DENTAL PRODUCTS

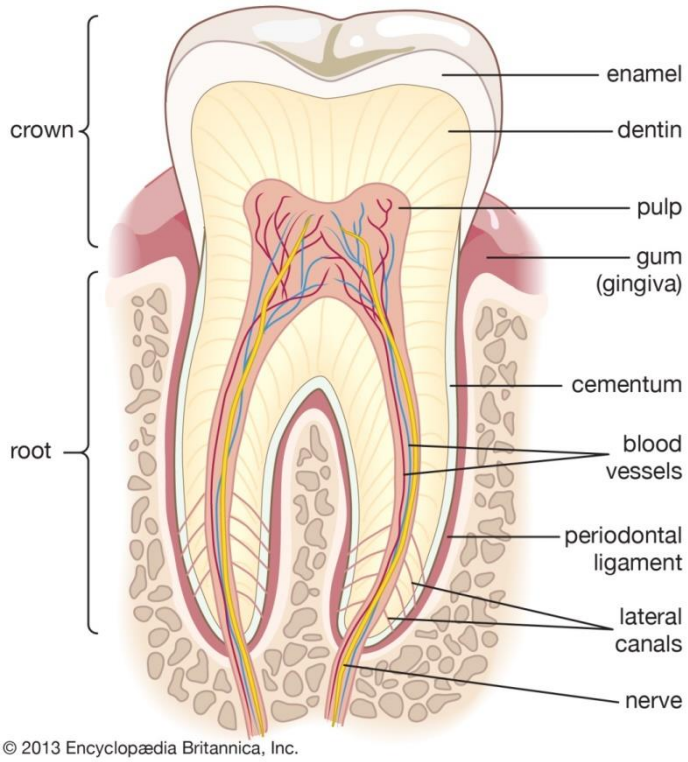
Tooth Anatomy

Tooth consists of three layers of calcified tissue:

1. **Enamel:** a white, hard calcified (consists primarily of Calcium phosphate & calcium carbonate) tissue covering dentin to cover the tooth projecting above the gum.

2. **Cementum:** a layer covering the portion of tooth lying buried in the gum.

3. **Dentin:** that part of the tooth that is beneath Enamal and Cementum and surrounds the pulp cavity.



- ❑ Dentine consisting 75% of mineral is hard and dense. Enamel consisting of 98% mineral, is even more dense. It is the hardest substance in the body.
- ❑ As in the case of bone, Vitamin A, C and D are all necessary for the proper tooth formation.
    - **Vitamin A** deficiency causes hypoplastic enamel (imperfectly calcified)
    - **Vitamin C** deficiency affects calcification of dentine.
    - **Vitamin D** not only helps the absorption of Calcium from GIT, but also for proper deposition of Calcium and Phosphate in tooth.

Other ions like Mg^{2+}, Cl^{-}, CO_3^{2-} and citrate are also present in tooth.

Common Dental Terms

1. **Abscess:** A serious infection sometimes caused by severe decay. Symptoms include pain and swelling. Root canal therapy is often required.
2. **Bleaching:** A process of applying hydrogen peroxide solution to whiten discolored or stained tooth.
3. **Crown:** Also known as Cap. An artificial cover for a decayed or damaged tooth. Made of plastic, metal, porcelain, or a combination of metal and porcelain.
4. **Filling:** Material used to fill a cavity. Usually composed of a mixture of metals (amalgam), plastic, porcelain or gold.
5. **Orthodontic treatment:** A method of correcting the position of teeth using braces or similar devices.
6. **Root Canal therapy:** also called endodontics. The cleaning out and filling the innermost part of the tooth, known as the pulp, that has been damaged or severely decayed.
7. **Periodontitis:** stage of gum disease and the leading cause of tooth loss among adults. Gums and tissue are inflamed, plaque gets into pockets below the gumline, tooth root become exposed and supporting bone is destroyed causing tooth loss.

Introduction to Dental Products

- Dental Products are used to maintain the dental hygiene and to prevent the decay of tooth. It is well known that the cleaner teeth keep good health and clean teeth cannot decay.
- In order to maintain dental hygiene numerous products are available in market. A large number of inorganic compounds is used in maintaining oral and dental hygiene.

