, 1969; Bielicki and Charzenski, 1983). However, the predominant selection of migrants seems to be for socio economic status rather than for tallness.

Bindon and Zansky (1986) found that the children from Western Samoa (traditional) were significantly shorter, lighter and lighter for height than their counterparts in American Samoa (modern) and Hawaii (migrant). The major influence on height and weight appears to be modernization (Western versus American Samoa), with migration (American Samoa versus Hawaii) playing only a small incremental role (significantly only for weight among boys) to them.

Socio-Economic Status

Bielicki and Welon (1982) listed four primary factors : higher socio economic status allows for better nutrition, better health care, reduced physical labour for children and greater growth promoting psychological stimulation from parents, schools, and peers. The influence of education, occupation, income, and housing on growth has become evident as well as the specific effects of each measure alone and in combination. With separate measures of socio-economic status it is possible to fractionate the influence of education, income and occupation on both growth and size (Garn et al., 1978).

It has been known that children of lower socio economic status are generally smaller and mature less rapidly, and have less muscle mass and skeletal mass, but more fat mass than individuals of higher

socio economic status (Garn and Clark, 1975; Eveleth and Tanner, 1976; Fulwood et al., 1981, Clegg, 1982; Malina *et al*., 1983; Bogin and Mac Vean, 1984; Majones, 1987). Mascie ï Taylor and Boldsen (1985) found that within Great Britain, geographic variations in climate, diet and genetic growth potential are subordinate to socio economic status as determinants of growth in height with a shorter height from low socio economic status families. Rona and Chinn (1986) in England and Malina *et al*.,(1981) in Oaxaca, Mexico showed that children from the lowest socio economic status segments of the city were smaller than national averages of rural children.

The effect of micro socio cultural factors associated with economic conditions was studied by Bharati and Basu (1990) on the Mahishya caste population of West Bengal. They found an increase in the anthropometric measurements with the improvement in economic conditions in both the sexes.

Therefore, it could be seen that some of the socio-economic and socio cultural factors which forms a part of the micro environmental surroundings of the people, sometimes affect the individual directly and others exert their influence through intermediate mechanisms like nutrition.

Secular Trend

The striking tendency for children to become progressively larger at all ages has been noticed. This trend is at present continuing in India and other third world countries. This trend in children's size is due both to earlier maturation culminating in final adult height being reached earlier and as per Tanner (1964) this adult height has also increased. Better nutrition and generally improved environmental circumstances are usually cited as the cause of it. The secular trend, both in earlier maturation and in greater size, is one of the most considerable phenomena of human biology as stated by Tanner.

Endocrine factors

There are several hormones that have an effect on growth and developments. In addition, there are a group of substances known as growth factors which acts independently and interactively with each other and with hormones.

Thyrotropin releasing hormone (TRH), secreted by hypothalamus, stimulates the release from the pituitary of thyroid stimulating hormone (TSH). The TSH acts on the thyroid gland to promote the release of two hormones, thyroxine and triiodothyronine. Thyroid hormones are needed for normal growth in stature, the development of normal body proportions, formation of bone from cartilage and formation of the teeth. Thyroid hormones have an important role in the maturation of brain enzyme systems and myelination.

Gonadal hormones: The pituitary secretes two hormones that regulate gonadal activity: luteinizing hormone (LH) and follicle stimulating hormone (FSH). In women they stimulate the growth of the

ovaries and the release of estrogens. In men, FSH promotes the production of spermatozoa and LH stimulates the secretion of androgens. Gonadotropins, estrogens and androgens have major influences on human development. Relatively high levels of estrogens and androgens are present in the bloodstream of the infants and it is correlated with the rapid velocity of physical growth, neurological development, motor control and cognitive advancement that occurs during infancy (Grumbach *et al*., 1974). Preece (1986) find that rising levels of testosterone and estradiol significantly correlated with growth rate during puberty and a cause of adolescent growth spurt.

Adrenal hormones: The cortex of the adrenal produces two classes of hormones: glucocorticoids and androgens. The control of adrenal androgen production may involve the activity of glucocorticoids and their pituitary stimulating hormone called adrenocorticotropic hormone (ACTH) (Bogin, 1991). Katz *et al.*,(1985) found a positive correlation between levels of adrenal androgens, skeletal maturation and fatness in adolescent boys. They have suggested that adrenarche may be one of the endocrine events that promotes maturation and determines, in part, adult proportions and body composition.

Hypothalamic and Pituitary: Gonadotropic releasing hormone (GnRH) by the hypothalamus, LH by the pituitary and testosterone by the testes are increased at night time is a first endocrine sign of puberty in boys (Grumbach *et al*., 1974).

Pineal gland and melatonin: GnRH, LH and gonadal hormone secretion is inhibited during childhood and stimulated with the onset of adolescence, may be is because of pineal gland. Pineal gland help regulate puberty. Silman *et al.* (1979) found daytime levels of circulating melatonin relatively high in early childhood and dropped to low levels in early to mid adolescence.

Growth hormones and growth factors

Growth hormone (GH) is synthesized and secreted by anterior pituitary gland. A hypothalamic hormone, growth hormone releasing factor (GHRF) stimulates the synthesis of GH and cause the release of GH into bloodstream (Barinaga *et al.*, 1985). Another hypothalamic hormone, growth hormone release-inhibiting hormone, also called somatostatin has an anti secretory effect on GH.

Another class of growth promoting substances are called the somatomedins or insulin-like growth factors (IGFs). IGFs have an important role in normal and abnormal growth. IGFs levels were found to be highest for boys at the time of peak growth velocity in height by Preece *et al.*, (1984).

Other pituitary hormones such as prolactin, melanocyte stimulating hormone, vasopressin, oxytocin and their hypothalamic releasing or inhibiting factors are necessary for normal metabolic activity, the maintenance of the placenta and foetus, birth and other life sustaining processes. Non-pituitary hormones play a similar vital role (Bogin, 1991).