

# In-Office Bleaching Technique and It's Effect on Dental Pulp



Assist. Lect. Rusul Jaffar Hadi  
MSc. Oral Histology and Embryology

# **Contents**

- **Introduction**
- **Anatomy of dental pulp**
- **Histology of dental pulp**
- **Tooth staining**
- **Definition of tooth bleaching**
- **Mechanism of action of dental bleaching agent**
- **Composition of commercial bleaching agents**
- **Types of vital tooth bleaching procedures**
- **Factors influencing tooth whitening efficiency**
- **Adverse effects of bleaching agents**
- **Conclusion**

# INTRODUCTION

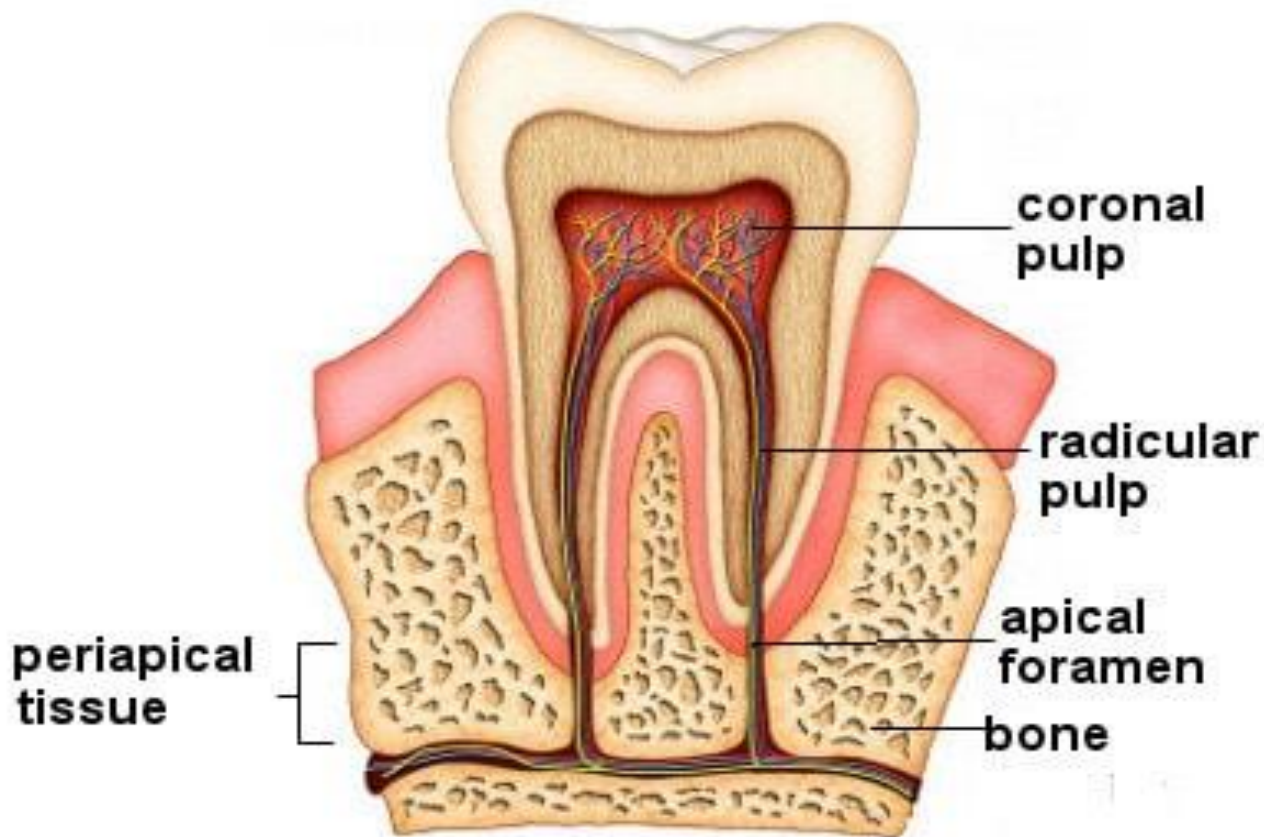


**Dental pulp** is a loose connective tissue that exists in a rigid chamber consists of enamel, dentine and cementum. This unique tissue consists of a heterogenous cell population including fibroblasts, odontoblasts, residential immuno-competent cells and undifferentiated mesenchymal cells. In addition, the dental pulp has a high numbers of sensory nerves and capillary networks.