Classification of Dental Products

Dental products include:

- **Anticaries agents:** These are the agents which help in prevention of dental decay. **e.g., Sodium fluoride, stannous fluoride**, sodium monofluorophosphate.
- **Cleaning agents (Dentifrices/ Polishing agents):** Dentifrices are agents used along with a toothbrush to clean and polish natural teeth. They must be abrasive to some degree to remove the stains from the teeth. They are supplied in paste, powder, gel or liquid form. **e.g., Calcium carbonate, Dibasic calcium phosphate,** calcium phosphate, sodium metaphosphate
- **Desensitizing Agents:** These reduce sensitivity of teeth to heat and cold. Examples include **strontium chloride and zinc chloride.**
- **Cement and fillers:** used to temporarily cover or protect the area that has undergone operation in dental surgery. **e.g., Zinc eugenol cement.**

Anticaries Agents

Sodium fluoride, stannous fluoride, sodium monofluorophosphate

- Dental caries, or tooth decay, involves a gradual demineralization (softening) of the enamel and dentin. If it is not treated then microorganisms may invade the pulp, causing inflammation and infection.
- Dental caries (tooth decay) is infectious disease, also called as dental plaque, in which acid formed by the action of oral microbial flora on carbohydrates. Dental plaque is a biofilm or mass of bacteria that grows on surfaces within the mouth. It is a sticky colorless deposit in starting, but it may often brown or pale yellow.
- It is characterized by decalcification of tooth accompanied by foul smell.
- Dental caries can be prevented and oral and dental hygiene can be maintained with the help of dentifrices. Dentifrices are the products that enhance the removal of stain and dental plaque by the toothbrush. The most accepted approach to prevent caries includes brushing accompanied by administration of fluoride either internally or topically to the teeth.

Mechanism of action of Fluoride:

- The deposited fluorides on the surface of teeth prevent the action of acids or enzymes in producing cavities.
- Fluoride is anticariogenic as it replaces the hydroxyl ion in hydroxyapatite with the fluoride ion to form fluorapatite in the outer surface of the enamel.
- Fluorapatite hardens the enamel and makes it more acid resistant. It is also possible that fluorides may possess some antibacterial activity and help in remineralization of enamel.
- A trace of amount of fluoride in drinking water is enough to prevent dental caries. Fluorapatite has also shown antibacterial activity.

Administration and Effects of over dose of Fluoride:

- Fluoride can be administered by two routes, orally and topically.
- Fluoride can be administered orally as sodium fluoride tablets or drops added in water or fruit juice. Fluoride when administered internally is readily absorbed from the gastrointestinal tract, partially deposited in the bone or developing teeth and the remainder gets excreted by the kidneys.
- A small quantity (0.5 -1 ppm) of fluoride thus becomes necessary to prevent caries. However, if more quantity of fluoride (more than 2-3 ppm) is ingested it is carried to bones and teeth and gives rise to mottled enamel known as dental fluorosis. Persons receiving slow continued ingestion of fluoride may suffer from mottling of teeth, increased density of bones, gastric disturbances, muscular weakness, convulsions and even heart failure.
- Topical fluoride solution, mouthwashes and gels are less effective than orally administered fluoride. Sodium fluoride tablets or solution of sodium fluoride in a dose 2.2 mg/day is generally

Sodium Fluoride

Molecular Formula: NaF

Molecular weight: 41.99 g/mol

Standards: Sodium fluoride contains not less than 98% and not more than 102% of sodium fluoride, calculated with reference to the dried substance

Method of Preparation:

1. It may be prepared by neutralizing hydrofluoric acid with sodium carbonate.

$$2HF + Na_2CO_3 \rightarrow 2NaF + H_2O + CO_2$$

2. Another method includes the double decomposition of calcium fluoride with sodium carbonate wherein insoluble calcium carbonate can be removed by filtration.

$$CaF + Na_2CO_3 \rightarrow 2NaF + CaCO_3$$

Properties:

A white powder or colourless crystals. Soluble in water practically, insoluble in ethanol (95 %)

Identification Tests:

1 gm of sodium fluoride is placed in a platinum crucible in a well- ventilated hood. To this, 15 ml of sulfuric acid is added and covered with a piece of clean polished glass. The crucible is heated on a water bath for an hour. After an hour the glass covered is removed and rinsed with water and wiped dry. It will be observed that the surface of glass has been etched.

