

# SIXTH SEMESTER (HONS)

## PAPER: C13T/ UNIT-5

### Individualization: Forensic Odontology (Tooth Structure and Growth)

The dental-facial complex, often referred to as the splanchnocranium, is not a static entity as it changes with the development of the mandible, face and dentition. Therefore, a dynamic relationship exists between the hard and soft palate of the oral cavity. Several factors affect the dental-facial complex: genetic composition, environmental factors (such as nutrition and health care), and functional factors (such as muscle movements). The main function of the dental-facial complex is mastication (chewing), secondary functions include breathing, speech, vision, olfaction and hearing.

#### Tooth Terms Used to Describe Parts of Teeth

Terms used to describe parts of teeth and jaws:

- Crown** : Portion of a tooth visible in the mouth.
- Root** : Portion of a tooth that normally is embedded in the jaw bone. In older persons, the root may also be exposed while in the mouth.
- CEJ** : *Cemento-Enamel Junction* (neck of the tooth that demarcates crown from root).
- Cusp** : Biting edges of a tooth. Front teeth (the pairs of central, lateral, and cuspid incisors) in each jaw do not have cusps. The back teeth (bicuspid and molars) have flat biting surfaces that possess bumps called *cusps*.
- Quadrant** : Each jaw is divided into two halves which are labeled left and right. The entire human dentition (teeth) has four quadrants.
- Incisors** : The front four teeth in the upper (maxillary) and lower (mandibular) jaws.
- Canine** : Commonly known as the *eyetooth*, the canine has the longest root of any tooth. It is located next to the incisors and in front of the bicuspid.
- Bicuspid** : A set of two teeth behind each canine and in front of the molars. Generally, they have two roots. Also known as *premolars*.
- Molars** : Large, flat surfaced teeth that have multiple roots located in the back of mouth.
- Incisal** : The biting edge of front teeth (incisors and canines).
- Occlusal** : The chewing surface of back teeth (premolars and molars).
- Buccal** : Tooth surfaces that touch the cheek. Term reserved for bicuspid and molars.
- Labial** : Tooth surface that touches the lips. Term reserved for front teeth (incisors).
- Palatal** : Upper bicuspid and molar surfaces facing the roof of the mouth (palate).
- Lingual** : Tooth surface that touches the tongue (front teeth).
- Mesial** : Tooth surface facing towards the midline of the face (line from nose to the chin).
- Distal** : Tooth surface facing away from the midline of the face.

**Enamel** : The hardest tissue in the human body that also covers the crowns of teeth.

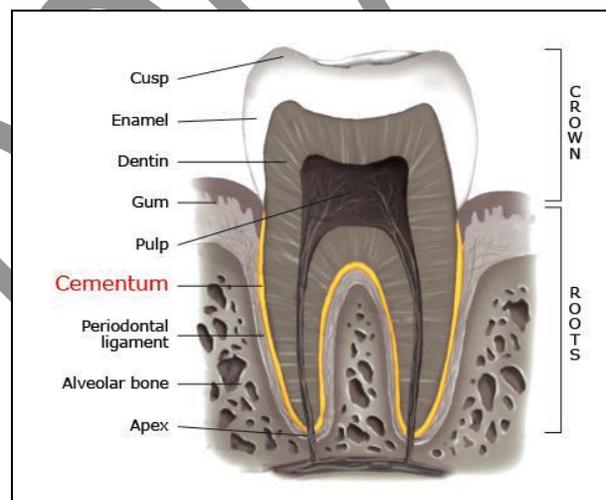
**Cementum** : The root is made of this hard tissue which is much like bone.

**Dentine** : The softer material that is underneath the outer enamel layer.

## **Tooth Anatomy:**

Three groups of tissues comprise the dental-facial complex: skeletal tissues, soft tissues and dental tissues. Skeletal tissues in the **splanchnocranium** include bone and cartilage, while soft tissue refers to muscles, glands, nervous and vascular structures. The five dental tissues in the dental-facial complex are (i) enamel, (ii) dentin, (iii) cementum, (iv) pulp and (v) gingival. Teeth are highly mineralized with the majority of the tooth being composed of hydroxyapatite ( $\text{Ca}_{10}[\text{PO}_4]_6[\text{OH}]_2$ ). Enamel is the hardest element in the human body and composed of approximately 97% hydroxyapatite and approximately 3% water and organic material (Schroeder, 1991). Dentin is less mineralized, composed of approximately 70% hydroxyapatite, calcium and phosphate, approx. 20% organic materials (primary proteins) and approx. 10% water. Cementum is composed of approx. 45% hydroxyapatite, approx. 33% proteins (mainly collagen) and approx. 22% water.

