4. **Zinc oxide eugenol impression material:**
It's described as a rigid, mucostatic, irreversible (set by chemical reaction) and hydrophobic impression material. We have 2 types of zinc oxide eugenol impression material

-----Type I hard

-----Type II soft.

- **General uses of zinc oxide –eugenol:** The combination of zinc oxide and eugenol is widely used in dentistry
  1. **Final impression for edentulous arches.** (impression material)
  2. **Occlusal bite registration.** (impression material)
  3. Temporary relining material for dentures.
  4. Temporary filling.
  5. Surgical pack in periodontal surgical procedure.
  6. Root canal filling.
  7. Cementation and insulating medium.

- **Presentation:** The impression material is in the form of two pastes (2 tubes):
  - Base paste (white color).
  - Reactor or accelerator or catalyst paste (red in color).

- **Composition:**
  
  **Base paste:**
  - zinc oxide 87 %. (reactive component take part in setting reaction).
  - fixed vegetable or mineral oil 13 %. (act as plasticizer).
  - water.

  **Reactor or accelerator or catalyst paste:**
  - oil of cloves or eugenol 12%. (reactive component).
  - gum or polymerized rosin 50%. (speed the reaction).
  - filler (silica type). 20%
  - resinous balsam 10 %. (improve flow and mixing properties).
  - lanolin 3%
  - accelerator solution CaCl2 and coloring agent 5%.
  - water.

- **Chemical reaction**

\[
\text{Zinc oxide} + \text{eugenol} + \text{H}_2\text{O} \rightarrow \text{zinc eugenolate} + \text{zinc oxide (unreacted)}
\]

The set material consists of a mixture of amorphous zinc eugenolate matrix which holds unreacted zinc oxide particles together.
• **Manipulation**

Two strips of equal length are squeezed from each tube (base and catalyst) on glass slab or paper pad mixed (mixing time=1 min.) until a uniform color is observed. Then the mixture is filled into **fitted** special tray (without spacer). No separating medium is needed before the stone model is pour, and after the stone has set it can be separated from the impression by immersion in hot water (50-60) C for 5 to 10 minutes.

• **Properties**

1. Setting time
   - Type I : Initial setting time=(3-6) Min., final setting time=**10** Min.
   - Type II : Initial setting time=(3-6) Min., final setting time=**15** Min.

   **Factor controlling the setting time:**
   - By varying the length of the two pastes (not recommended).
   - Setting time can be decreased by adding zinc acetate or acetic acid or drop of water.
   - Longing the mixing time, short is the setting time.
   - High atmospheric temperature and humidity accelerated the setting time.
   - Setting time can be delayed by cooling the mixing slab, spatula or by adding small amounts of waxes or oils.

2. Accurate registration for surface details due to good flow. The material has mucostatic properties (recording tissue in uncompressed state).
3. Rigid non elastic once set and should not be used for partially edentulous arches, or undercut areas it’s fractured when removed from undercut area.
4. It requires a special tray for impression making.
5. It has adequate adhesion to acrylic tray (no need adhesive material).
6. It has advantages of being dimensionally stable, a negligible shrinkage (less than 0.1 %) may occur during hardening.
7. No separating medium is needed before the stone model is poured because it does not stick to the cast material.
8. The paste tends to adhere to skin, so the skin around the lips and the cheek should be protected with petroleum jelly (Vaseline) to make the cleaning process much easier.
9. Although the material not toxic, Eugenol can cause burning sensation and tissue irritation. So non eugenol paste was developed where the zinc oxide is reacted with a carboxylic acid.

10. It can be checked in mouth repeatedly without deformation.

- **Advantage**
  1. Good adapted to the soft tissues without causing displacement of the soft tissue (mucostatic), so it has good reproduction of surface detail.
  2. Good dimensional stability.
  3. Well Adhere to the special tray (no need for adhesive).
  4. Inexpensive.
  5. Not need separating medium before the stone model is pour.
  6. It can be checked in the mouth repeatedly without deformation.
  7. Minor defects can be corrected locally.
  8. It has enough working time to complete border molding.
  9. Pour any time.

