Chapter I
INTRODUCTION

Anthropology is a science, which deals with the comparative study of man as a physical and cultural being. It has two main branches – cultural or social anthropology and physical anthropology. Cultural anthropology studies man as a cultural being, his works, behaviour, social patterns etc. while physical anthropology is concerned with the study of human biological evolution and variation.

The primary aim of the contemporary physical anthropological and human population genetic researches has been to expound the nature of biological variations in different human populations as the meaning of these differences in the understanding of the ongoing evolutionary process. But the systems used have been varying from time to time based on the technological development as well as the nature of the subject. Among the other systems regularly studied in this context, human dentition is of special interest and occupies important place long since (Rami Reddy, 1986).

‘Dental anthropology’ a sub-branch of physical anthropology is a term used as early as 1900 when the subject gained academic and research importance (Turner II, 1978), although its root lay in the seventies of the 19th century, has shown by a number of investigations. The different aspects that can be studied under this sub-branch of anthropology are morphology, metrics, health, evolution, growth, genetics, usage, forensics and ethnographic treatment-all serving as research tools and areas of academic and applied studies (Rami Reddy, 1986).
“Dental anthropology is defined as a study of people (and their close relatives) from the evidence provided by teeth” (Hillson, 1996). Dental anthropology is a subfield of physical anthropology under the broad discipline of anthropology which is concerned with the study of human teeth - one of the anatomical systems of man. One of the main themes of dental anthropology has been a study of variation in size and shape of the teeth, as recorded in casts of living mouths or seen in the skulls of archaeological and fossil collections. Dental anthropology studies the variation in size and shape of the teeth, the development of teeth in relation to age, their appearance in the mouth, and the processes of wear and other changes that occur once they are in place. It also includes the microscopic traces, preserved inside the tissues of the teeth, of the growth and ageing processes. Yet another area of interest is the study of dental diseases in relation to diet and other factors, and the most recent development is the study of the biochemistry of dental tissues (Hillson, 1996).

Many contributors to this area of research come from fields outside of anthropology, notably dentistry, genetics, anatomy, and palaeontology. It encompasses a broad range of subjects which, in turn, have finer levels of specialization. Some workers concentrate on developmental aspects of the dentition, from tooth germ formation to developmental defects of crown. Others focus on post-eruptive changes such as ordinary crown wear and culturally-prescribed dental modification. The study of dental pathologies, in particular caries, patterns of tooth loss, and periodontal disease, provides yet another avenue of research. Researchers interested in those elements of human
dentition that have some underlying genetic basis of study of tooth size and morphology (Cadien, 1972).

Teeth being the hardest and most durable materials of all parts of the body due to the presence of enamel and dentine in them preserve well and hence account for a large proposition of the human and pre-human fossils remains available for study. The environment has revealed by many a study postulating modes of inheritance for different dental traits (Kraus, 1951; Turner II, 1967). Dental anthropology is academically located within the human bone biology studies. Its main goal is to recognize attributes in the teeth form which can help us create bicultural dynamics of human populations, specially related to health–illness state, feeding habits and micro evolutionary transformations, related themselves to the ethno genesis of current and ancient times. In Dental anthropology, teeth are used to obtain information on culture, health, diet, variability and evolutionary trends as well as eruption and dental pathologies in the past and modern populations.

The abundant published literature available on the Southeast Asian, East Asian and Pacific populations demonstrates the existence of similarities and dissimilarities in the distribution of frequencies of different dental characteristics among different populations which are as notable and significant as those that can be encountered in other biogenetic markers such as blood-groups and red cell enzymes, demographics, etc. that greatly render it possible to compare and classify populations. The large genetic component and high habitability of dentition have been demonstrated by a number of genetic studies, which facilitated the postulation of the modes of inheritance for various
dental traits (Lundstrom, 1948 and 1963; Kraus, 1951; Turner II, 1967 and Cadien, 1972). More such work is, however, necessary to substantiate these hypotheses.

In most of the foreign countries dental anthropological researches till recently were devoted to bring to light phenotypic trait frequencies and their distribution pattern basing on which attempts were made to contemplate on the question of population interrelationships. In recent years, however, emphasis has been shifted to the study of dental genetic and development to deduce conceptual model explaining the ways in which the genes operates in bringing about dental variations and their adaptive nature as reflected in the cultural and behavioral changes occurring in different populations in time and space. Cadien (1972) opines thus: “... there are definite genetic factors that influence the entire dentition, those that affect only certain groups of teeth; and those that act upon single tooth. These must be sorted out before the differences between human populations can be fully understood”.

While this tremendous turnout of research work of high quality and great intrinsic value in dental anthropology of foreign populations resulted in abundant body of published literature outside India, while very few studies at micro or macro-levels has been done in India in general and Northeast India in particular.

Uses

Dental anthropology much like those of other subfields of anthropology can be applied to the welfare of the mankind in the areas of dental development, pathology, morphology, forensic deontology and odontometry. The area of dental development can be used in the application of tooth eruption times and calcification standards in the
nationwide nutritional survey, in the diagnosis and treatment of children with growth disturbances, in solving a number of orthodontic problems including malocclusion, in the age estimation of skulls of unknown age, in the evaluation of racial differences and primate evolution, in the determination of personal identity or individuality of persons involved in different crimes-accidents-explosions etc. and tooth formation standards based on the study of crown and root development of teeth in clinical assessment of early or late dental maturity.

In the area of dental pathology, dental caries and periodontal disease are the most common oral problems of man. In view of the alarming increase in the prevalence rates of these diseases in the human populations, it is of utmost importance to study these diseases in relation to different demographic, socio-economic, environmental and hereditary factors to delineate standards and levels of health for the public health planner to devise and extend preventive and treatment services to the well-being of one and all.