The crown and root comprise the gross anatomy of the tooth. The crown is covered by enamel (composed mainly of calcium and phosphorus) and is the portion of the tooth that is exposed in the oral cavity. The root is covered by cementum and is the portion of the tooth anchored to the alveolar bone in a special joint called gomphosis. Within the gomphosis, the periodontal ligament anchors the tooth to the alveolar bone of the maxilla and mandible. The alveolar bone between two teeth is called the interdental septum, while the alveolar bone between two roots of a single tooth is called interradicular septum. The neck of the tooth refers to the region of the root immediately adjacent to the crown, while the cemento-enamel junction is the point of junction of the crown and root. The apical foramen is located at the apex of the tooth root and is the opening through which the nerve, blood and lymph supply each tooth.



Enamel is the hardest, most mineralized and most brittle material in the human body and is composed mainly of calcium and phosphorus. It is an acellular material that covers the crown of the tooth.

Dentin forms the bulk of the tooth and is not normally exposed in the oral cavity. In the crown, enamel covers the coronal dentin and in the root, a hard substance called cementum covers the root dentin.

Cementum is a mineralized, avascular connective tissue that coats the tooth root between the dentin and periodontal ligament. The primary function of cementum is to anchor the collagen fibres of the periodontal ligament to the tooth, thus anchoring the tooth firmly to the alveolar bone.

The pulp or pulp organ is the nerve centre of the tooth and is centrally located in the pulp chamber of the tooth. The pulp has sensory, reparative and nutritive properties.

The gingival (gums) is part of the oral mucosa and mirrors the alveolar bone and cemento-enamel junction. The function of the gingival is to help anchor the teeth and secure them in the alveolar bone.

## Types and Forms of Teeth

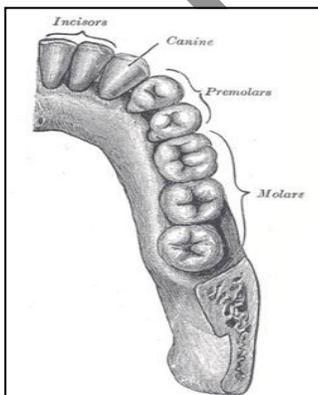
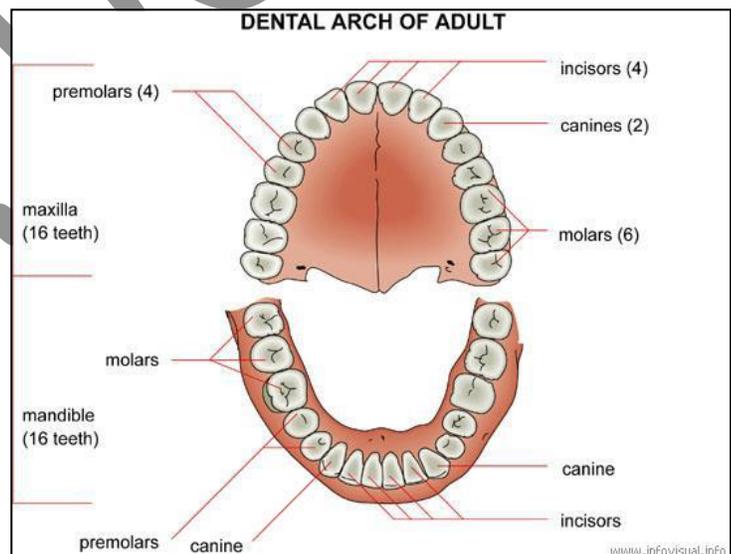
Teeth vary in form, this variation reflects differences in function. Based on forms and functions the teeth are classified into incisors, canines, premolars and molars.

- **Incisors:** They are the four front teeth in each arch. The Central incisor is the first tooth next to the midline. The Lateral Incisor is the second. The form of the incisors is more or less similar to a chisel, which makes them suitable for cutting of incising food. The side of the tooth toward the tongue, the lingual surface, is shaped like a shovel, to aid in guiding the food into the mouth.
- **Canine (Cuspid):** It is the third tooth from the midline. The canine is cone or wedge shape and it is designed to function as a holding or grasping teeth suitable for piercing, cutting and tearing.
- **Premolars (Bicuspid):** They are the fourth and fifth tooth from the midline. The fourth tooth is the First Premolar, the fifth tooth is the Second Premolar. These teeth are characterized by the presence of at least two projections (cusps), a wedge-shaped projection similar to that of the canine, and a slightly rounded projection. Because of their intermediate form and location between canine and molars, they also have an intermediate function of tearing and grinding food.
- **Molars:** These are the sixth, seventh and eighth tooth from the midline. The sixth is the First Molar, the seventh is the Second Molar and the eighth is the Third Molar or wisdom tooth. The molars are characterized by wide surface with multiple projections (cusps) and therefore are suitable for grinding food.