# Anatomy of dental pulp

Typically the center area of each tooth occupies by the dental pulp and mainly consists of delicate connective tissue. Generally the location of the pulp is the pulp chamber of the crown and the root canal of the tooth. In the crown in which part of the pulp is located it is named by the coronal pulp as well as the pulp that present in the root is termed by the radicular pulp. Therefore, the shape of the pulp follows the shape of the tooth in which it is contained





# Histology of dental pulp

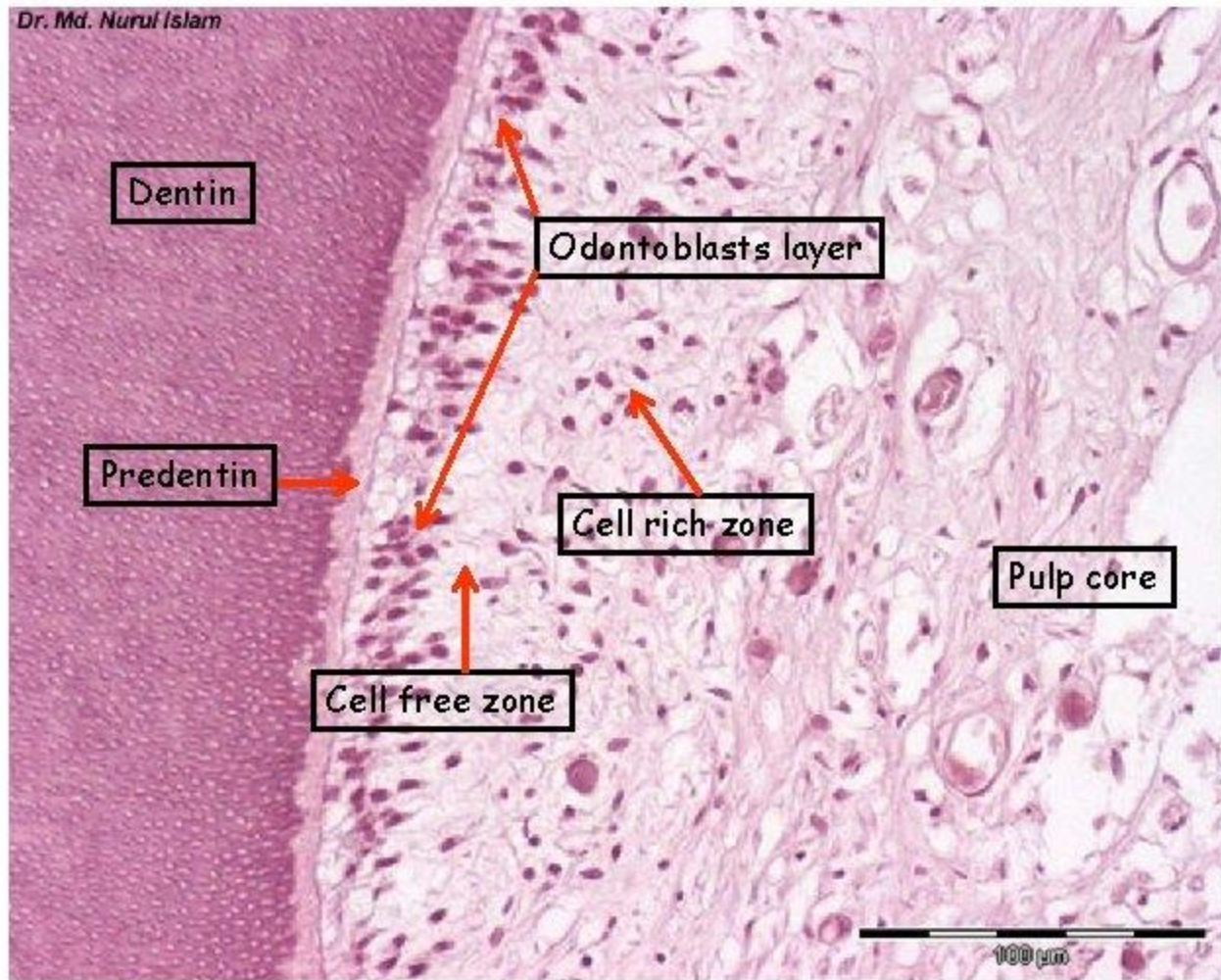
The dental pulp is soft connective tissue which the dentin supports by it. During histological examination, four unique zones can be distinguished:

**1-Odontoblastic zones:** it is representing the peripheral aspect of pulp, which contains the odontoblast cells body.

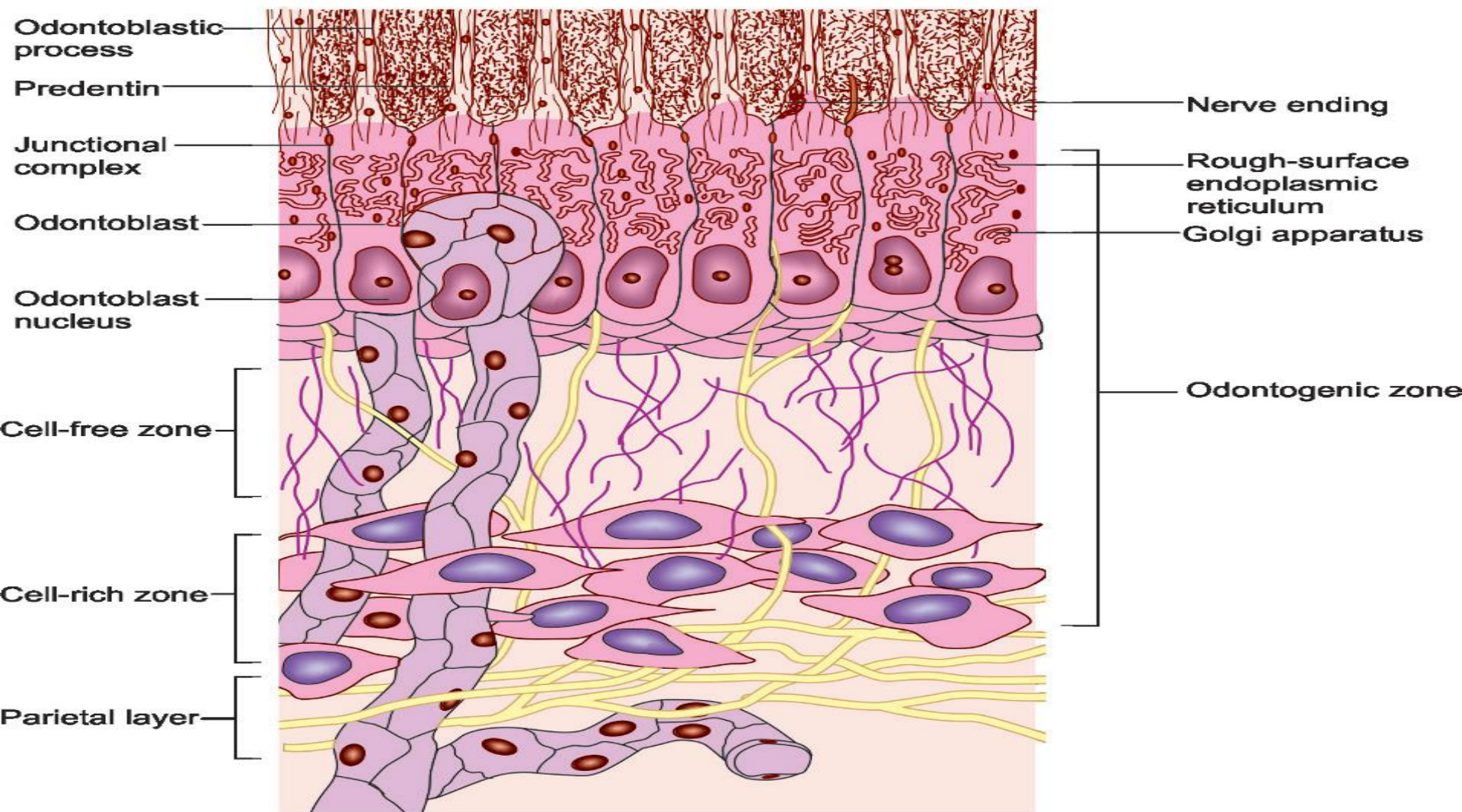
**2-Cell-free zone or zone of Weil:** This zone contains many bundles of fibers, numerous capillaries and nerves but does not contain any cells.

**3-Cell-rich zone:** it contains several fibroblasts which represent the predominant cells type of pulp and also contains undifferentiated mesenchymal cells which can be differentiated into different pulp cells.

**4-Pulp core:** This zone mainly contains the main blood vessels in the pulp and Raschkow plexus of nerves







The dental pulp is sensitive to different external factors and may result in initiating of inflammatory cascades. The rapidly progressing and advanced insults can result in extreme immune responses in the pulpal tissues, demonstrated as reversible, irreversible pulpitis or even progress to total necrosis and death. One of the pulpal irritants is the **dental bleaching** procedure which represents the most traditional way to modify the color of teeth.