While the area of dental morphology is generally used in the understanding of biological history and racial classifications of human populations as also in micro-evolutionary studies, it is necessary to assess the incidence of malocclusion cases in relation to a number of genetic and non-genetic factors to plan and gear up treatment needs.

In the area of forensic deontology, teeth identification made by employing different methods and sophisticated equipment can be used linking the victim or the suspect to a particular crime/accident. Similarly, in the area of odontometry, standards of tooth size are applied in the personal identity or establishment of the individuality of a
person, and also in orthodontic diagnosis and treatment. Norms of tooth size, dental arch size and shape, tooth spacing and crowding obtained in relation to different variables can be used as a frame of reference to understand those of individual subjects viewed and their practical implications. It is urgently needed to undertake carefully planned research investigations into the dental anthropology of the people to obtain and standardize the findings for application to different situations concerning their oral health, forensic and related problems in India in general and Northeast India in particular. Tooth morphology provides few clues as to age, sex, body size, elapsed time since death, etc., so its primary usage is in discerning the ethnic affiliation or race of an individual (Scott and Turner II, 2000).

**History and development**

In pre-Darwinian times, the nascent field of physical anthropology focused on human racial variation and classification. Teeth played almost no role in these early discussions, as workers focused on externally visible characteristics like skin, hair, eye colour, hair and nose form, stature, etc. By the end of the nineteenth century with but few exceptions teeth had yet to enter anthropological consciousness in any significant way (Scott and Turner II, 2000). Dental anthropology began in the eighties of the eighteen century when physical anthropological investigations centered mainly round the analysis of the morphology of the skeletons and teeth, though as a subject of academic research, its importance was not recognized until 1900. The root of the dental anthropology lay in the seventies of the 19th century as shown by a number of investigations, when the subject got its breakthrough for the first time.
In 1927, Krogman published the first comprehensive review of research on primate dentition. This hundred page treatise, comprising an entire issue of the journal of dental research, should be considered a cornerstone in the field. It is obvious that to Krogman (1927), dental anthropology included the study of dental growth, theories of dental origin, primate dentition and population variation.

Following Krogman's work, research on dental anthropology proliferated in numerous anthropological and dental research journals. In addition, there were a number of special journal issues, dissertations, monographs, and books developed to this subject (e.g. Moorrees, 1957; Wolpoff, 1971; Kurten, 1982; Rami Reddy, 1985). In the American Journal of Physical Anthropology alone, annual report of the editorial notes that dental papers comprised about 11% of the total manuscripts submitted in 1985. This is not a new trend, but rather a continuation of interest that has existed since the early days of the journal. While anthropology was very much alive on the individual level, there was no forum in which to communicate with others in the field to facilitate the exchange of ideas. The Dental Anthropological Association (DAA) was officially created in 1986 during the American Association of Physical Anthropologists (AAPA) meeting in Albuquerque, New Mexico, and established the 'Dental Anthropology Newsletter' as its official publications. Since its inception, the DAA has sponsored symposia and scientific sessions where it exemplifies the diversity in dental anthropology, including interest in recent and archaeological populations as well as variation in methodological approaches and scientific results.
The term Dental anthropology first appears in the title of an article published in 1900 by George Buschan, although Klatsky and Fisher are credited with its formal introduction. The field is rooted in French, German, and English encyclopedic mammalian deontological treatises of the past two centuries. That teeth poses qualities valuable for anthropological study (i.e. they are durable; evolutionary conservative and yet adaptable; rich with genetically determined traits; and reflective of behaviour, ecology, and diet) was recognized by such 19th century natural historians as L. Rousseau, G. Koch, J. Henle, and R. Owen.

In the early 20th century, scholars began to pay attention to teeth as an additional system that began to provide insight into human variation. Most of the emphasis was on human skeletal remains because techniques for making impressions of the living were limited. Ales Hrdlicka, who had access to an enormous sample of Native American skeletal remains at the Smithsonian Institution, was among the first to note interesting dental morphological distinctions between major human groups. In particular, Hrdlicka (1911, 1920) noted that American Indians were distinguished from other human populations by the development of pronounced marginal ridges on the lingual surface of the upper incisors (i.e. shovelling). W.K. Gregory (1922), in his opus the origin and evolution of the human dentition, also noted morphological attributes of recent humans, but he did not feel that intergroup variation was pronounced or significant.

Although Hrdlicka authored many books, he never wrote one devoted entirely to teeth. The task was left to other pioneers in this field, including T.D. Campbell (1925) in Austria and J.C.M. Shaw (1931) in South Africa. These workers studied the size,
morphology, number, wear, and pathology of Australian aboriginals and South African black populations, respectively. Given the paucity of Comparative data, their books were largely descriptive in nature. To complement these early dental monographs, other significant contributors during this period include R.W. Leigh's (1925) analysis of oral pathology under varied environmental conditions, W.M. Krogman's (1927) paper on anthropological aspects of human teeth, C. Nelson's (1938) study of the Pecos Pueblo population, and M.S. Goldstein's (1948) work on the teeth of Texas Indian crania. Other key contributions at this time were Percy Butler's (1937, 1939) articles on the field effect in the mammalian dentition one of the most influential papers in the history of dental anthropology, A.A. Dahlberg's (1945). "The changing dentition of man" applied Butler's concept of dental fields to human teeth, forever changing the minor in which anthropologists would analyze metric, morphologic, and numeric variation in the dentition.

