Inorganic Pharmaceutical Chemistry

Lec8: Dental Products.

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The teeth are accessory digestive organs.
People use their teeth to bite and chew food, the first step in the digestion of food.
A number of inorganic compounds are used in maintaining the oral and dental hygiene.
Most of them are over the counter (OTC) products.
Dental products include:

- Anticaries agents (dentifrices and fluoride salts)
- Polishing agents.
- Desensitizing agents.
1. **Enamel**: Hard calcified (consists primarily of calcium phosphate and calcium carbonate) tissue covering dentin of the crown of tooth.

2. **Crown**: The crown is the visible portion of tooth above the level of the gums.

3. **Gingiva (gums)**: Soft tissues overlying the crowns of unerupted teeth and encircling the necks of those that have erupted.

4. **Pulp Chamber**: The space occupied by the pulp.

5. **Neck**: The area where the crown joins the root.

6. **Dentin**: That part of the tooth that is beneath enamel and cementum.

7. **Alveolar Bone (jawbone)**: The part of the jaw that surround the roots of the teeth.

8. **Root Canal**: The portion of the pulp cavity inside the root of a tooth; the chamber within the root of the tooth that contains the pulp.

9. **Root**: Embedded in the socket are one to three roots.

10. **Cementum**: Hard connective tissue covering the tooth root, giving attachment to the periodontal ligament.

11. **Periodontal Ligament**: A system of collagenous connective tissue fibers that connect the root of a tooth to its alveolus.
Dental Products: *Anticaries agents (dentifrices and fluoride salts)*

- 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 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 flossing and brushing accompanied by administration of fluoride either internally or topically to the teeth.
Dental Products: *Anticaries agents (dentifrices and fluoride salts)*

- 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.
- Fluorapatite has also shown antibacterial activity.
- Fluoride is most beneficial up to an age of 12 or 13 because unerupted permanent teeth are mineralizing during that time.
Fluorapatite Formation

(A) Fluoride ions ($F^-$) replace hydroxyl groups ($OH^-$) in hydroxyapatite to form fluorapatite in the tooth enamel. (B) A portion of the apatite crystal lattice is depicted showing the replacement of hydroxide for fluoride.
Under cariogenic conditions, carbohydrates are converted to acids by bacteria in the plaque biofilm. When the pH drops below 5.5, the biofilm fluid becomes undersaturated with phosphate ion and enamel dissolves to restore balance. When fluoride (F–) is present, fluorapatite is incorporated into demineralized enamel and subsequent demineralization is inhibited.

16-Dec-15
Demineralization/Remineralization with fluoride
Dental Products: *Anticaries agents (dentifrices and fluoride salts)*

- 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.
- It is not always feasible to administer fluoride internally and in post-adolescent individuals, it is not beneficial.
- Inorganic phosphate salts can also be useful in the prevention of dental caries (e.g., calcium sucrose phosphate, \( \text{NaH}_2\text{PO}_4 \), \( \text{Na}_2\text{HPO}_4 \), etc.).
Dental Products: *Polishing Agents*

- 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.
- Examples include dicalcium phosphate, sodium metaphosphate, calcium pyrophosphate, calcium carbonate and calcium monohydrogen phosphate.
- Pumice is too abrasive for daily use in a dentifrice.
Dental Products: Desensitizing Agents

• 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.
• Examples include strontium chloride (Sensodyne®) and zinc chloride (Listerine®).
Dental Products:

- **Sodium Fluoride**: NaF Mol. Wt. 41.99
- **Uses**: It is used as preventive for dental caries because of its fluoride ion content.
- **Usual dose**: 2.2 mg (equivalent to 1 mg of fluoride ion)
- **Application**: 1.5-3.0 ppm (equivalent to 0.7-1.3 ppm of fluoride ion) in drinking water; topically, as 2% solution for the teeth.
- **Formulations**: Sodium fluoride is administered as solution, tablet, oral gel for systemic use or as mouth wash for local use.
Dental Products:

- **Zinc chloride**: ZnCl\(_2\) Mol. Wt. 136.29
- **Uses**: It is used as desensitizing agent, antiseptic, and astringent to the skin and mucous membrane as a 0.5–2.0% solution. It ranks very low among disinfectants.
- It is used as an active ingredient to prepare magnesia cements for dental fillings and certain mouthwashes.
- It is also used as dentin desensitizer, topically as a 10% solution to the teeth.
- **Formulation**: It is for topical use only and is administered as solution and mouthwash.
Some mouthwashes with significant antimicrobial activity

<table>
<thead>
<tr>
<th>Agent</th>
<th>Dose</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorhexidine gluconate</td>
<td>0.12–0.2% aqueous mouthwash, rinse for 1 min twice daily. Also 0.5–1.0% gel or spray</td>
<td>A cationic chlorinated bisbiganide with significant antiplaque and antifungal activity and oral retention; traces can still be found in saliva after 24 h May stain teeth or tissues if patient drinks tea, coffee or red wine</td>
</tr>
<tr>
<td>Triclosan</td>
<td>0.03% mouthwash, rinse for 1 min twice daily</td>
<td>A non-ionic chlorinated bisphenolic antiseptic with moderate antiplaque and antifungal activity, but less retention in mouth than chlorhexidine More effective against plaque when with copolymer or zinc citrate</td>
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</tbody>
</table>
### Active principles in toothpastes (dentifrices)

<table>
<thead>
<tr>
<th>Category</th>
<th>Ingredients</th>
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</thead>
<tbody>
<tr>
<td>Anticaries</td>
<td>Amine fluorides, Calcium phosphate, Calcium pyrophosphate, calcium trimetaphosphate, Nicomethanol fluorhydrate, Potassium fluoride, Sodium fluoride (NaF) 1450-1500 ppm (&lt; 600 ppm in child paste) Sodium monofluorophosphate (NaFPO₃), Stannous fluoride, Xylitol</td>
</tr>
<tr>
<td>Antibacterials</td>
<td>Chlorhexidine, Fluorides, Hexetidine, Hydrogen peroxide, Plant extracts Potassium peroxypophosphate, Sanguinarine, Siliglycol, Sodium bicarbonate Stannous pyrophosphate, Triclosan, Urea peroxide, Xylitol Zinc chloride, Zinc citrate, Zinc trihydrate</td>
</tr>
<tr>
<td>Anti-malodour</td>
<td>Chlorhexidine, Triclosan, Zinc chloride, Zinc citrate</td>
</tr>
<tr>
<td>Whiteners</td>
<td>Benzalkonium chloride, Calcium carbonate, Calcium phosphates Carboxymethyl cellulose, Citroxaine, Pentasodium triphosphate Potassium tetra pyrophosphate, Sodium benzoate Sodium bicarbonate, Sodium tripolyphosphate</td>
</tr>
<tr>
<td>Anti-tartar</td>
<td>Azocycloheptane diphosphonate, Potassium pyrophosphate, Zinc chloride, Zinc citrate</td>
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<tr>
<td>Anti-hypersensitivity</td>
<td>Formaldehyde, Potassium citrate, Potassium chloride, Potassium nitrate Sodium citrate, Sodium fluoride, Stannous fluoride, Strontium chloride</td>
</tr>
<tr>
<td>Others</td>
<td>Enoxolone, Essential oils, Keratin, Panthenol, Permethol Provitamin B5, Tocopherol, Vitamin E</td>
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</tbody>
</table>
References:

- Inorganic Medicinal and Pharmaceutical Chemistry by Block, Roche Soine and Wilson, 1986.
- http://pocketdentistry.com/4-treatment/