- **Disadvantage**
  1. Messiness
  2. Non elastic and may fracture if undercuts present.
  3. Variable setting time due to temperature and humidity.
  4. May irritate to soft tissue due to the eugenol.
  5. The skin around the lips and the cheek should be protected with petroleum jelly (Vaseline).
  6. It need special tray.

**Elastic impression material**

It is the ideal impression materials for reproduction of tooth form and relationship, which can be with-drawn from the undercut area & return to its original form without distortion.

**Types of Elastic impression material**

2. Elastomeric Impression Materials.
1. Hydrocolloid Impression Materials (Aqueous Impression Material)

Hydrocolloid impression materials used in dentistry are based on colloidal suspensions of polysaccharides in water.

The colloid exists in two forms:

- In Sol form: (fluid, low viscosity & random arrangement of polysaccharide chain.)
- In Gel form: (high viscosity may develop elastic property when the long polysaccharide chains become aligned.).

**Gelation:** Is the conversion of sol to gel & development of elastic properties through alignment of polysaccharide chains.

Hydrocolloids are classified into two types based on mode of gelation:

1. **Reversible:** called reversible because their physical state can be reversed; this make them reusable (by lowering the temperature). Gel formation is induced by cooling the sol; on reheating the bonds of the gel are readily destroyed & the material reverts to the sol. e.g. Agar impression material.

2. **Irreversible:** once these set is usually permanents, so known as irreversible. set by chemical reaction & once the gel formed doesn't revert to the sol form. e.g. alginate impression material.

1. **Agar (reversible hydrocolloid):**

It is elastic, Reversible, Hydrophilic, mucostatic impression material. Agar was the first successful impression material to be used in dentistry. It is an organic hydrophilic colloid (strong affinity to water) polysaccharide extracted from certain type of seaweed; although it is an excellent and accurate impression material. Presently it has been largely replaced by alginate & rubber impression material (The preparation of agar to clinical use requires careful control & expensive apparatus). When agar heated they go into sol (liquefy) & on cooling they return to gel state.

\[ \text{Gel} \xrightarrow{\text{heating}} \text{sol} \xrightarrow{\text{cooling}} \text{gel} \]

- **Uses:**
  1. Widely used at present time for cast duplication (during fabrication of cast removable partial denture).
  2. Full mouth impression without deep undercut.
  3. Crown & bridge impression before elastomers came to the market.
  4. As tissue conditioner.
**Presentation:**

1. **Tray impression material**: Gel form in collapsible tube for loading the tray. Each tube has enough material to fill a full arch, water-cooled tray is needed.
2. **syringe material**: Packaged in plastic or glass cartridges that fit a syringe or in preloaded syringe. The syringe material has different color & it is more fluid than tray material and easy ejected from the syringe and inject around the teeth.
3. **In bulk container (for duplication)**

**Composition:**

1. **Agar** (12% for tray material; 6-8 % for the syringe type). (Colloid). The agar content is reduced in the syringe type, so it is more fluid at the time of injection than the tray material at the time of insertion.
2. **Borax** (to improve strength of the gel).
3. **Potassium sulphate** (accelerator for model material, to ensure proper setting of gypsum cast against agar).
4. **Alkyl benzoate** (preservative; antifungal agent).
5. **Wax, hard** (as a filler, effects strength, viscosity & rigidity).
6. **Dyes & flavoring** (trace), (to improve appearance and taste).
7. **Water (85%)**, (as dispersion medium).

**Gelation of Agar:**

Is a solidification process (means the setting of a reversible hydrocolloid impression material). The physical change from the sol to gel, & vice versa is induced by a temperature change. The gel must be heated to a higher temperature (liquefaction temperature 100C) to return it to the sol condition. It transverses to gel at 37C to 50C (gelation temperature). If the gelation temperature is too high the heat from sol may injure the oral tissue.

**Manipulation**

Agar hydrocolloid requires special equipments:

A. Hydrocolloid conditioner.
B. Water cooled rim lock tray.
• **Hydrocolloid conditioner.**

Agar is normally conditioned prior to use, using specially designed conditioning bath (temperature controlled water bath), the conditioning bath consists of 3 compartments each containing water hold at different temperature which are:

1. **Boiling section or liquefaction section:** The tube of gel is first placed in the 100C bath for 10 minutes; this rapidly converts the gel to sol & the content of the tube become viscous. The sol should be homogenous and free of lumps. Every time the material is reliquefied three minutes should be added; this is because it is more difficult to break down the agar brush heap structure after the previously use (The material should not be reheated more than four times). The tube is then transferred to

2. **Storage section:** 65-68C temperature is ideal for storing the agar in the sol condition till needed.