P.O. Pederson's (1949), The East Greenland Eskimo Dentition, with its extensive set of observations on Inuit and a bibliography citing articles in a diverse array of languages, ushered in a new age for dental anthropology. At this time, following key theoretical developments that led to the modern evolutionary synthesis, anthropologists started paying more heed to genetics and process, and less to typology and classification. G.W. Lasker's (1950) paper "Genetic analysis of racial traits of the teeth" set the stage for new ways of thinking about the inheritance and utility of dental morphological variation. In the late 1940's, Dahlberg (1951) initiated a major dental casting project among the Pima Indians of Arizona. After modest beginning with plaster casts made
from wax bite impressions, Al and Thelma Dahlberg went on to collect over 8000 Pima Indian casts. From this foundation, Dahlberg was able to build up some of the first characterizations of the extant American Indian dentition.

The 1950’s saw a flurry activity in the anthropological uses of the teeth. C.F.A. Moorrees (1957) published ‘The Aleut Dentition’, which covered all facets of dental anthropology, from size, morphology, and number to pathology and oral tori. T. Murphy (1959a, 1959b) developed new standards for scoring tooth crown wear based on the pattern of dentine exposure, a scheme that provided for more information on wear than the Broca scale of the late 19th century. Lasker (1950) discussed the potential uses of dental morphology in the interpretation of forensic remains, while Bertram Kraus (1951, 1957) conducted pioneering work in dental genetics and odontology. S.M. Gam, along with his colleagues at the Fels Institute, began publishing dozens of articles that focused on dental variation, development, and interactions between variables.

Although the term “dental anthropology “had been used earlier, one of the crystallizing events of the field was the publication of Dental Anthropology, edited by Don R. Brothwell (1963). This work emanated from the Symposia of the Society for the Study of Human Biology. A perusal of the contents is telling. Of 15 contributions, 3 dealt with primate teeth, 1 with fossil hominid teeth, and 11 with recent human populations. That balance approximates the overall focus of dental research during the middle of the 20th century.
Following the publication of dental Anthropology, the field greatly expanded in terms of practitioners and publications. From 1963 to the present, many articles and dissertations have dealt with various aspects of the human dentition. Topical trends include an ever increasing emphasis on methodologically standardized studies of tooth crown and root morphology dimensions, increased interest in oral health concerns, especially the negative impacts of agriculture, and a greatly expanded interest in the study of developmental stresses measured by growth defects, in particular linear enamel hyperplasia. The International Symposium of Dental Morphology, which met in 1965, would meet on regular basis across the next decades, leaving in its wake a number of significant edited volumes that highlighted current research on dental ontogeny, genetics and variation.

Recent development in the fields, since 1991, there has been at least 3 broadly influenced developments in the fields (1) the Dental Anthropology Association founded in 1986, enlarged the size of its small Newsletter, changed name to Dental Anthropology, and adopt at the standards and styles of a professional journal, all carried out under the editorship by Alice M.(Sue) Haeussler, (2) English translations were made for the large and largely unread body of dental anthropology studies written in Russia, and a dental anthropological research programme was initiated in the People’s Republic of China, (3) the publication of several books designed to be used as textbooks, as well as scientific references, in dental anthropology. There are, of course, many other advances since 1991, including increased course offerings in dental anthropology in a number of universities and colleges, continued publication of the assembled papers for.
the International Dental Morphology meetings, development of new methods, descriptions of new fossil dentitions, and new synthesis on human and non-human dental variation among other subjects.

**Dental Eruption**

Historically, the term eruption has been used to denote the tooth emerging through the gingiva, but then it became more completely defined to mean continuous tooth movement from the dental bud to occlusal contact. However, not all tables of dental chronologies reflect the latter definition of eruption; the terms eruption and emergence are used here at this time in such a way as to avoid any confusion between historical use of eruption and its more recent expanded meaning.

Emergence of the primary dentition takes place between the sixth and thirtieth months of postnatal life. It takes from 2 to 3 years for the primary dentition to be completed beginning with the initial calcification of the primary central incisor to the completion of the roots of the primary second molar. The emergence of the primary dentition through the alveolar mucous membrane is an important time for the development of oral motor behaviour and the acquisition of masticator skills (Bosma, 1963). At this time of development, the presence of “teething” problems suggests how the primary dentition can affect the development of future neurobehavioral mechanisms, including jaw movements and mastication. Learning of mastication may be highly dependent on the stage and development of the dentition (e.g., type and number of teeth
present and occlusal relations); the maturation of the neuromuscular system, and such factor as diet.

Dental eruption is generally defined as the time when any part of the crown has emerged through the gingival surface (Rami Reddy, 1986). The term emergence refers to the moment any portion of the crown pierces the gingiva. Actual penetration of the gingiva is merely a transitory stage in the total process of tooth eruption. It refers to the movement of a tooth towards its final occlusal position. The process by which the crown of the developing tooth passes through its interrosseous surroundings and is maintained in normal occlusion within the oral cavity is known as tooth eruption. Tooth eruption is generally defined as the time when any part of the crown of the tooth has emerged through the gingival surface. In the words of Rabinow (1973), “... dental maturation is a continuum, comparable to skeletal maturation. One may calculate dental ages through the entire growth period, from foetal life to adolescence, by accessing stages of tooth formation, crown calcification, root development and eruption status from appropriate roentgenograms (oblique jaw views or pantomograms) and comparing the developmental status of each tooth with appropriate norms”.