# Tooth staining

Defined as the “discoloration of a tooth surface or surfaces as a result of ingested materials, bacterial action, tobacco, and/or other substances”

There are three categories for tooth discoloration as extrinsic, intrinsic and later presented a third category called internalized discoloration.

1- **Extrinsic stains** describe a superficial type of discoloration that affects the outermost layer of a tooth, or the enamel. Extrinsic stains are often caused by coffee, tea, cola, or tobacco products. Even though extrinsic stains are not as permanent as intrinsic stains, they will not respond to regular brushing



**smoking**



11

**Coffee and tea**

**2-Intrinsic stains:** this type of stain that affect the inner layer of the teeth. Usually, these stains exist on the tooth's dentin, there are several conditions can cause this type of stain such as: amelogenesis imperfecta, dentinogenesis imperfecta, fluorosis, enamel hypoplasia, tetracycline staining, root resorption and aging.



**Amelogenesis Imperfecta**



**Tetracycline staining**



**3-Internalized discoloration** can be caused by defect on tooth surface which allows the chromogenic bacteria to enter the tooth and finally leading to staining. There are three types of defects including developmental defects which also cause intrinsic staining (enamel hypoplasia, fluorosis), acquired defects (attrition, abrasion, and erosion) and defects from restorative materials like amalgam causing tooth staining due to the movement of tin into dentinal tubules



**Erosion**



**Amalgam discoloration**



Tooth discoloration can be treated by different treatment methods including **scaling and polishing**, **bleaching** and **porcelain veneers**. These treatment modalities may be used individually or in combination according to the etiology and degree of the staining.



# Definition of dental bleaching

The dental bleaching is a treatment used to reestablish the actual natural color of teeth or to achieve a whiter color and represents a popular treatment in dentistry. The dental bleaching is oxidizing agent, mainly composing from **hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>)** remove the coloring substances by penetration through the dental enamel and dentin



# Mechanism of action of dental bleaching agent

Stains are classically composing of organic compounds that possess prolonged chains of alternating single or double bonds and are referred to chromophores. The action of bleaching technique is characterized by chemical degradation of the chromophores.

Three distinctive phases can be recognized in bleaching method

**Diffusion**

**Interaction**

**Surface change and color**

## 1- Diffusion

In the first phase H<sub>2</sub>O<sub>2</sub> with aid of an activator (chemical or physical) dissociates into free radicals called reactive oxygen species (ROS) which have a low molecular weight and capable of penetrate through the interprismatic spaces in the enamel and through the dentinal tubules in dentin to interact with the organic chromophores . Generally, hydrogen peroxide dissociation and penetration had been found to be enhanced according to different factors including: **higher hydrogen peroxide concentrations, prolonged application, increased temperature, in young teeth where have larger sizes of the dentinal tubules than older teeth, the tooth with restorations, acidic pH and light activation.**

