Sealers, liners and bases are materials placed between dentin (and sometimes pulp) and the restoration to provide pulpal protection or pulpal response.
CAUSES OF IRRITATION

Caries → **Bacteria** → Pulpal inflammation.

Restorative **procedures** → Mechanical process during cavity preparation (heat, pressure, vibration).

→ Chemical constituents of the restorative materials.

Thus, the reaction of the P.D organ is not due to a single factor, but due a cumulative effect.
Cutting with rotary instruments produces a layer of debris attached to tooth surface called **smear layer**

20-30% porous
Thus, pulpal protection requires consideration of:

1. Chemical protection
2. Electrical protection
3. Thermal protection
4. Pulpal medication
5. Mechanical protection
REMAINING DENTIN THICKNESS (RDT)

Best protection of the pulp is sound dentin (1-2mm)

Concerns become important as the tooth preparation extends closer to the pulp.

Conservation of the remaining tooth structure is more important to pulpal health.

It is contraindicated to currently suggest routine placement of liner and base
1a. Slight tooth injury, small restoration, no pulp exposure

1. Dentin injury by minor caries/cavity preparation and restoration
2. TGF-β and bioactive molecules released from dentin
3. Increase in odontoblast secretory activity
4. Deposition of reactionary dentin by primary odontoblasts

1b. Severe tooth injury, large restoration, with pulp exposure

1. Pulpal exposure by caries/cavity preparation terminally injures underlying odontoblasts
2. TGF-β and bioactive molecules released from dentin to pulp.
3. Odontoblastoid precursor cell proliferation/migration/differentiation.
4. Chemotactant gradient from odontoblastoid cells to site of injury
5. Deposition of tertiary dentin matrix by newly differentiated odontoblastoid cells.
IDEAL REQUIREMENTS OF INTERMEDIARY MATERIAL:

It should:

✓ Improve marginal **sealing** and the adaptation

✓ **Sedative action, biocompatible & Non-irritant** to vital pulpal tissues & Enhance the formation of reparative dentin.

✓ **Compatible** with the overlying restorative material.

✓ **Provide** **thermal & electrical** insulation

✓ Reduce the **galvanic** action of metallic restorations.

✓ **Strong enough & have minimal effective film thickness.**

✓ **Resist degradation**

✓ **Easy to apply**
Protective Needs from restorations Vary acc. to

Extent
Location of prep
& type of Restorative material used
TYPES AND CLASSIFICATION OF INTERMEDIARY MATERIALS

LINERS
- Suspension Liner
- Cement Liner
- Solution Liners
- Varnishes
- Dentin sealer
- Bonding systems

Cement BASES
1) Solution liners are thin film materials which seal dentinal tubules and provide a protective coating for freshly cut tooth structure of the prepared cavity.
LINERS

Cavity varnishes:

- **Composition:**
  - They are natural organic copal resin or synthetic resin gum dissolved in solution of ether, chloroform or acetone

- **Functions:**
  - Evaporate rapidly leaving thin semipermeable membrane.
    - barrier against chemical irritation
    - seals dentinal tubules; thereby it reduces movement of dentinal fluid and subsequently decreases hypersensitivity.
    - improving the adaptation
    - electrical insulation
    - It is compatible with pulp-dentin organ
      - The thickness varies from 5 to 25 microns.
      - 2-3 coats are applied
Indications of varnish:
1. Under amalgam.
2. Under cast gold.
3. Under acidic base material such as Zinc phosphate cement.

Contra Indications of varnish:
1. Under resin composite restorations.
2. Under glass ionomer, resin modified glass ionomer and polycarboxylate cement..
The use of **varnishes** has decreased considerably in the late 1990s after the development of adhesive sealers.
Adhesive sealers:

Have bonding ability

Include:
- adhesive bonding systems
- desensitizing systems
- resin luting cements
- glass ionomer luting cements.