The age and order of eruption of deciduous and permanent teeth show as much marked variation between one individual and the other as among the different racial groups within the same region or outside. As such Hellman (1923), six decades ago, remarked: “The arrival of a comet which makes its appearance once in many years, can be accurately calculated to a small fraction in time, but notwithstanding the inestimably greater frequency with which the event of eruption occurs, the appearance of a tooth
defines accurate forecast”, which is perhaps valid even today. Therefore, one can establish a trend or a constant if a larger sample is studied from a racial group.

Unlike in permanent teeth eruption times there is no significant difference in the eruption times of deciduous teeth in children of same physical health in many ethnic groups as well as between males and females, through the role of genetic factors has been shown by twin studies. After the crown and part of the root are formed, the tooth penetrates the mucous membrane and makes its entry into the mouth. Further formation of root is supposed to be an active factor in pushing the crown towards its final position in the mouth. Eruption of the tooth is said to be completed when most of the crown is in evidence and when it has made contact with its antagonists in the opposing jaw. Eruption may and usually does continue after this; i.e. more of the crown may become exposed and the tooth may move further occlusally to accommodate itself to new conditions.

**The Primary/Deciduous Dentition**

There are totally 20 teeth in children and 32 in adults. The teeth in children are known as deciduous or primary teeth. The teeth in adults are known as permanent teeth. The primary tooth remains intact until a child is about 6 years of age. From 6 years onward permanent teeth start appearing in the mouth replacing the primary teeth, i.e. the permanent teeth occupy the place where the primary teeth were present. When permanent teeth start erupting, the primary or deciduous teeth fall off that is called
shedding. Thus, 20 deciduous teeth are replaced by 32 permanent teeth. The total teeth are collectively called dentition, i.e. deciduous dentition and permanent dentition.

Three different types of teeth are present in the deciduous dentition.

1. Incisors
2. Canines
3. Molars

The number and type of teeth present in the oral cavity in one of the face (either left side or right side) in primary dentition are expressed by the following formula.

\[
\frac{2}{i} + \frac{1}{c} + \frac{2}{m} = 10
\]

In this formula each tooth is represented by its initial letter. ‘i’ for incisor, ‘c’ for canine and ‘m’ for molar. Each letter is followed by a horizontal line and the number of each type of tooth is placed above the line for maxilla (upper jaw) and below the line for the mandible (lower jaw). The formula includes one side only. The above formula should be read thus:

Incisors – two maxillary and two mandibular
Canines – one maxillary and one mandibular
Molars – two maxillary and two mandibular (Kumar, 2007).

The entire deciduous dentition is designated by the notation:
The Permanent Dentition

The permanent set of teeth which are 32 in number are larger in size and continue to function throughout the life span of an individual if well cared for. These teeth start eruption, generally, from the age of 5 1/2 to 6 years and have fully erupted and come into occlusion by the age of 21 years or so. All the deciduous teeth are replaced by the permanent teeth during the age of 6 to 13 years. The care of deciduous teeth is equally important as care of the permanent teeth because they not only function in the early childhood but they also act as guides to permanent (development) successors as well as help in proper development of the jaws. The diseases which affect the deciduous teeth could also be passed on to the permanent teeth.

The transition to the permanent dentition begins with the emergence and eruption of the first permanent molars, shedding of the deciduous incisors, and emergence and eruption of the permanent incisors. After the shedding of the deciduous canines and molars, emergence and eruption of the permanent canines and premolars, and emergence and eruption of the second permanent dentition is completed except for the third molars. The permanent or succedaneous teeth replace the exfoliated deciduous teeth in a sequence of eruption that exhibit great variety. The number of teeth in adults, including third molars when present, is 32.

The permanent dental formula in human is:

\[
\begin{array}{cccc}
I & C & P & M \\
2 & 1 & 2 & 3
\end{array}
\]

\[= 16\]
In a clinical notation system for the permanent dentition, the maxillary teeth are numbered from 1 to 16, beginning with the right third molar. Beginning with the mandibular left third molar, the teeth are number 17 through 32. Thus, the right maxillary first molar is designated as 3, the maxillary left central incisor as 9, and the mandibular right first molar as 30. The entire dentition is designated by the notation:

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1 2 3 4 5 6 7 8  |  9 10 11 12 13 14 15 16
32 31 30 29 28 27 26 25  |  24 23 22 21 20 19 18 17
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The usual order in which the permanent teeth appear is as follows:

1. First Molars
2. Mandibular Central and Lateral Incisors
3. Maxillary Central Incisors
4. Maxillary Lateral Incisors
5. Mandibular Canines
6. First Premolars
7. Second Premolars
8. Maxillary Canines
9. Second Molars
10. Third Molars.
It has been suggested that a certain sequence or eruption of the teeth is considered to be favourable to the development of a normal occlusion.

**Major contrasts between primary and permanent teeth**

In comparison with their counterparts in the permanent dentition, the primary teeth are smaller in overall size and crown dimensions. They have markedly more prominent cervical ridges, are narrower at their “necks”, are lighter in colour, and have roots that are more widely flared; in addition, the buccolingual diameter of primary molar teeth is less than that of permanent teeth (Finn, 1957). More specifically, in comparison with permanent teeth, the following differences are noted:

1. The crowns of primary anterior teeth are wider mesiodistally in comparison with their crown length than are the permanent teeth.

2. The roots of primary anterior teeth are narrower and longer comparatively. Narrow roots with wide crowns present an arrangement at the cervical third of crown and root that differs markedly from the permanent anterior teeth.

3. The roots of the primary molars accordingly are longer and more slender and flare more, extending out beyond projected outlines of the crowns. This flare allows more room between the roots for the development of permanent tooth crowns.

4. The cervical ridges of enamel of the anterior teeth are more prominent. These bulges must be considered seriously when they are involved in any operative procedure.
5. The crowns and roots of primary molars at their cervical portions are more slender mesiodistally.