3. **Tempering section:** 46 C for about 2 minutes with the material loaded to the tray. This is done to reduce the temperature so that it can be tolerated by the sensitive oral tissue and also make the material viscous. If the material is maintained at this stage for long time it slowly begins to revert to the gel form.

<table>
<thead>
<tr>
<th>100 C 10 min.</th>
<th>65-68 C 2 min.</th>
<th>46 C 2 min.</th>
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<tbody>
<tr>
<td>Liquefaction section</td>
<td>storage section</td>
<td>tempering section</td>
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• When the impression is recorded, the sol is expressed from the tube into a tray & seated in patient’s mouth. The rate of conversion from sol to gel may be accelerated by spraying cold water onto the impression tray whilst it is in the mouth, or by using water- cooled rim lock impression trays.
A. **Water cooled rim lock tray:**
Metal tray with a narrow-bore metal tube attached to outer surface. The tube is connected to a cold water supply (18 to 21) C & the circulating water reduces the temperature of the tray.

The tray containing tempered material is removed from the bath, the outer surface of the agar is scraped off, then the water supply is connected to the tray and the tray is positioned in the mouth, water is circulated at until gelation occur. Rapid cooling is not recommended (e.g. ice cold water) as it can induce distortion. Then after the agar has gelled it is removed rapidly from the mouth with single stroke or snap, the impression is rinsed thoroughly with water & excess water is removed by shaking the impression.

The cast should be poured immediately, storage in air result in dehydration & storage in water result in swelling the impression. If storage is unavoidable, it should be limited to one hour in 100% relative humidity (which results in least dimensional changes). When the gypsum product has set, the agar impression material must be removed as soon as possible (the impression will be dehydrated become stiff and difficult to remove in addition the prolonged contact will result in rougher surface on the model).

- **Properties of agar:**
  1. It is hydrocolloid mucostatic impression.
  2. It is cheap and is used in some laboratories for making duplicate models (reused up to 4 times).
  3. Very accurate reproduction of surface details because in sol form the agar is sufficiently fluid.
  4. In gel form it is sufficiently flexible to be easily removed.
  5. Agar is highly accurate at the time of removal from the mouth. Storage of agar impression is to be avoided; the cast should be poured immediately.

Storage in air results in dehydration (shrinkage) and storage in water results in swelling of impression; it absorbs water in process known as **imbibitions.** The gel may also loose water by exuding of fluid in process known as **syneresis** (during syneresis small droplet are formed on the surface of hydrocolloid and the process occur irrespective of the humidity of the surrounding atmosphere), If storage is unavoidable, it should be limited to one hour in 100% relative humidity by wrapping it in wet towel (which result in least dimensional changes)
6. Poor mechanical properties & low tear resistance but it is better than alginate.
7. It is important to remove the tray by rapid snap action that enhanced elastic recovery & decrease permanent deformation.
8. It is necessary to have reasonable thickness of impression material to limit the extent of deformation arising on removal from the undercut.
9. Working time range between 7-15 minutes & setting time about 5 minutes. Both can be controlled by regulating the flow of water through the cooling tube.

• **Advantages:**
  1. Accurate impression material if the material is properly handled.
  2. It has good elastic properties and reproduces most undercut areas correctly.
  3. It well tolerated by the patient.
  5. No mixing required.
  6. Cheap.
  7. Can be reused when used as duplicating material (not commended when used as impression material).

• **Disadvantages:**
  1. Need special equipment such as water cooled tray and temperature controlled bath and there is an initial cost in proving this equipment.
  2. Water cooled tray is very bulky.
  3. Low tear resistance.
  4. A soft surface of gypsum cast result unless plaster hardener is used.
  5. Great care must be exercised to ensure that the water baths do not get contamination.
  6. Difficult to disinfect.
  7. If it is not pour as soon as possible led to low dimensional stability due to imbibitions and syneresis.