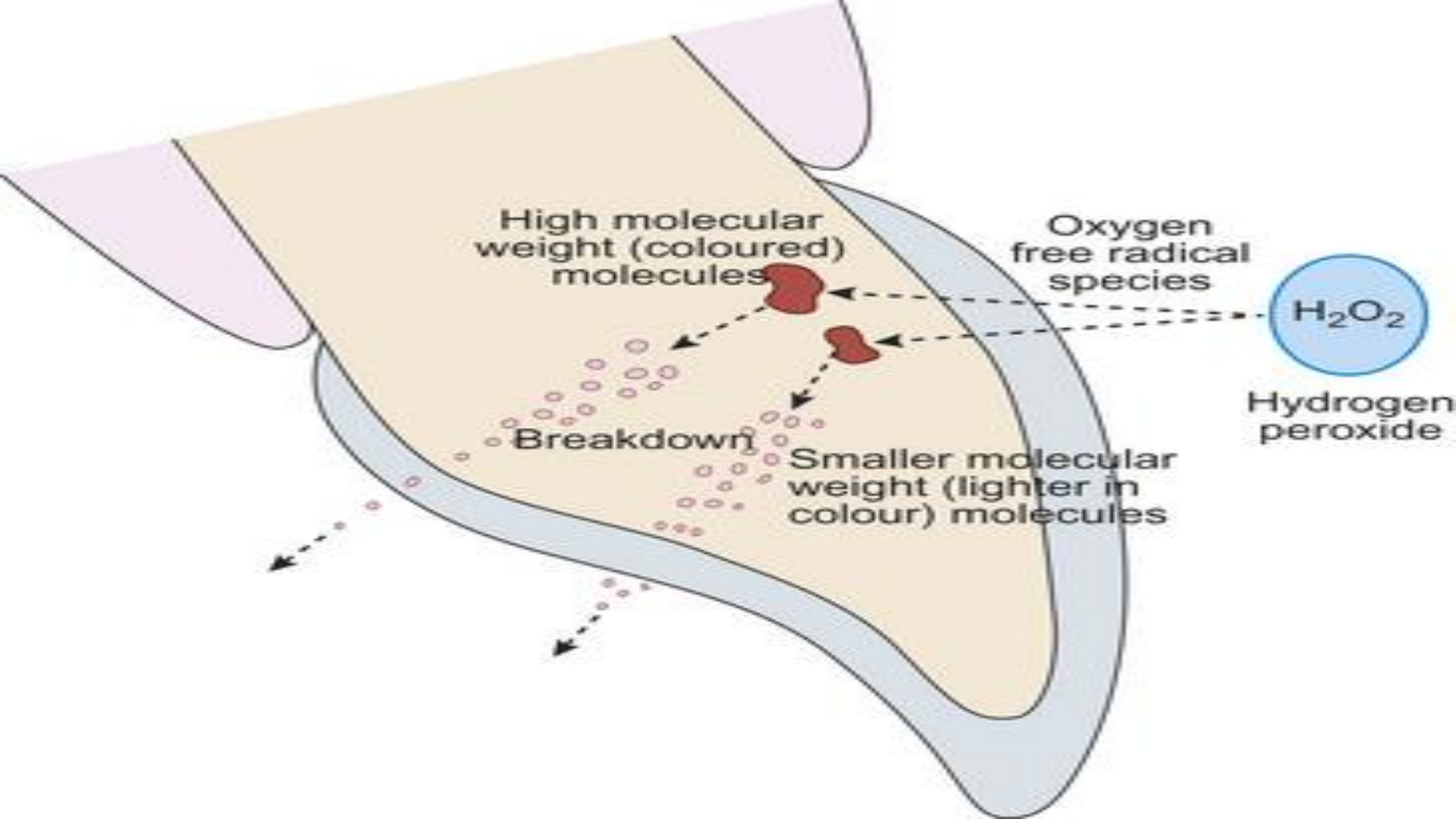
## 2- Interaction

The second phase is involved generally from the interactions of H<sub>2</sub>O<sub>2</sub> degradation with the organic chromophores and this interaction named as the “Chromophore Theory”. There are different factors influences on the activity of the free radicals including: **The temperature, pH, light**. When free radicals break one or more double bonds or oxidize the chromophores, the discolored teeth appear bleached and whiter in color this process known as redox reaction. The results from these reactions are products, which are low in molecular weight reflect less lights and removed easily from the tooth

## 3-Surface change and color

The third phase which is the final phase of bleaching process is actually associated with identifying the color change through the changing the tooth surface that became reflects the light differently. Several factors effect on the perception of tooth color, **including the type of light, the object, and the viewer**.





# Composition of commercial bleaching agents:

The bleaching agents comprise both active and inactive ingredients:

## 1- The active ingredients:

- A- Hydrogen peroxide ( $H_2O_2$ ):
- B- Carbamide peroxide ( $CH_6N_2O_3$ )
- C- Sodium perborate ( $NaBO_3$ )
- D- Chlorine dioxide ( $ClO_2$ )

## 2- Inactive ingredient:

- A-Thickening agents
- B-Carrier
- C-Surfactant and pigment dispersants
- D- Preservative
- E-Flavoring
- F- Additives - Calcium phosphate- Fluoride

# TYPES OF VITAL TOOTH BLEACHING PROCEDURES



**IN OFFICE BLEACHING**

**AT HOME BLEACHING**

**OVER COUNTER  
BLEACHING**

## In-office bleaching

In office bleaching procedure uses a high concentration of H<sub>2</sub>O<sub>2</sub> ranging (25–40%). In this approach, the dentist control during the procedure and when the desired outcome accomplished has the ability to stop the procedure. The peroxide may activate according to the type of bleaching gels either **chemically activated or physically activated (heat or light)**. There are different forms of curing lights used to stimulate bleaching gel including halogen curing lights, Diode lasers, or Metal halide (Zoom) light. The power bleaching can produce an optimum result in single session but some cases of severe discoloration need more than one session to achieve the perfect result.