## Dental Morphology:

### Dental Arches and Quadrants

The twenty deciduous teeth in the young mouth and the thirty two permanent teeth in the adult mouth are arranged in two arches called the “Dental Arches”, one upper and one lower. Each arch contains



half of the number of the teeth (10 deciduous then later 16 permanent teeth).

The upper jaw is called the “Maxilla” and the teeth in this arch is called the “Upper of Maxillary Teeth”. On the other hand, the lower jaw is called the “Mandible” and the teeth in this arch is called the “Lower or Mandibular Teeth”.

The imaginary vertical line which equally divides the body into right and left halves is called the midline or the “Midsagittal Plan”. This line also divides each dental arch into right and left segments, referred to as “Quadrants”.

The permanent teeth and the deciduous teeth are equally arranged into four quadrants, as follows:

- Upper right quadrant or Maxillary right quadrant.
- Upper left quadrant or Maxillary left quadrant.
- Lower left quadrant or Mandibular left quadrant.
- Lower right quadrant or Mandibular right quadrant.

## Different Tooth Morphology

### Front Teeth

Human incisors have thin, knife-like crowns that are used for cutting and tearing food. There are two of this type in each jaw (the dental arch). The first incisor is called the *central incisor* and is located directly below the nose or above the chin (midline). The second incisor is the *lateral incisor* and its position is adjacent to the central incisor. The upper incisors and canines overlap (*overbite*) the lower teeth when the mouth is closed.

### Maxillary Central Incisor

This is the most noticeable tooth in the mouth. It has a straight biting edge. Both sides are curved with the distal being more rounded. *Mammelons* are seen on the biting edges of newly erupted and unworn incisors of juveniles and young adults. These are bumps that wear down by the adult years. Mesial and distal aspects present a distinctive triangular outline. This is true for all of the incisors.

An important shape variation of the upper incisors is the shovel shaped incisor. It presents as a large, scooped out indentation on the lingual (tongue side) surface. This feature is seen in populations having Mongolian racial origins.



### Maxillary Lateral Incisor

The maxillary (upper) lateral incisor resembles the central incisor but is narrower in width. The side surfaces have similar shapes as its two adjacent teeth, the central incisor and canine. The tooth is narrow and can be peg-shaped (smaller and narrow). It is sometimes absent in 1–2% of the population. The back (lingual) surface can have deep pits often requiring fillings.



### Canines:

Canines (eyeteeth or cuspids) are the longest rooted teeth. This single-rooted tooth is present in each quadrant. The appearance of canines is a genetic trait seen in all *carnivores*. In color, this tooth appears darker (yellow or brown) than the adjacent teeth. This tooth functions with the incisors to tear and shred food. This may be the final tooth to be lost during life because

it has a thick root, well embedded in bone. The mandibular canine is noticeably narrower in width than the upper and usually shorter.



### **Mandibular Central Incisor**

The mandibular (lower) central incisor is the smallest tooth in the mouth. It is a long, narrow, symmetrical tooth. The biting edge is straight.



### **Mandibular lateral incisor**

This tooth resembles the central incisor, but is a bit larger in most dimensions. The biting edge's shape assists in this tooth's identification. The edge is "bent" front to back, reflecting the curvature of the jaw.



### **Back Teeth**

#### **Upper and Lower Bicuspid (Premolars)**

Bicuspid (two cusps) are located between the canine and molar teeth. There are two per quadrant and are identified as the first and second bicuspid. The upper have two well-defined cusps: buccal and lingual. The lower has one prominent cusp and another much smaller. The larger cusp is the buccal (towards the cheek).



*Adult maxillary right first premolar.*



*Adult maxillary right second premolar*

### **Molar Teeth:**

Adult molars are located in the back of the jaw. They have the most chewing surface of any tooth and have three to five chewing cusps. Lower-jaw molars have two large roots and the upper-jaw molars have three roots.