6. The cervical ridges buccally on the primary molars are much more pronounced, especially on the first molars maxillary and mandibular.

7. The buccal and lingual surfaces of primary molar are flatter above the cervical curvatures than those of permanent molars, thereby narrowing the occlusal surfaces.

8. The primary teeth are usually less pigmented and are whiter in appearance than the permanent teeth.

**Dental Caries**

Dental caries or tooth decay and pyorrhea or periodontal diseases are the commonest diseases of the mouth. The former being the disease of the tooth proper and the later, that of the supporting structures of the tooth. Both these disease have afflicted not only the human races all over the world since pre-historic times up-to-date but also the non-human primates.

Dental caries is a pathological condition of the teeth resulting in the decalcification of the dentine or enamel and the disintegration of the remaining organic material often leading to the loss of the teeth and occurs in association with other conditions such as periodontal disease, which causes recession of the alveolar bone resulting in loosening of the teeth and their subsequent loss; dental enamel hypoplasia, which is a developmental enamel defect is the deciduous and permanent teeth seen as
transverse lines, pits, and grooves on the enamel surface; ante-mortem or tooth loss; and attrition, which is the gradual wearing away of the hard parts of the teeth.

The FDI (International Dental Federation) Commission on Classification and Statistics for Oral Conditions (COSTOC) in its recommendation to the World Health Organization, on the classification of epidemiologic studies of dental caries and definitions of related terms (1975), defined dental caries “as a localized, pathologic process of bacterial origin, that results in the demineralization of the hard tooth structures and progression to cavitation. Caries, being a disease process, starts with a microscopic cavity. Hence, it is necessary to specify tooth decay as dental caries ...”. It is characterized by the molecular decay of bone softening the enamel and dentine in which it becomes thin and dark and usually breaks down with the formation of pus. It is generally held that there are micro-organisms of the type Lactobacillus acidophilus odontolyticus in the mouth which are cariogenic in nature and produce acids by acting on food debris lodging around the teeth. These acids largely dissolve the hard tissues of the teeth leading to dental caries. German scientists named Leber and Rottenstein in 1867, and Underwood and Mills in 1881, propounded the Acidogenic theory based on the experiments conducted on animals. Experiments confirmed this facts, because the existence of micro-organisms in man’s mouth is necessary to ensure the physiological functions in the body, although it is still unknown which type of micro-organism or virus is responsible for the disease as many kinds of them produce acids under varying circumstances ranging from neglect of oral hygiene to sugar containing food debris.
James (1979) lists a number of contributory factors causing tooth decay which he divides into two broad categories namely- intra-oral and extra-oral causes. Included in the intra-oral causes are the dental plaque consisting of food and bacteria in a creamish film sticking to the teeth; anatomy of the tooth – shaped, form and structure; position of the teeth; dental appliances and restoration; and lack of saliva flow. The extra-oral causes are hereditary; high sugar intake, nutritional deficiency in calcium, phosphorous, fluorides, vitamins A, C and D and proteins, soft foods, and bottle feeding. Laus (1981), however, reduces them only to four to five well known factors which cause dental caries; low fluoride levels in drinking water, food products containing large quantities of sugar, bad childhood health in general, and inadequate quantities of saliva and disturbance of its optimal composition. Hereditary predisposition of dental tissue to caries appears to be another factor. The most important factors that contribute to the disease are consumption of food products with increased quantities of sugar and fluoride-lacking drinking water. When the disease acquires a high degree of severity the affected individual finds it difficult to eat and swallow and at times resulting in speech problems and fever.

First of all, there is a loss of polish and translucency of the tooth surface, i.e. it changes the colour from white to brown or black. The area becomes soft and porous and the food starts getting lodged into it. The person becomes sensitive to cold and hot drinks and sweet and sour things. It gives mild to severe toothache depending upon the nearness and involvement of the pulp. The tooth becomes tender and is not able to chew food with it. In Sushruta Samhita the symptoms are described thus: “The tooth becomes
loose and perforated by black holes accompanied by a copious flow of saliva. The appearance of an extremely diffused smell with a sudden aggression of the accompanying pain without any apparent cause is also one of its specific features”. Once the pulp is involved, it becomes a passage for the oral micro-organisms to travel into the bone, smelling appear into that area and other complications of inflammation follow.

Caries of the teeth could be acute or rampant when the susceptibility is very high. Almost all surfaces are affected. Even the very immune areas, viz. the cervical and proximal surfaces of mandibular incisors are involved. The other type is chronic or slow growing. It may involve one tooth or a group of teeth at the same time. There is another type called arrested, where further progress of caries does not take place because the area had become self-clean sample and secondary detain has formed.

It has been labelled as a disease of the Western countries but this is not true. It is very much prevalent in our country. Different surveys conducted in this country reveal that the incidence is on the increase in the developing countries. More and more children are affected by it. It is second important disease next to pyorrhea for loss of teeth in Indians. Shourie (1946) made a comprehensive survey of children from various parts of India. He reported that 44.5% of the children were free from caries which was considered to be much higher than that recorded in children in England and U.S.A. The incidence of caries in deciduous teeth was higher in girls than in boys. Urban children in all age groups showed more caries than the rural children.
Dental and Oral Pathology

Periodontal disease

Periodontal disease is the most common oral health problem of man and also a major problem in modern dental practice. Palaeopathological studies indicate that man has been subject to periodontal disease since prehistoric times, and our earliest historical records reveal an awareness of periodontal disease and need for treating it.