| <b>Advantages of In- office bleaching technique</b>                                    | <b>Disadvantages of In- office bleaching technique</b> |
|--|--|
| <b>Best for patients who do not deal well with bleaching procedure at home</b>         | <b>More expensive</b>                                  |
| <b>It is favorite for the patient since it is provide fast result from one session</b> | <b>More often causes tooth sensitivity and pain</b>    |
| <b>Does not need patients compliance</b>   | <b>Can cause gingival burns</b>                        |





**Chemical activation**



**Diode laser**



**Metal halide (Zoom) light**

## **Take-home (at home bleaching)**

At home bleaching products usually contain carbamide peroxide or hydrogen peroxide. The concentrations used in these product reach up to 21% carbamide peroxide which is equal nearly to 7% hydrogen peroxide and applied for at least 16 days 2 hours a day.

## **Over-the-counter (OTC)**

The concentration of whitening agent in these products is ranging (3–6% hydrogen peroxide) which represent a low concentration comparing to other products. It can be applied to the teeth in several ways via strips, gum shields, or paint-on product formats. They are also presented as pre-fabricated trays, toothpastes and whitening dentifrices. It should be applied two times each day for up to 2 weeks



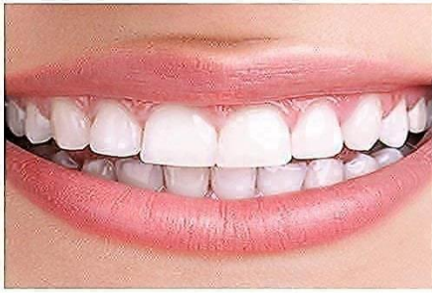
① Remove the strips, and peel off



② Apply it along the gums



③ Press gently for a comfort fit



④ After 60 min remove and rinse the mouth.



## Factors influencing tooth whitening efficiency

### 1- Concentration and duration of application of bleaching agent:

The concentration of the peroxide and application period represent the key factors responsible for tooth whitening effectiveness that the higher concentration of (H<sub>2</sub>O<sub>2</sub>) and longer duration of contact to teeth the more desirable outcome

### 2- Heat and light

Since each reaction required an energy therefore using a physical factor such as light or heat which represent the most typical way to activate and dissociate H<sub>2</sub>O<sub>2</sub>.

Increasing in temperature or using light can result in faster chemical reaction, However can damage the dental pulp irreversibly. Later, new methods have been developed light generate less heat and accelerate the whitening process including, halogen curing lights, lasers, light emitting diodes (LEDs), and LED plus lasers.

### 3- Other factors:

**A- Type of the stain:** represent a major part in the tooth bleaching results for example it was reported that tetracycline staining in severe cases is more challenging and required longer time of bleaching to obtain optimum result.

**B-Tooth color:** The color of dentine is determined the color of the teeth and the yellower teeth have better bleaching efficiency since it reflects a possible increased the organic contents of the tooth which act as the substrate that required for oxidizing action of hydrogen peroxide in bleaching process.

**C- Gender:** A better whitening reaction to bleaching technique was found in women and the reason for this particular suggestion is not certainly clear.

**D- Age:** The ideal outcomes of bleaching occur with younger patients can be explained that they have larger dentinal tubules and larger organic content in their teeth and the activity of H<sub>2</sub>O<sub>2</sub> controlled by these organic contents which is decrease with age



## **Adverse effects of bleaching agents**

**1- Effects on soft tissues:** most soft-tissue burns caused by in-office bleaching. For that reason, it is essential to isolate the soft tissues with a rubber dam or other methods to inhibit tissue burns. In general, fortunately these burns are reversible and treated by application of an antiseptic ointment and rehydration.

**2-Systemic effects:** Hydrogen peroxide has been established not to be mutagenic, teratogenic, or carcinogenic. In spite of the low concentration of home-bleaching there is a possible adverse effect, since it is not controlled by the dentist and there is a possibility of swallowing the gel and causing irritation in gastrointestinal mucosal, for example, a burning in palate and throat, and slight upsets in the stomach or intestines.

### 3- Effects of bleaching agents in dental aspect:

#### A- Tooth sensitivity

Tooth sensitivity represents the most commonly side effect of bleaching. Previous studies found that the occurrence of tooth sensitivity during in office or at home bleaching ranging from 18% to 78%. Clinical trials observed that tooth sensitivity is temporary, and typically persists for about 4 days after the termination of bleaching procedure. In vitro studies have revealed that tooth sensitivity largely results from interaction between hydrogen peroxide and the pulp tissue since peroxide can pass through enamel and dentin and reach the pulp chamber. Patients that have already a history of tooth sensitivity, they have a higher possibility for such a side effect from tooth bleaching, and this should needs to be taken in concern before undergo bleaching treatment.



