***Oral Histology***

***Lec.5* *Dr. Nada AL-Ghaban***

***Dentin structure***

The dentin provides the bulk and general form of the tooth and is characterized as a hard tissue with tubules throughout its thickness. Since it begins to form slightly before the enamel, it determines the shape of the crown, including the cusps and ridges, and the number and size of the roots. As a living tissue it contains within its tubules the processes of the specialized cells, the odontoblasts.

***Chemical and physical properties of Dentin:-***

By weight, **70%** of dentin consists of the minerals( [hydroxylapatite](http://en.wikipedia.org/wiki/Hydroxylapatite)) , **20%** is organic material (90% collagen fibers type I and III and 10% ground substance include non-collagenous protein), and **10%** is water. Yellow in appearance, it greatly affects the color of a tooth due to the [translucency](http://en.wikipedia.org/wiki/Translucency) of enamel. Dentin, which is less mineralized and less brittle than enamel, is necessary for the support of enamel. Unlike enamel, dentin continues to form throughout life and can be initiated in response to stimuli, such as tooth decay or attrition.

***Dentin structural units***

***1- Dentinal tubules and its process:***

Dentin consists of microscopic channels, called *dentinal tubules*, which radiate outward through the dentin from the pulp to the exterior cementum or enamel border. The dentinal tubules extend from the dentinoenamel junction (DEJ) in the crown area, or dentinocemental junction (DCJ) in the root area, to the outer wall of the pulp. These tubules contain fluid and [cellular](http://en.wikipedia.org/wiki/Cell_%28biology%29) structures (odontoblastic process or *Tomes’ fiber*). As a result, dentin has a degree of [permeability](http://en.wikipedia.org/wiki/Vascular_permeability), which can increase the sensation of pain and the rate of [*tooth decay*](http://en.wikipedia.org/wiki/Dental_caries). The strongest held theory of dentinal hypersensitivity suggests that it is due to changes in the dentinal fluid associated with the processes, a type of *hydrodynamic mechanism.*

The course of D.T. is somewhat curved, resembling an *S shape* known as primary curvature. Starting at right angles from pulpal surface, the first convexity of this doubly curved course directed toward the apex of the root ending perpendicular to D.E.J, this configuration indicate the course taken by odontoblasts during dentinogenesis. Secondary curvature also can be distinguished over the entire length of D.T., they probably reflect the minor changes in the direction of movement of odontoblasts. In the root and in the area of incisal edge or cusps, the tubules are almost straight.

The ratio between surface areas at the outside and inside of the D. is about **5:1**, so the tubules are farther apart in the peripheral layers and are more closely packed near the pulp. In addition they are larger in diameter near the pulpal cavity (3-4µm) and smaller at their outer ends( 1µm).

The terminal part of D.T.branched into2-3 branches near D.E.J resulting in the increase number of tubules in this area. Also there are lateral branches of D.T.which called canaliculi .

***2-Peritubular D.****:*It’s the D. that surrounds the D.T. and form 1µm thick sheath around each tubule. Peritubular D. is missing in D.T. in interglobular D. indicating that this is a defect of mineralization in this area. Peritubular D. is highly calcified and its about 40% more calcified than adjacent intertubular D.

***3-Intertubular D.:*** It’s the D. located between the D.T., and its formed the most of the body of D. Its less mineralized than the peritubular D., and it consist of network course of collagen fibers in which apatite crystals deposited on it. 

## *Types of dentin:*

### *1-Primary dentin*

Its the most prominent dentin in the tooth, lies between the enamel and the pulp . The outer layer closest to enamel is known as *mantle dentin*. This layer is unique to the rest of primary dentin. Mantle dentin is formed by newly differentiated odontoblasts and forms a layer approximately *150 micrometers* wide. Mantle dentin lacks phosphorylation, has loosely packed collagen fibrils and is less mineralized. Below it lies the *circumpulpal dentin*, a more mineralized dentin which makes up most of the dentin layer and is secreted after the mantle dentin by the odontoblasts. Circumpulpal dentin is formed before the root formation is completed.

Newly secreted dentin is unmineralised and is called *predentin*. It is easily identified in haematoxylin and eosin stained sections since it stains less intensely than dentin. It is usually *10-50 micrometer* wide and lines the innermost region of the dentin. It is unmineralized and consists of collagen fibers type I and III,and ground substance(include non-collagenous protein). It is similar to osteoid in bone and is thickest when dentinogenesis is occurring.