### **Maxillary Adult Molar**

The biting surface outline is square (not as much as the mandibular molars) with four distinct cusps. Some maxillary molars have an extra cusp (Carrabelli cusp) located on the mesiolingual cusp (tongue side of the tooth). There are three roots, two buccal and one lingual that is the longest of the three.



*Adult maxillary right first molar.*



*Adult maxillary right second molar.*

### **Maxillary Third Adult Molar**

They are the most often congenitally missing adult teeth. Third molars' shape is also the most variable of all human teeth and is the smallest of the maxillary molars. There are three roots: two buccal and one lingual that are generally fused together into an ice cream cone shape.

### **Mandibular First Adult Molar**

The lower first adult molar is the widest of all molar teeth and has two roots. This tooth possesses a five-sided (and five cusp) occlusal shape that is a classic feature.



*Adult mandibular right first molar.*

### **Mandibular Second Molar**

There are two roots that are shorter than the first molar.



*Adult mandibular right second molar.*

### **Mandibular Third Molar**

The two roots are short, curved and can be larger or smaller than the other molar teeth. The shapes of this tooth are variable with the tooth frequently not properly erupting into the oral cavity (impaction).

### **Dental Formula:**

The number and type of teeth for all human are expressed by the dental formula. The type of each tooth is represented by its initial letter:

- *I: Incisors*
- *C: Canines*
- *P: Premolars*
- *M: Molars*

Each letter is followed by a horizontal line and the number of each type of teeth is placed above the line for maxillary half and below it for the mandibular half.

- The human deciduous teeth are 20 in number and are expressed by the following formula:  $I2/2 - C1/1 - M2/2 = 10$  teeth on jaw
- The human permanent teeth are 32 in number and is expressed in the following formula:  $I2/2 - C1/1 - P2/2 - M3/3 = 16$  teeth for jaw

### **Dental Numbering System:**

Several notational methods for dental charting have been devised as a shorthand method of notation to quickly identify a tooth without writing the entire cumbersome anatomic description. Today, there are over 30 different systems for charting teeth. But here two most popular numbering systems are given-

In 1882, Gustav Julius Parreidt, a German dentist proposed the Universal Numbering System (UNS), which is used frequently today throughout the US. For permanent (adult) dentition, the UNS assigns a unique number (1-32) to each tooth, starting with the maxillary right third molar (1) and counting medially across the maxillary dentition to the right central incisor (8), then distally from the left central incisor (9) to the maxillary left third molar (16). This numbering system continues with the mandibular left third molar (17) and continues mesially across the mandibular dentition to the left central incisor (24), then distally from the right central incisor (25) and ends with the mandibular right third molar (32). The deciduous (baby) dentition is labeled similarly, using the letter A-T, beginning with the maxillary right second deciduous molar (A) continuing across the maxillary arcade to the maxillary left second deciduous molar (J), dropping down to the mandibular left second deciduous molar (K), and ending with the mandibular right second deciduous molar (T).

In 1971, the Federation Dentaire Internationale (FDI) devised a system that is used throughout the world by organizations such as Interpol, the World Health Organization, and the International Association of Dental Research. This system provides a unique two digit number for each tooth. The first number in the pair represents the quadrant of the mouth, and the second number delineates the tooth, numbered from mesial to distal per quadrant. Any number beginning with '1' represents the permanent maxillary right quadrant, '2' represents the permanent maxillary left quadrant, '3' permanent mandibular left quadrant and '4' permanent mandibular right quadrant. All central incisors have a second digit of '1', while all third molars have a second digit of '8'. Deciduous quadrants are delineated with the first numbers 5-8 in the same fashion.

### **Development, Calcification & Eruption of Teeth**

#### ***Development of Teeth:***

During the **six week** of fetal life tiny **teeth germs** begin to grow within the **alveolar process of the fetus**. "**Tooth Germs**" are small clumps of cells that have the **ability to form dental (tooth) tissues** i.e. enamel, dentin, cementum and pulp.

- From the **deepest layer of oral epithelium** a band called the "**Dental Lamina**" extends deep inside the jaw all around.
- From the dental lamina **epithelium bud out** and named the "**Dental Organ**", which is the **first sign of tooth** development.