Periodontal disease was the commonest of all disease which there was evidence in the embalmed bodies of the Egyptians of 4000 years ago. Oral hygiene was practiced by the Sumerians of 3000 B.C., and elaborately decorated golden toothpicks found in the excavations at Ur in Mesopotamia suggest an interest in cleanliness of the mouth. In the oldest known Chinese medical work, written about 2500 B.C. by Hwang Fi, oral disease is divided into three types, as follows: 1) FongYa or inflammatory conditions; 2) YaKon or diseases of the soft investing tissues of the teeth; 3) ChongYa or dental caries. Gingival inflammations, periodontal abscesses, and gingival ulcerations are described in accurate detail. One gingival condition is described as follows: “The gingivae are pale or violet red, hard and lumpy, sometimes bleeding; the toothache is continuous”. Herbal remedies, “Zn-hine-tong”, are mentioned for the treatment for these conditions. The Chinese were among the earliest people to use the “chew stick’ as a toothpick and toothbrush to clean to the teeth and massage the gingival tissues.

Among the ancient Greeks, Hippocrates of Cos (460-335 B.C.) was the father of modern medicine, the first to institute a systematic examination of the patients pulse,
temperature, respiration, secretion, sputum and pains. He discussed the function and eruption of the teeth and also the etiology of periodontal disease.

Among the Romans, Aulus Cornelius Celsus (first century A.D.) referred to diseases which affect the soft parts of the mouth and their treatment as follows: “If the gums separate from the teeth, it is beneficial to chew unripe pears and apples and keep their juices in the mouth”. He described looseness of the teeth caused by the weakness of their roots or by flaccidity of the gums and noted that in these cases it is necessary to touch the gums lightly with a red hot iron and then smear them with honey. The Romans were very interested in oral hygiene.

Rhazes (850-923), an Arabian of the Middle Ages, recommended opium, oil of roses, and honey in the treatment of periodontal disease. To strengthen loosened teeth he recommended astringent mouth washes and dentifrice powders. He described a procedure of scarification of the gingiva, and strong counterirritants in the treatment of disease of the gums.

In the fifteenth century, Valescus of Montpellier (1382-1417) stated that in order to treat disease of the gums, tartar must be removed little by little either with iron instruments or with dentifrices. In the fourteenth century and fifteenth centuries references is also made to white wine, roasted salt, and aromatic substances as adjuncts in periodontal therapy.

With the beginning of the eighteenth century dentistry developed the early signs of scientific curiosity which were the precursors of present day research disciplines. Pierre Fauchard (1678-1761), the father of modern dentistry, in the first and second
editions of his epochal treatise “Le ChirurgenDentiste” discussed many aspects of the subject of periodontology. He described chronic periodontal disease as a “kind of scurvy” which attacked the gums, the alveoli, and the teeth.

With the beginning of the twentieth century there developed a prolific group of clinicians and scientists throughout the world with a major interest in the periodontal field. The periodontium is the investing and supporting tissues of the tooth, and consists of the periodontal ligament, the gingiva, cementum, and alveolar bone. The cementum is considered a part of the periodontal ligament. The periodontium is subject to morphological functional variations as well as changes with age.

Pyorrhea or periodontal disease unlike dental caries is the disease of the periodontium or the supporting structures of the teeth namely the gum, alveolar bone, periodical membrane and cementum. Inflammation and dystrophy are the two ways by which the disease of the periodontium occurs. Inflammation of the gums or gingiva results in gingivitis manifested as change in colour, enlargement, bleeding, puffiness, friability, ulceration or sloughing. Gingivitis is the first stage of the periodontal disease when the gums are affected. Accumulation of tartar (calculus), the scaly yellowish or brownish hard chalk-like substance that forms at the gums around the teeth, is the most common cause of gingivitis, others being the bacterial infection, acute necrotizing ulcerative gingivitis, mouth-breathing habit, axis and contour of the teeth, faulty dental fillings, presence of food particles between the teeth, abrasions, cuts, fingernail and fishbone injuries, puberty and pregnancy periods, skin disease, syphilis, tuberculosis, leukaemia or blood cancer, vitamin-C deficiency, etc. Periodontal disease or
Periodontitis is the extension of gingivitis when inflammatory conditions spread to deeper structures leading to characterized by degenerating factors affect the gums and periodontium resulting in the fall of certain teeth. Thus periodontal disease, which is also widespread a disease as dental caries, leads to tooth loss, bad smell tooth spacing, deterioration in the general bodily health, etc.

The term periodontal disease has received different meanings and is used rather ambiguously. It is used in a general sense to encompass all diseases of the periodontium in much the same way as are terms such as liver disease and kidney disease. It may be considered synonymous with periodontopathia, although this term is not in current use.

Periodontal disease may be of different types. The most common by far is also called periodontal disease; in old text-books and papers it was called pyorrhea, periodontoclasia, periclasia, etc. This disease is initiated by plaque accumulation in the gingivo-dental area and is basically inflammatory in character. Initially it is confirmed to the gingiva and is termed gingival disease, later supporting structures become involved and the disease receives the name of periodontal disease. The term chronic destructive periodontal disease, which very accurately describes the condition, was used.

<table>
<thead>
<tr>
<th>Periodontal disease (Synonym not currently used: periodontopathia)</th>
<th>Periodontal disease</th>
<th>Chronic destructive periodontal disease</th>
<th>Periodontitis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other disease of the periodontium</td>
<td>Gingival disease</td>
<td>Trauma from occlusion</td>
<td>Periodontal atrophy</td>
</tr>
</tbody>
</table>
The above classification illustrates the different meanings currently assigned to the term periodontal disease.