## B- Effect of bleaching agent on dental pulp

Hydrogen peroxide must diffuse through the enamel to reach the underlying dentin, which is typically responsible for tooth color in order to bleach the teeth. However, in vitro study has confirmed that because of the low molecular weight of H<sub>2</sub>O<sub>2</sub> even at low concentrations can diffuse through dentine via the dentinal tubules and influence the pulp chamber. The penetration of H<sub>2</sub>O<sub>2</sub> and its adverse effects on pulp can be enhanced by a number of factors including

- 1- higher concentration of peroxide ,
- 2- longer time of application results in releasing more ROS in the pulp
- 3-increased temperature.
- 4-The acidic pH could cause enamel surface demineralization and increase in the porosities of the enamel accordingly, greater and faster penetration of H<sub>2</sub>O<sub>2</sub> into the pulp chamber.
- 5- larger size of dentinal tubules
- 6- light activation as results in increase the temperature of the tooth
- 7- the presence of restoration as microleakage from restorations margins can be reflected a probable way for H<sub>2</sub>O<sub>2</sub> penetration into the pulp chamber.

Reactive oxygen radicals have the ability to diffuse through different mechanical barrier of the teeth as have the ability to penetrate through interprismatic spaces and dentinal tubules and overwhelmed numerous defense mechanisms, including the odontoblastic process, dentinal fluids, and collagen fibers consequently reach the pulp.

As the free radicals contact with the pulp tissue different defense systems have developed to overcome the accumulation of ROS. These include numerous non-enzymatic molecules including vitamins A, E, C, glutathione, and flavonoids, as well as antioxidant enzyme including superoxide dismutases (SOD), glutathione peroxide and catalase. Probably higher level of ROS will result in oxidative stress to the pulp cells because of the unbalance between the production of reactive oxygen species (ROS) and the pulpal enzymes that protect the pulp from H<sub>2</sub>O<sub>2</sub> degradation which are significantly inhibited by the action of hydrogen peroxide in bleaching agent and this results in pulpal damage ranging from a temporary inflammatory reaction to the incidence of local necrosis.