- The **mesodermal tissue around each dental organ** become influenced by its **growing cells** forming localized area of mesoderm called the “**Dental Papillae**”, which is seen in the concavity of the dental organ.
- A **mesoderm tissue** also encircle each **dental organ and dental papilla** forming the “**Dental Sac**”.
- The **dental organ, dental papilla and dental sac** are called the “**Tooth Germ**”.
- Cells forming the “**Enamel**” are differentiated from the “**Dental Organ**”.
- The cells forming “**Dentin and Pulp**” are differentiated from the “**Dental Papilla**”.
- Cells that form “**Cementum, Periodontal Ligament and Alveolar Bone**” are derived from the “**Tooth Sac**”.

The dental lamina of each jaw gives off ten dental organs of deciduous teeth. Lingual to the deciduous dental organs, “*Successional Laminae*” are extended to form the permanent successors. These teeth are the permanent incisors, canines and premolars. The development of the dental organ begins at the fifth month intrauterine for the permanent central incisors and ends at about the age of ten months for the second premolar. The tooth germs for the developing permanent incisors and canines are in a position lingual to the deciduous roots, while that for the premolar are within the bifurcation of the deciduous molar roots.

### **Calcification:**

Each cell is specialized to form one of the **hard dental tissues, enamel, dentin and cementum**, first lays down a **soft organic matrix**. This is followed by deposition of mineral salts, mostly **calcium**, circulating in the blood, into this matrix in the form of globules called “**Calcospherites**”. The calcospherites **enlarge and fuse together** forming the **calcified dental tissues**. This calcification process continue till about the **fourth year of life for the deciduous teeth** and for the permanent dentition until the **twenty-fifth year of life**.

### **Eruption of Teeth:**

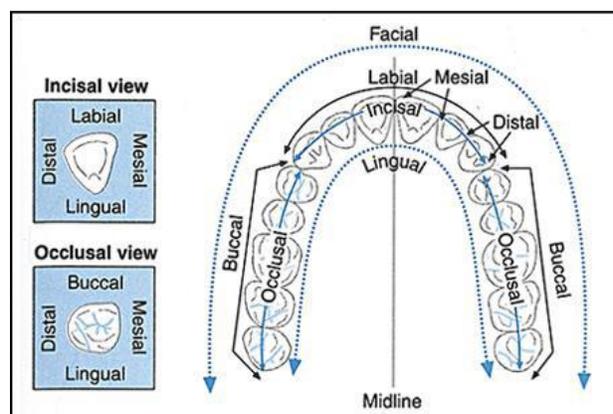
The development of the **crown and root** takes place within a bony “**Crypt**” in the **jaw bone**. After the formation of the **crown and about 1/3 of the root**, the tooth starts to **erupt** and penetrate the **oral mucous membrane**. The tooth continue to erupt and as it reaches the **occlusal plane 2/3 of it root becomes formed**. When the tooth is newly erupted, the dental pulp is large and then becomes progressively smaller.

Formation of the tooth is said to be completed when the **apex of the root** is formed. This occurs between **1-11/2 years** after the emergence of the tooth in the mouth for the deciduous teeth and between **2-3 years** for the permanent teeth.

After the tooth reach the occlusal plane it continue to erupt and more of the crown become exposed as the tooth moves occlusally. Formation of the root dentin and cementum continue after the tooth is completely formed.

As for the chronology of eruption of teeth the following rules is to be considered:

- **Eruption of mandibular teeth usually precede** that of maxillary teeth.
- **Teeth in both jaws erupt in pairs**, one on the right and one on the left.
- **Teeth erupts slightly earlier in girls** than in boys.



## Deciduous Dentition:

At the age of **6 months**, the deciduous **mandibular central incisors** show up in the mouth. The usual sequence of eruption of deciduous dentition are: **Central Incisors (6 months lower and 7 months upper)**, **lateral incisors (7 months lower and 8 months upper)**, **first molar, 12 months lower and 14 months upper**, **canines, 16 months lower and 18 months upper**, **second molar, 20 months lower and 24 months upper**.

Although deciduous teeth are temporary yet they are important for the following reasons:

- Normal function on both sides of the dental arches is important for normal jaw development.
- To guide the first permanent molars into their normal position.
- Deciduous teeth contribute to the health and wellbeing of the individual during an important period of growth between 6-12 years.