The terminal effect of periodontal disease observed in adults has their inception earlier in life. Gingival disease in childhood may progress to jeopardize the periodontium of the adult. The increasing awareness of the prevalence of gingival and periodontal disease in children, coupled with the need for more information regarding the early stages of periodontal disease, have focused attention upon the periodontium in childhood.

Gingivitis, inflammation of the gingiva, is the most common form of gingival disease. Inflammation is almost always present in all form of gingival disease because of the bacterial plaque, which cause inflammation and irritational factors that favour its accumulation and are very often present in the gingival environment. The inflammation caused by dental plaque gives rise to associate degenerative, necrotic and proliferation changes in the gingival tissues.

The role of inflammation in individual cases of gingivitis varies as follows:

i). Inflammation may be the primary and only pathologic change. This is by far the most prevalent type of gingival disease.

ii). Inflammation may be a Secondary feature, super-imposed upon systematically caused gingival disease.

iii). Inflammation may be the precipitating factor responsible for clinical changes in patients with systematic conditions that of themselves do not produce clinically detectable gingival disease. Gingivitis in pregnancy is an example.
The most common type of gingival disease is the simple inflammatory involvement caused by bacterial plaque attached to the tooth surface. This type of gingivitis, sometimes called chronic marginal gingivitis or simple gingivitis, may remain stationary for indefinite periods of time or may proceed to destruction of the supporting structures (Periodontitis).

**Dental Morphology**

Tooth morphology is defined as the subject which deals with the external and internal structure, morphology, function, eruption and shedding of all the teeth in the mouth. The mouth is called as oral cavity in medical term. Human beings have two jaws in which all the teeth are fixed. The jaws are upper jaw and lower jaw. The term maxilla refers to the upper jaw and the term mandible refers to the lower jaw. At birth there are usually no teeth visible in the mouth, but many teeth in various stages of development are found in the jaws (Kumar, 2007).

**Supernumerary Teeth**

Supernumerary teeth or hyperdontia are extra teeth beyond the normal number unlike hypodontia or decrease in the number of teeth both representing numerical variations in the teeth. Supernumerary teeth of the present study cab be found in any location in the dental arch but are generally observed outside the dental arch. They are known to cause a considerable amount of dental disturbance by interfering with the growth, development, and eruption and arrangement of the normal teeth. There may be certain supernumerary teeth which remain un-erupted and block the eruption of other
teeth, the presence of which can be highlighted only by X-rays without which it becomes highly difficult to decide which teeth are supernumerary and which represent normal dentition.

The supernumerary teeth are either peg-shaped or have a larger crown. They have often been considered as atavistic in nature indicating an ancestral or primitive pattern. They may be present on one side of the mouth and in line with the other teeth. Sometimes, these are hereditary with a higher frequency occurring in the maxilla. Usually, these are found in the premolar and molar regions in the deciduous as well as permanent dentitions. They occur in all human races in varying proportions. They also have been reported in non-human primates such as gorilla (4.4%), chimpanzee (2.9%), orang-utan (6.8%) and gibbon (0.7%) as revealed by Colyer and Sprawson (1944).

Carabelli's Cusp

The cusp of Carabelli’s is an accessory cusp that develops as an elevation or tubercle on the lingual surface of the mesiolingual cusp (protocone) or surface of the maxillary molars particularly the first one. The trait was first detected and described by Von Carabelli in 1842 since when it gained much importance as a ‘marker’ for differentiation between populations of different ethnic origins. Besides, it is also used in the phylogenetic studies. In the opinion of Lasker (1950) the anomaly of Carabelli appears to be an inherent constitutional variable in man and other primates. Its occurrence has been traced back to Palaeolithic man particularly in Europe.

The trait shows considerable variation in its occurrence, size and location as known from a number of published works of different authors. The highest frequency of
this trait occurs in the deciduous second molar followed by the permanent first, second and the third molars. The trait varies in size from a small furrow or groove or line to large cusp with a triangular tip; the intermediate form between these two extremes are a pit, a y-shaped furrow, a slight protuberance, and a small cusp often found with a furrow. The former two structures namely the furrow and pit are called as negative cusp while the latter two, protuberant and cusp formed structures are described as positive cusps. The trait may occur unilaterally and bilaterally. Regarding the location of the trait, it may be stated that the cusps occurs on the mesial half of the lingual surface of the deciduous second molars and permanent first molar whereas on the permanent second molar the structure is more distally located.

**Shovel-Shaped Incisors**

The term shovelling, first introduced by Muhlreiter in 1870 according to El-Najjar and Mc Williams (1978), is used to described a condition resulting from a combination of a concave lingual surface and elevated mesial and distal marginal ridges enclosing a central fossa in the upper and lower incisor teeth. It also occurs on the monocuspid canines when their mesial and distal lingual marginal ridges produced the shovelled contour. Hrdlicka (1911) who has done pioneering work in the area of dental anthropology reported pronounced shovelling in the incisor teeth of the American Indians. In the years 1920-21, he found the highest incidence of this trait in the incisors of different Mogoloid groups - Chinese, Japanese, Eskimos and American Indians whereas in Negroes the proportion was lower and among the Caucasians the lowest. These findings of Hrdlicka were later confirmed by the works of a number of scholars.
Nelson (1937-1938); Goldstein (1948); Pedersen (1949); Dahlberg (1945 and 1949) showing that the shovel-shaped teeth are characteristics of the Mongoloid stock. The existence of this trait has been found in the Peking man (*Sinanthropus pekinensis*) by Weidenreich (1937) who suggested genetic continuity of the trait from the fossil human ancestors of China to the modern Mongoloid populations. Lasker (1950) found these teeth in 14% of White Americans studied by him. He noticed no difference in the incidence of the trait between central and lateral incisors but in the latter teeth, the character has been observed to be predominantly more pronounced. In the natives of Eastern Islands of New Guinea, Barksdale (1972) noticed the trait in only 6 percent of the samples. Campbell (1925) held that the character was not a frequent one in the Australian aboriginals.