### 2-Secondary dentin

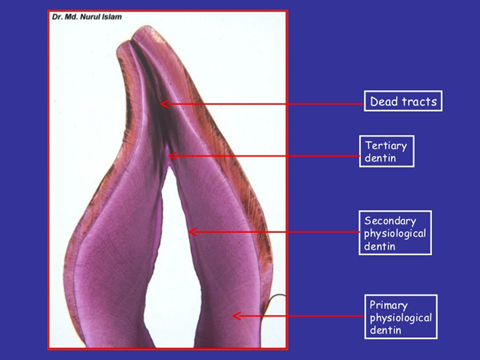
Secondary dentin is formed after root formation is complete, normally after the tooth has erupted and is functional. It grows much *more slowly* than primary dentin. It has a similar structure to primary dentin, although its deposition is not always even around the pulp chamber. It is the growth of this dentin that causes the decrease in the size of the pulp chamber with age. This is clinically known as *pulp recession*; cavity preparation in young patients therefore carries a greater risk of exposing the pulp. If this occurs, the pulp can be treated by different therapies such as direct pulp capping.

**3-Tertiary dentin**

Tertiary dentin or pathologic type of D., is dentin formed as a reaction to external stimulation such as cavities. It is of two types, either *reactionary*, where dentin is formed from a pre-existing odontoblast, or *reparative*, where newly differented odontoblast-like cells are formed due to the death of the original odontoblasts, from a pulpal progenitor cell. Tertiary dentin is only formed by an odontoblast directly affected by a stimulus; therefore, the architecture and structure depend on the intensity and duration of the stimulus, e.g., if the stimulus is a carious lesion, there is extensive destruction of dentin and damage to the pulp, due to the differentiation of bacterial metabolites and toxins. Thus, tertiary dentin is deposited rapidly, with a sparse and irregular tubular pattern and some cellular inclusions of odontoblasts in its matrix because of rapid formation; in this case it is referred to as *"osteodentin".*

Stimuli of different nature not only induce additional formation of reparative D. but also lead to changes in the D. itself, calcium salts may be deposited in or around degenerated odontoblastic processes and may obliterate the tubules. This type of D. called *transparent or sclerotic D.,*and can be demonstrated only in ground sections. It appear light in transmitted light and dark in reflected light, because the light passes through the transparent D. but reflected from the normal D.

In ground section of D., the odontoblastic process disintegrated as a result of sever stimuli to the pulp like caries, attrition or abrasion, and the empty tubules are filled with *air*. They appear dark in transmitted light and white in reflected light, this type of D. called *dead tracts*andits area of decreased sensitivity. Reparative D. seals these dead tracts at their pulpal end.



***Incremental lines in D.***

***1-Imbrication or von Ebner lines:***

It appear as fine lines, which in cross section run at right angles to the D.T. The course of the lines indicates the growth pattern of the D. The distance between the lines corresponds to the daily rate of opposition, which in crown varies from *4-8µm* and becomes decreasingly less as root formation progress.

***2-Counter lines of Owens:***

Its hypocalcified line, distinguish in *longitudinal ground section* as accentuated few lines. They arises due to disturbances in D. matrix and mineralizing process. ****

***3-Neonatal lines:***

This line separating between prenatal and postnatal D., and mostly found in *deciduous and first permanent molar*. This line is the result of incomplete calcification, due to metabolic disturbances at the time of birth to the abrupt changes in environment and nutrition.

***Interglobular D.:***

Mineralization of the D. sometimes beings in small globular areas that normally fused to form a uniformly calcified D. layer. If fusion does not take place, unmineralized or hypomineralized regions remain between the globules, which termed *interglobular D.*This type of D.is found in the crown in both sections (decalcified and ground sections) near the D.E.J. and in the root near C.D.J. In ground sections is sometimes lost and replaced by air ,so it appear black. 

***Tomes’ granular layer:***

In the ground sections a thin layer of D. adjacent to the cementum almost appears granular and only found in the root, this is known as Tomes’ granular layer. Its thought to represent an interference with mineralization of the entire surface layer 