### Time of Dental Eruption: Milk/ Deciduous Teeth

Baby Teeth		Age Tooth Comes In (months)	Age Tooth Is Lost (years)
<b>Upper Teeth</b>			
Central Incisor	9.6	7.0	
Lateral Incisor	12.4	8.0	
Canine (Cuspid)	18.3	11.0	
First Molar	15.7	10.0	
Second Molar	26.2	10.5	
<b>Lower Teeth</b>			
Second Molar	26.0	11.0	
First Molar	15.1	10.0	
Canine (Cuspid)	18.2	9.5	
Lateral Incisor	11.5	7.0	
Central Incisor	7.8	6.0	

## Permanent Dentition:

The permanent tooth in its **follicle attempt to force** its way into the position held by its predecessor. The **pressure brought** to bear against the deciduous root result in its resorption. Root resorption of deciduous teeth will continue until the **crown looses its anchorage**, becomes **loose and finally exfoliated**. The first tooth of the permanent dentition to **erupt and emerge in oral cavity is the first mandibular molar**. The first permanent molars are called the “**Six Years Molars**” because they erupt at the age of 6 years, just distal to the second deciduous molar. The chronology of the permanent dentition is shown in following table and figure.

### Time of Dental Eruption: Permanent Teeth

Teeth	Age Tooth Comes In (years)
Central Incisor	7.35
Lateral Incisor	8.45
Canine (Cuspid)	11.35
First Premolar (Bicuspid)	10.20
Second Premolar (Bicuspid)	11.05
First Molar	6.30
Second Molar	12.25
Third Molar	Variable 17 to 21
Third Molar	
Second Molar	11.90
First Molar	6.05
Second Premolar (Bicuspid)	11.20
First Premolar (Bicuspid)	10.50
Canine (Cuspid)	10.35
Lateral Incisor	7.50
Central Incisor	6.40

## Age Estimation based on Dental Data

The need for age estimation has increased in recent years because there is increase in numbers of unidentified cadavers and human remain especially in metropolitan cities and age estimation for living individuals who do not have valid proof of date of birth with them. Dental ageing technique can be broken down into two categories.

- 1) **Developmental changes:** Developmental changes that occur to the human dentition while the teeth are growing and emerging into the oral cavity.
- 2) **Degenerative changes:** That occurs once the teeth have erupted and begin to wear down.

### **1) Developmental Changes**

#### **A) Hard Tissue Formation**

Tooth formation begins at a very early stage of life by six month. The sequence of formation and eruption of teeth with give a precise age estimation method. In this method, each tooth is scored based on its developmental stage and scores are compared with values corresponding to a particular age. For example: a deciduous second incisor crown that is fully formed and is recovered adjacent to a deciduous second incisor crown that is only  $\frac{3}{4}$  complete suggest a single individual of age less than 6 months. But, if complete deciduous second molar is found in association with these 2 teeth, then it may represent that there are more than 1 individual. This is used if dentition is completed and not applicable if there is missing teeth due to cases etc.

#### **B) Dental Eruption**

Human dentition has 2 eruption stages and their associated ages. To assess the age of unknown individual, we can compare the postmortem radiographs of the individual to the eruption standards produced by the Schour and Massler.

#### **C) Third Molar Eruption**

Third molar emergence tends to be around 17-19 years of age. This tooth has high variations, may be completely developed but impacted or it may be completely absent. Only radiograph can be the give the accurate document of this tooth.

#### **D) Dental Measurement**

This technique was an alternative to the qualitative assessment where the length of tooth was measured.

### **2) Degenerative Changes**

That occurs once the teeth have erupted and begin to wear down. There is an intuitive connection between **tooth wear and age**, as those with **more wear tend to be older**. We can use **volume of pulp cavity** because it's seen that the volume of pulp cavity reduces due to **deposition of secondary dentine** with ageing.

### **Sex Determination**

Sex determination is very important subdivision of forensic odontology, which plays a major role in identification of the unknown individuals in natural disasters; chemical and nuclear bomb explosion scenarios

It can be done by four methods:

- 1) **Craniofacial morphology** and dimension: The morphology of the skull and mandible, pattern formed by six traits those are mastoid, supra-orbital ridge, size and architecture of the skull, zygomatic extensions, nasal aperture, and mandible gonial angle and Frontal sinus dimension are taken into consideration.

- 2) Sex difference in tooth dimension: Sex determination by measuring mesio-distal and bucco-lingual dimensions is most simple and reliable method for sex determination. Both the dimensions are more in male than in female.
- 3) Tooth morphology: In **male**, the distal accessory **ridge in canines is more prominent** than in female. In **female, there is less number of cusps in mandibular first molar** (distobuccal or distal). These features can be because of evolutionary reduction in the female lower jaw size.
- 4) Sex determination by DNA analysis: The study by Das and his associates stated that the sex determination could be obtained from the studying the X and Y-chromosomes up to four weeks of the death.

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M.C.DOLAH