**Diastema**

Diastema is a space or gap present between the maxillary central incisors or between the maxillary lateral incisors and canines. The former one is called median diastema which is more frequently observed in the maxilla while the second type, the lateral diastema is occasionally combined with lack of or a reduction in the size of the lateral incisors. The lateral diastema is similar to its counterpart found in anthropoid apes and certain fossil men in which the mandibular canine, being large, needs space or diastema between the maxillary lateral incisors and canine. The diastema may be broad or narrow.
Crowding

Crowding is another non-metric trait which is complex in nature. There is unanimity as to whether this trait which is prominent in modern man, as an inherent constitutional variable, Lasker (1950), but the fact is that the crowding of teeth results due to the inheritance of large teeth from one parent and small jaw from the other, which are determined before birth. This is unlike in the case of spacing which occurs between teeth when the jaw is large and teeth are small. Thus, the existence of crowding as also spacing indicates that the tooth size need not be in complete accord with the jaw size. According to Cadien (1972) “extreme crowding of teeth probably is not an advantageous condition, so selection may be operating to reduce it”. Therefore, crowding, one of the many causes for malocclusion, may be considerably influenced by genetic as well as environmental factors.

The dental anomaly which is known for its significance in understanding human evolution is most neglected in population studies in India or outside. The only study known to the writer is that of Boyd (1972) among the natives of Eastern Highlands of New Guinea who have shown crowding to the extent of 34.4% cases in mandible and 26.1% cases in maxilla in sample of 218 dental casts of natives. There were only nine cases with marked crowding in which the arch length was found to be greater than 5 mm. Mandibular crowding has been found to be significantly greater in these natives. Boyd in an attempt to relate crowding to tooth size computed the mean mesiodistal tooth measure from second molar to second molar in each arch for the natives and found a progressive increase in tooth size as crowding becomes more severe. On the whole, the
absolute tooth size was found to be greater in subjects with crowding than in those with spacing.

**Cingulum or Lingual Cusp**

El-Najjar and McWilliams (1978) following Black and Wheeler, define cingulum as "the lingual cusp known of an anterior tooth. A self or swelling which is found on the tooth just above the cervical line is the site of the development of many supernumerary cusps". According to Segal (1963), "the ridge found on the lingual lobes of the incisors and the canine is termed the 'cervical ridge', or the 'cingulum'. It is more specifically in the cervical portion of the lingual surface. It may be present as a prominence in the cervical one-third of the deeply concave, lingual surface of the upper and lower, central and lateral incisors of the permanent as well as deciduous dentition. In shape, it may be just the highest area at the junction of marginal elevation or it may extend tongue-like into the concavity of the lingual surface. It may be simple or divided by the furrows into two or more smaller cusplets (Sicher, 1965).

This dental tubercle is separate from the Shovel-shaped form of the incisors but the detection of this character becomes difficult when the marginal ridges come in contact with each other. The only work available in the literature is that of Pedersen (1949) among the East Greenland Eskimos for whom no percentage of the incidence of the cusp is given. Later Barksdale (1972) reported the occurrence of lateral incisors with lingual cusps or cingulum in 18% of the casts of the Eastern Highland natives of New Guinea studied. No data are available on pedigree studies at all.
Occlusion

Dental occlusion is the relationship between the masticatory surface of the maxillary and mandibular teeth, when the mouth is closed. Individuals with correct or normal occlusion have their teeth of either jaw arranged in well-formed arches, elliptic maxilla and parabolic mandible, presence of contact between individual teeth and between each tooth of one jaw with two teeth of opposing jaw barring the mandibular central incisors and maxillary wisdom teeth, all forwardly placed mandibular teeth but central incisors, smaller arch than the upper one to facilitate the occlusion of the former inside the latter showing the upper incisors covering the lower incisors and the coincidence between the two jaws in the midline.

The normal or excellent occlusion of the natural dentition described above is not a fixed or static condition due to the changing cultural environment of man in space and time and any deviation or failure from the norms, or when the biting surfaces do not meet correctly, it makes the occlusion defective which is termed as malocclusion to differentiate it from the normal occlusion. The term malocclusion is ill-defined and biased, Corruccini and Whitley (1981) since it does not necessarily cause a functional problem, Moorrees et al., (1971). Therefore, majority of the people prefer to speak of "occlusal variation" rather than using the word malocclusion.

The irregular occlusal variation or the so-called malocclusion is caused by hereditary or environmental factors. Those scientist or orthodontists who emphasize the role of genetics in the causation of malocclusion have not totally ignored the environmental causes. They, however, emphasize such factors as finger or thumb-
sucking, mouth breathing, abnormal muscle patterns, inadequate masticatory function, abnormal swallowing patterns, and premature loss and over retention of milk teeth apart from a number of hereditary factors such as large teeth and small jaws, abnormal skull growth, cleft palate, ill-developed soft tissues like short upper lip and abnormally large tongue, deviation in the eruption times and the pattern of teeth etc. and certain diseases like rheumatoid arthritis and rheumatic fever of childhood affecting jaw growth in the areas of condyles forming part of temporo-mandibular joints; decrease or increase in the number of teeth; diseases and injuries; endocrine dysfunction, forceps delivery and so on.