Adhesive sealers can be used under any type of dental restoration.
2- Suspension Liners:

combination of alkaline calcium hydroxide and other basic metal oxides (zinc oxide) in a resinous solution provide a protective film having greater physical integrity, chemical neutralizing capacity for acids as well as pulpal protection.

insufficient to provide any thermal or electrical insulation

Hypocal and Pulpdent
3- Cement Liners:

- materials placed in medium thickness to provide pulpal medication and/or chemical protection

- Relief of pulpal inflammation and Enhance dentin formation

All *cement liners and bases* have some degree of solubility in oral fluids. Thus, they should be placed *only on dentin* and completely removed from cavity walls and margins.
Newer liners place **less emphasis on pulpal medication** and focus more on chemical protection by sealing, adhesion, and mechanical protection.

- To act as **stress breakers** to resist polymerization stresses in composite restoration.
- To provide **fluoride** release
- **Sealing** the dentin from an invasion of micro-organisms and irritants resulting from restorative procedures (chemical protection). Antibacterial action
Needs are greatest with pulpally extended metallic restorations that are not well bonded to tooth structure and that is not insulating, such as amalgam and cast gold, or with other indirect restorations.

Resin restorations: The insulating nature & sealing effects of the bonding agents preclude the need for traditional liners and bases unless the tooth preparation is extremely close to the pulp and pulpal medication becomes a concern.
Cement Bases

Thick consistency applied in thick sections to substitute lost dentin and provide thermal and mechanical protection.

**Types of bases:**

1. Resinous Hard-setting Calcium hydroxide \((Ca (OH)_2)\)
2. Reinforced Zinc oxide and eugenol \((RZO/E)\)
3. Zinc phosphate cement \((ZPC)\)
4. Zinc polycarboxylate \((PCC)\)
5. Glass ionomer \((GIC)\)
6. Resin modified glass ionomer cement \((RMGIC)\)
They are provided in different forms:

1- Powder form.

2- Suspensions of calcium hydroxide-powder in distilled water or solutions of synthetic resins.

3- Paste form conventional and Light cured paste
Setting reaction:

acid-base reaction to produce an alkaline paste of pH =11.

The final set cement is hydrolytically instable; calcium, hydroxyl and salicylate ions are continuously released from the mass.

N.B.: After certain period of time, the entire mass will disappear from under the restoration.
Properties & indications:

1- The material has three pharmacological actions:
   - Anti-inflammatory action.
   - A calcifying agent (reparative dentin).
   - Antiseptic.

2- Low strength.

3- Good thermal insulation & strong (resinous hard-setting formulations) but since they degrade over time, they can no longer provide mechanical support for the restoration.

4- Bad electrical and chemical insulation at any thickness because it is porous & soluble.

5- High solubility and poor physical properties which restrict its use over the smallest area when known or suspected pulp exposure exists.

Visible light-activated CaOH products have overcome deficiencies.
Setting reaction:

Polymerization reaction of the monomers and CaO particles do not enter into the reaction.

Can be used as:

1- Sub-base.

2- Capping agent "direct or indirect".
1. ZINC OXIDE EUGENOL (ZO/E and RZO/E):

**Composition:**
- Powder: zinc oxide.
- Liquid: Eugenol or oil of cloves.
- Polymers
- Fillers

RZO/E, eugenol XX ethoxy benzoic acid

**Indication:**
- Liner in moderately deep cavities & Temp. filling & Temp. cementation.
- RZO/E can be used as a base material, when biological consideration is more important than mechanical one.
Contraindication:

1. In very deep cavities (dentin bridge ≤ 0.5mm) or as a direct pulp capping material.
2. With resinous tooth colored restoratives.
3. With glass ionomer cements as well as polycarboxylate cement, where it would deprive the bonding capabilities of these materials.
Properties:

a. Pharmacological actions (obtunding, palliative or sedative).

b. Placed in moderately deep cavities, RZO/E can have irritating action on pulp tissues at this depth.

c. It has effective thermal and electrical insulating capacity in film thickness as low as 0.25mm.

d. It has two main weaknesses, its low crushing strength and slow setting.
2. ZINC PHOSPHATE CEMENT:

Composition:

**Powder:** zinc oxide and magnesium oxide.

**The liquid:** is orthophosphoric acid

**Setting reaction:** Acid – base reaction.
Properties:

1) Excellent thermal insulating capacity.
2) Good electrical insulator.
3) Highest strength: 20,000 psi.
4) It is compatible with any restorative material and intermediary base material.
5) It is easier in manipulation.
6) It is irritant to the pulp (acidic pH).
7) It has an exothermic setting reaction.
Two mixes of the cement were prepared:

- The luting mix (thin mix)

- The base mix (viscous mix),

Indications:
Replacement of dentin lost by extensive dental caries.
• ZOE and ZPhC cements have been used for years for a variety of restorations. Their use has diminished in recent years with the growing question of their benefit to pulpal health and with the advent of materials that are adhesive to dentin and release fluoride.
3. POLYCARBOXYLATE CEMENT:

The powder:
zinc oxide and some magnesium oxide & silica

The liquid:
aqueous solution of polyacrylic acid and co-polymers.

Setting reaction:
Chelation reaction or acid base reaction.
chemically bond to tooth structure
• Zinc poly-carboxylate has been used as luting cement and a base material for its high tensile strength, its potential of adhesion (bonds chemically) decrease microleakage, good thermal & electrical insulator and its minimal irritation to the pulp.

✓ The pH rises rapidly to 3.4 after two minutes from the start of mixing.
✓ Polyacrylic acid is weaker than phosphoric acid.
✓ Polyacrylic acid has low diffusion mobility into the underlying dentin due to its large molecular size and because of immediate complexing with fluoride and calcium of tooth structure which would hinder further penetration of the acid.
Glass ionomer has been used as cavity liner or base in an attempt to take advantage of two highly desirable properties: **chemical bond** to tooth structure and **fluoride release**.
**Powder**: aluminosilicate glass with flux fluoride salts (calcium alumino fluorsilicate).

**Liquid**: polyacrylic acid.

The setting is through acid-base reaction.

RMGIC is a hybrid ionomer modified by resin monomers.
Properties:

- Adhesive potential.
- Anticariogenic.
- It can be applied as a base with 1mm. film thickness.
- High compressive strength.
- High sealing ability.
- Adequate thermal insulating capacity chemical and mechanical protection.
- Bad electrical insulation.
- High compatibility to pulp/dentin organ.
- Incompatible with cavity varnish and zinc oxide and eugenol.
- It can not stimulate reparative dentin.
Indications:

used as liners, bases, luting cements as well as restorations.

under resin composite restoration in a technique known as the Sandwich Technique to combine the benefit of adhesion and fluoride release of GI with better esthetic and higher mechanical properties of resin composite.

reducing the total volumetric polymerization shrinkage of resin composite

Manipulation:

cavity should be conditioned with polyacrylic acid

Packing of the cement should be done before it loses its glossy appearance, in order to gain its full adhesive potential
CLINICAL CONSIDERATIONS FOR USE OF INTERMEDIARY MATERIALS

- Remaining dentin thickness (RDT)
- Adhesive properties of liner or base
- Type of restorative material:
* (RDT ≥ 2mm) .. no need for pulpal protection other than chemical protection (i.e. sealing).

* **Amalgam** only a solution liner (varnish, dentin sealer or bonding system in case of bonded amalgam) is utilized.

* **Resin composite**, only its bonding system is needed.

* **GIC restoration** does not need any pulpal protection in this case.

* **Indirect restoration**, a solution liner is needed for sealing in addition to the use of luting cement.

* **Cast gold restoration**, a varnish or dentin sealer may be used while with composite/ceramic inlays a dentin bonding agent is used with luting cement.
• In (RDT=0.5-2mm),
• **amalgam** … use of a cement liner/base that is capable of pulpal sedation, e.g. ZOE or Ca(OH)2 in addition to a solution liner for sealing.

* **Resin composite**, dentin bonding agent will provide sufficient sealing, while a liner/base of GIC or RMGIC might sometimes be needed to reduce the volume of the cavity preparation not for pulpal protection.

* **GIC restoration** does not need placement of any intermediary material.

* **Indirect restorations** will also need sealing in addition to liner/base and luting cement.
* If (RDT ≤ 0.5mm), there is strong need for pulpal protection. Pulpal medication with Ca (OH)2 is essential with all restorative materials to induce secondary dentin formation and relief pulpal inflammation. Sealing is also essential in addition to a strong base to substitute dentin loss.

Same recommended procedures for sealing and placement of base cement previously mentioned.