Uses:

1. Sodium fluoride due to its fluoride ion is an important agent in dental practice for retarding or preventing dental caries. Fluoridised teeth have been resistant to microorganisms causing dental caries. It also decreases microbial acid production.

2. Sodium fluoride in 2 % aqueous solution is widely used topically.

Application:

1.5 to 3 ppm (equivalent to 0.7 to 1.3 ppm of fluoride ion) in drinking water; topically as a 2% solution to the teeth.

Caution:

When consumed in larger doses, sodium fluoride is poisonous. High fluoride water greater than 3 ppm) brings about mottling of teeth, gastric disturbances, etc. Stiller larger doses may lead to systemic toxicities effecting central nervous, cardiovascular, musculo-skeletal and respiratory systems

Stannous Fluoride

Molecular Formula: SnF_2

Molecular weight: 56.7 g/mol

Standards: It contains not less than 71.2% of stannous ion and not less than 22.3% and not more than 25.5% of fluoride, calculated on dries basis.

Method of Preparation:

1. It may be prepared by evaporating a solution of stannous oxide in hydrofluoric acid in the absence of oxygen.

$$SnO + 2HF \rightarrow SnF_2 + H_2O$$

Properties:

1. Its white crystalline powder having astringent salty taste.
2. It is soluble in water but insoluble in alcohol
3. An aqueous solution of stannous fluoride on standing, white ppt of stannous hydroxide will be developed.

$$SnF_2 + 2H_2O \rightarrow Sn(OH)_2 + HF$$

4. It should be kept in air tight closed container because of its tendency to get oxidised to stannous tetra-fluoride.

Identification Tests:

1. To 5 ml of 10% w/v solution in a test tube, when 2ml of calcium chloride is added, a white precipitate of calcium fluoride is obtained.
2. When 2 drops of 10% w/v solution of stannous fluoride and 2 drops of silver nitrate is mixed, a brown precipitate is formed.

Uses:

It is used to prevent dental caries in the form of solutions, gels, mouth washes or dentifrices but it has an unpleasant taste and may cause discoloration of teeth on over usage.

Cleaning agents
(Dentifrices/ Polishing agents)

e.g., Calcium carbonate, Dibasic calcium phosphate, calcium phosphate, sodium metaphosphate, calcium pyrophosphate

- Dentifrices contain agents for cleaning tooth surfaces and providing polishing effect on the cleaned teeth. These agents are abrasive in nature. They are responsible for physically removing plaque and debris. The overall effect provides whiteness to the teeth. Dentifrices are applied as powders or pastes.
- The main drawback is that it will not be able to clean surfaces inside cavities and crevices between teeth, even if the material reaches them during application. The cleaning action is dependent upon abrasive property and the rubbing force used. Pumice is too abrasive for daily use in a dentifrice.

Dibasic calcium phosphate/ Dicalcium Phosphate

- It is also known as Dicalcium phosphate or Dicalcium orthophosphate or calcium hydrogen phosphate. It occurs as a dihydrate ($CaHPO_4.2H2O$).
- When exposed to air, it effloresces losing water to form anhydrous dibasic calcium phosphate ($CaHPO_4$).
- In a very fine powder form, it finds use un dentifrices. It provides good flow properties and is odorless and tasteless.

Method of Preparation:

It may be prepared by reacting neutral solution of calcium chloride with disodium hydrogen phosphate

$$CaCl_2 + Na_2HPO_4 \rightarrow CaHPO_4 + 2NaCl$$

Uses:

1. This salt is having 1:1 ratio of calcium to phosphorus. It is most frequently recommended for oral administration as an electrolyte replenisher.
2. As a salt it is able to supply both calcium and phosphorus which is need for the growth in children and pregnant women's.
3. Externally it finds use as Dentifrice having cleaning action. The moderate abrasive quality makes it suitable for toothpaste and tooth powders.

Calcium Carbonate

Molecular Formula: CaCO3

Molecular weight: 100.1 g/mol

Synonym: Precipitated Chalk, Precipitated Calcium carbonate.

It has been regarded as one of the most abundant and widely distributed of calcium salts. In nature, it is found as chalk, marble, lime stone, aragonite and calcite and one of the main constituents of pearls and shells.

