DENTINOGENESIS

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- Dentin formation begins when the tooth germ has reached the bell stage of development.
- Under the influence of the inner enamel epithelium, the outermost **ectomesenchymal cells of the dental papilla** differentiate into odontoblasts.
- **Two Phases:**
  1. ***Collagen matrix formation***
  2. ***Mineralization of deposited matrix***

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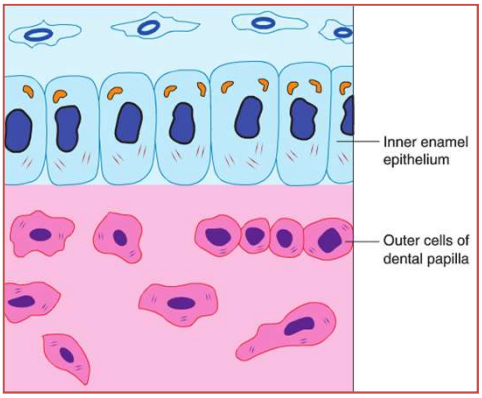
1st Phase: Collagen Matrix Formation



Initially, the cells of the dental papilla are **small, undifferentiated and have few organelles**. These are separated from the inner enamel epithelium by an **acellular zone**.

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•Inner enamel epithelium releases:

- Transforming growth factor
- Insulin growth factor and
- Bone morphogenetic protein

• These all play an important role in the differentiation of odontoblasts.

• Fibronectin, decorin, laminin and chondroitin sulphate are essential for this differentiation.

• Differentiation begins adjacent to the deepest invagination of the enamel organ (i.e. the portion of the future cusp tip).

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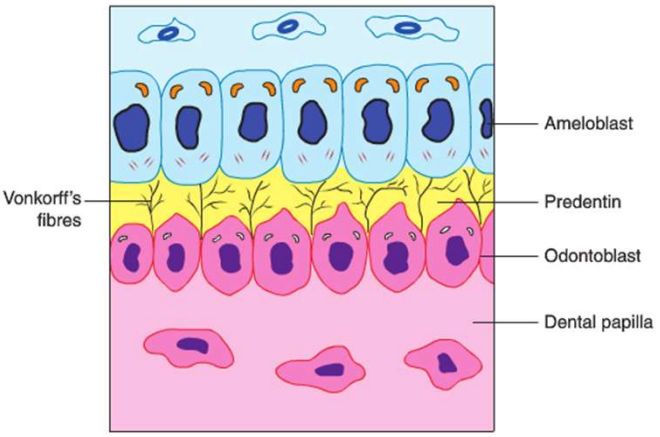

Later, the cells of dental papilla immediately adjoining the acellular zone enlarge to become **preodontoblasts**, which change their shape from ovoid to columnar and **differentiate into odontoblasts**.

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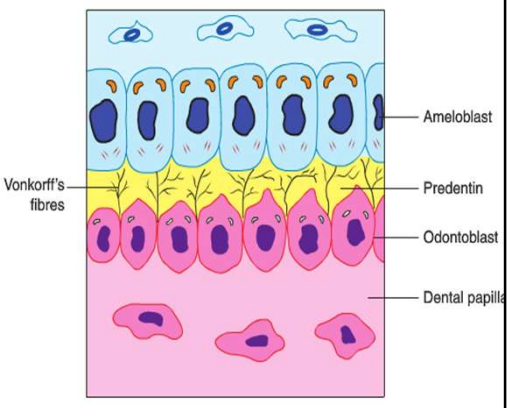
-The **nucleus** is oriented **towards the base** (away from inner enamel epithelium)

- Increased amounts of protein-synthesizing organelles appear in the cytoplasm.

- The *acellular zone between the dental papilla and the inner enamel epithelium is narrowed down* and finally eliminated as the odontoblasts increase in size (40 µm) and occupy this zone.



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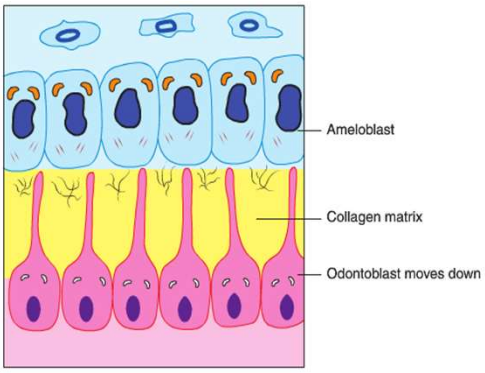
• Several **processes arise** from the apical end of the odontoblast.

• Collagen I and precursors of phosphorin are found in the endoplasmic reticulum, Golgi complex and secretory granules. These migrate into the processes and are emptied into the extracellular matrix.



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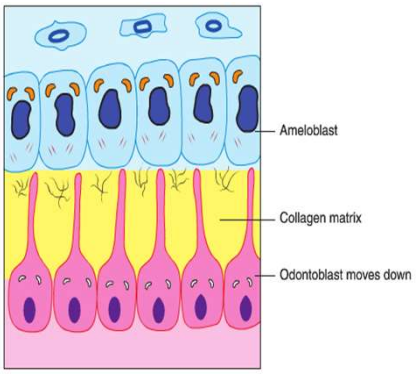
• Matrix formation begins with the appearance of large diameter collagen Fibrils (0.1–0.2 µm) known as **Vonkorff's Fibres**.

• Vonkorff's Fibres are laid down at ***right angles* to the future DEJ**. These fibres also give fan shaped extensions. They show a **corkscrew** appearance in sections stained with silver.

• Once the mantle dentin is laid, the remaining collagen fibres are laid ***parallel*** to the DEJ.



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• With the continuation of matrix formation, the length of the odontoblastic processes and the tubule increases.

• Dentin is formed at a rate of about **4 µm/day** till the crown is formed and the tooth erupts.

• As each increment of the matrix is formed, it remains for a day before it is calcified and the next increment of the matrix forms.

• The rate of matrix formation is **slower in the radicular dentin** and it contains collagen fibres which are parallel to the cemento-dentinal junction.

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2nd Phase: Mineralisation of Matrix

• As the odontoblasts give off processes, they also bud off several membrane-bound vesicles called **matrix vesicles**, which are involved in the mineralisation of the mantle dentin.

• These vesicles contain the **enzyme alkaline phosphatase**, which increases the concentration of phosphates.

• The phosphate combines with calcium (taken up from the tissue Fluid) to form **apatite crystals**.

• These apatite crystals grow to form a cluster of **crystallites** which fuses with adjacent clusters to form a continuous layer of **mineralised matrix**.

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Initially, the apatite crystals are deposited on the surface of collagen Fibrils and in the ground substance. Later, the crystals are laid down within the Fibrils.

Depending on the rate of dentin formation, there are **two mineralisation patterns**:

1. *Globular Pattern*
2. *Linear Pattern*

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The **Mantle dentin** shows *globular calcification* where the crystals are deposited in several discrete areas. Globular masses are formed as the crystals grow. They enlarge and fuse to form a single calcified mass.

The mineralisation in **Circumpulpal dentin** is either of the *globular pattern* (if the rate of dentin deposition is fast) or the *linear pattern* (if the rate of dentin deposition is slow).

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Genes involved in Dentinogenesis

1. *MAP1B gene* (role in odontoblast differentiation)
2. *PHEX gene* (role in dentin mineralisation)
3. The genes for some proteins like Dentin matrix protein 1 (DMP1), Dentin phosphophorin (DPP) are present at mineralization front.
4. Gene for Dentin sialoprotein (DSP) which is localised pre-dominantly in the dentinal tubules at the site of peritubular dentin.

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THANK YOU

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