# BLEACHING PROCEDURE

**The 30% bleached group**



# BLEACHING PROCEDURE

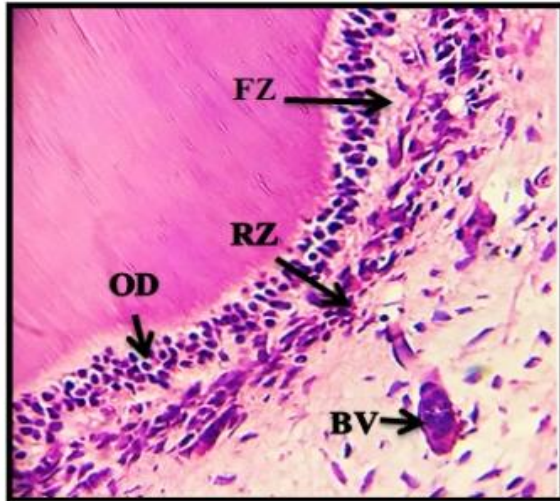
**The 40% bleached group**



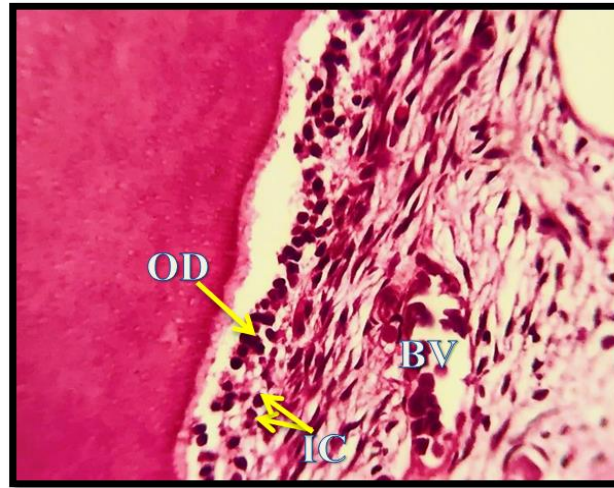


# 1 DAY DURATION

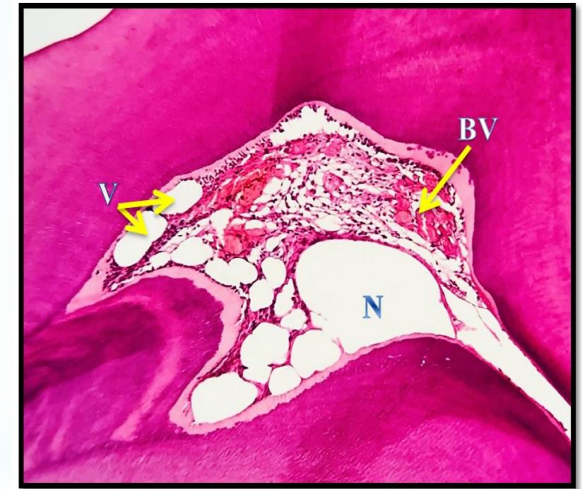
Control group



40% bleached group



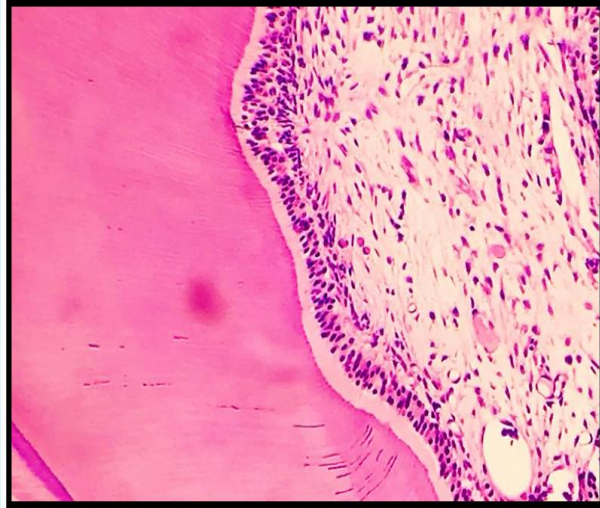
30% bleached group





# 7 DAYS DURATION

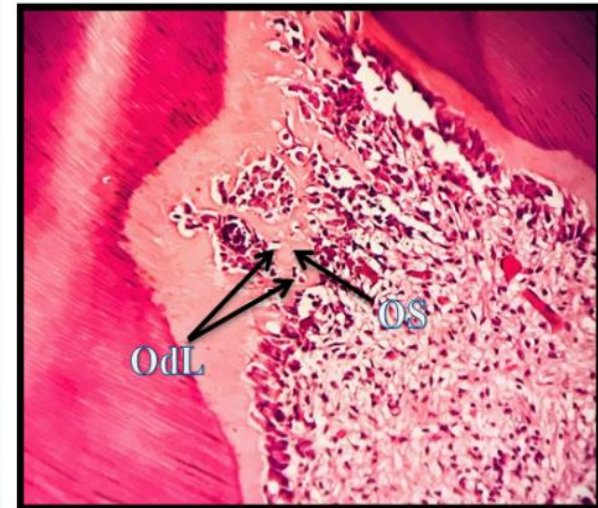
Control group



40% bleached group



30% bleached group



### 3 Effects on physical properties of the tooth

During tooth bleaching, the pH of bleaching gel causes enamel demineralization since it is known that enamel begins to dissolve if a solution with pH <5.5 was applied on it and this results in surface morphological change reduction of enamel hardness . In contrast, bleaching gel either with neutral or alkaline pH does not modify the enamel roughness or neither produce harmful effects on the enamel surface .

### 4 Effects on enamel/dentine bonding

Bleaching may effects on Bonding to enamel/dentine, most of the studies showed that when bonding procedure was achieved directly after completion of bleaching treatment, both tensile strength and shear strength of composite resin bonds to enamel considerably reduced .

Bleaching can also adversely effects on bonding between glass ionomer and dentine and this because of precipitations of hydrogen peroxide on the cut surface of dentin.

# CONCLUSIONS



**Recently dental bleaching represents most of the clinical procedures frequently demanded by patients in order to get whiter teeth, but few of them know about the side effects of teeth whitening, so care must be taken when using bleaching agent at home because it can cause permanent damage to the teeth. Also, the dentist must be careful when using this material and many factors should needs to be taken in concern before undergo bleaching treatment include the concentration, PH, time of application and the tooth itself during diagnosis if there is a filling or crack because these factors may result more post bleaching pain and sensitivity.**



thank  
you