Preparation:

On commercial scale, calcium carbonate is obtained by mixing the boiling solution of calcium chloride and sodium carbonate and allowing the resulting precipitate to settle down

$$CaCl_2 + Na_2CO_3 \rightarrow CaCo_3 + 2NaCl$$

The precipitate is collected on filter and washed with boiling water, until becomes free from chloride ions, finally the precipitate is dried.

Properties:

It occurs as fine, white, micro-crystalline powder. It is odorless and tasteless. It is stable in air. It is almost soluble in water and alcohol. Calcium carbonate neutralises acids with effervescence.

$$CaCO_3 + 2\ HCl \rightarrow CaCl_2 + CO_2 + H_2O$$

Uses:

1. Precipitated chalk, which is having a fine powdery texture, is used in dentifrice, both powders and pastes.
2. It furnishes both abrasive and antacid effect in the mouth. If forms a common ingredients of tooth powder and toothpaste.
3. It is having a tendency to cause constipation and hence it is usually administered alternatively or along with magnesium salts.
4. It is rapidly acting non-systemic antacid. It neutralizes gastric acid and forms calcium chloride.

Desensitizing Agents

e.g., strontium chloride and zinc chloride.

- Desensitizing agents reduce the pain in sensitive teeth caused by cold, heat or touch. These products should be non-abrasive and should not be used on a regular basis unless directed by a dentist.
- The exact mechanism of action of desensiting agents is not known with certainty. However they act probably like local anesthetic.

Strontium chloride

Molecular Formula: $SrCl_2.\ 6H_2O$

Molecular weight: 266.2 g/mol

Preparation:

It is prepared by adding strontium carbonate to hydrochloric acid until effervescence gets ceased. The solution is filtered, concentrated and allowed to crystallize.

$$SrCO3 + 2HCl \rightarrow SrCl_2 + H_2O + CO_2$$

Properties:

It is available in the form of white crystals or granules. It produces effervescences in dry air. Soluble in water and alcohol

Uses: It acts desensitizing agent in dental remedies.

Zinc Chloride

Molecular Formula: $ZnCl_2$

Preparation:

It is prepared by heating granulated zinc with hydrochloric acid. When evolution of hydrogen ceases, the solution is filtered and evaporated to dryness.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

Uses:

1. It is used as an antiseptic astringent to the skin and mucous membrane as a 0.5–2.0% solution.
2. It is used as an active ingredient to prepare magnesia cements for dental fillings and certain mouthwashes.
3. It is also used as dentin desensitizer, topically as a 10% solution to the teeth. It is for topical use only and is administered as solution and mouthwash.

Cement and fillers

e.g. Zinc oxide eugenol cement.

- Dental cement is used to temporarily or permanently cover protect areas that have undergone operation as in dental surgery. The cementing material is applied as a paste, which gets hardened an a short while forming a protective layer. After healing the operated tissue, the hardened cement can be removed by the dentist.
- The temporary cement is also medicated, usually with eugenol, which is antiseptic and local anesthetic.

Zinc oxide eugenol cement

- Zinc oxide eugenol (ZOE) is a material formed by the combination of zinc oxide and eugenol contained in oil of cloves.
- They are cements of low strength. Also, they are the least irritating of all dental cements and are known to have an obtundent effect on exposed dentin.

Classification:

Type I ZOE: For temporary cementation

Type II ZOE: Permanent Cementation

Type III ZOE: Temporary filling and thermal base

Type IV ZOE: Cavity Liners

ZOE cement is available as:

1. Powder and liquid
2. Paste system

Method of Preparation:

- In the First Step Hydrolysis of Zinc Oxide to its hydroxide takes place. Water is essential for the reaction (dehydrated zinc oxide will not react with dehydrated eugenol)

$$ZnO + H_2O \rightarrow Zn(OH)_2$$

- The reaction proceeds as a typical acid – base reaction
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$$Zn(OH)_2 + 2HE \rightarrow ZnE_2 + 2H_2O$$

(Zinc hydroxide) (Eugenol) (Zinc eugenolate)

- The Chelate formed is an amorphous gel that tends to crystallize imparting strength to the set mass

Structure of set cement: The set cement consists of particles of zinc oxide embedded in a matrix of zinceugenolate.

- Setting time is around 4-10min.

Uses:

1. Zinc oxide eugenol is used in temporary and permanent cementation and also used as pulp capping agent.

2. It is used to reduce pain sensation in teeth and also has anesthetic and anti bacterial activity