Dental Materials are Biomaterials

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Reading Assignments that Correspond to this lecture

- Dental Materials_clinical application_Hatrick& Eakle third edition
  - Chapters 1 to 3
  - Chapter 4 read on your own-will not be discussed in lecture
  - Purpose of the lecture is ***to highlight important concepts***, test questions will be based upon lecture and reading assignments
  - Learning the language (terms) associated with Dental Materials –memorize all definitions on page 7 and 8- ***some terms will appear*** on NBDHE

Dental Materials Lecture #1 Outline

- Introduction to Dental Materials/Evidence based Dentistry
- Oral environment & Dental Materials
- Physical & Mechanical Properties of Dental Materials
  - What is a Biomaterial?/What is a Dental Material?
  - Classification of Dental Materials
  - Retention of dental materials
  - Examples of Dental Materials
  - Introduction to Rubber Dam

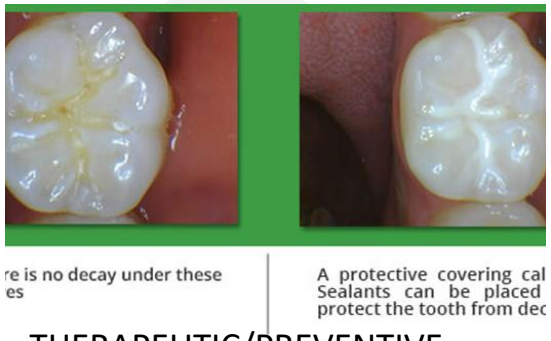
Learning Objectives for this Lecture

- Define Evidence Based Dentistry and how this relates to the topic of Dental Materials
- Understand the relationship between the oral cavity and dental materials, and how this effects the life span of dental materials.
- Understand the key terms listed on page 7-8 of the textbook
- List the Classification of Dental Materials
- Explain the different physical and mechanical properties of dental materials.
- Be able to name methods of isolation and demonstrate use.

Dental Hygienist Role In Dental Materials

- Recognize, Understand, and Care for Dental Materials
- Deliver DH services in a manner that does not alter the dental materials surface (Ultrasonics?)
- Application of preventative and therapeutic agents
- Educate Patients on how to maintain their dental restorations

Dental Materials Can be “Grouped” or organized in different ways

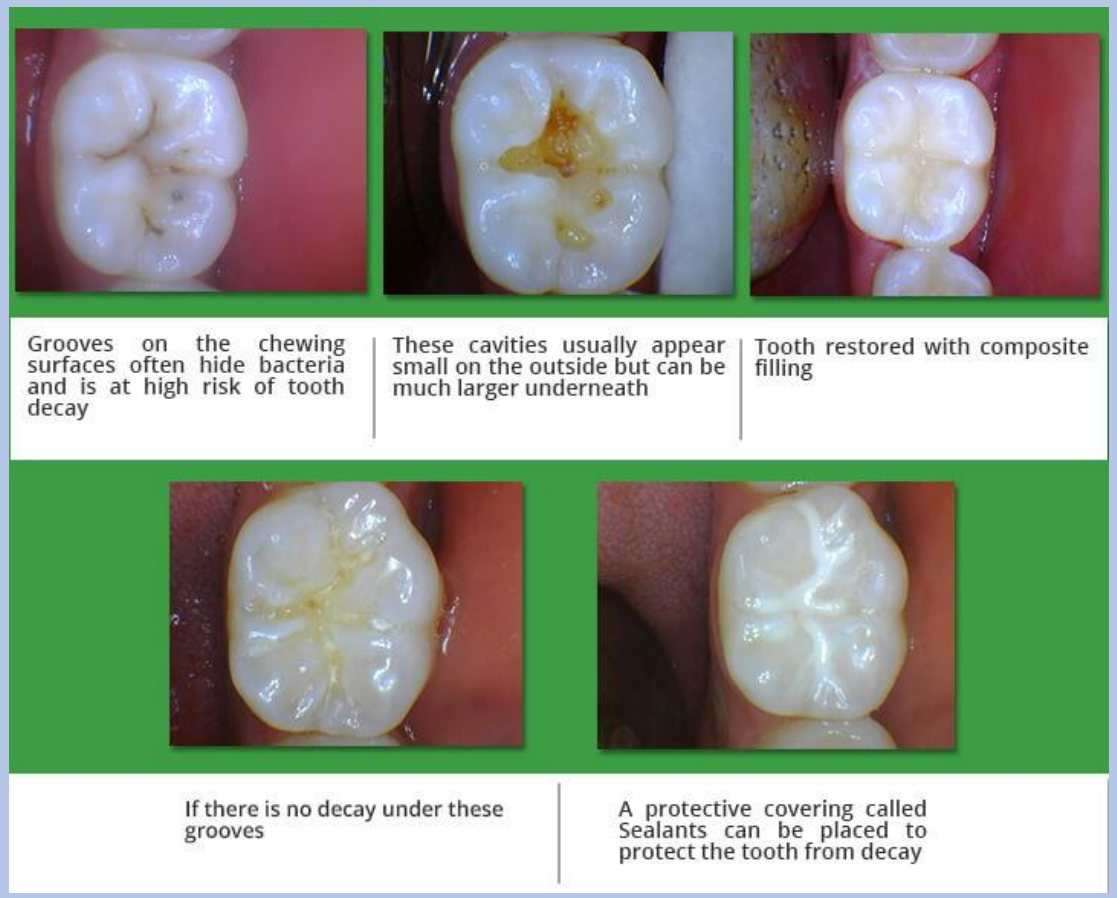


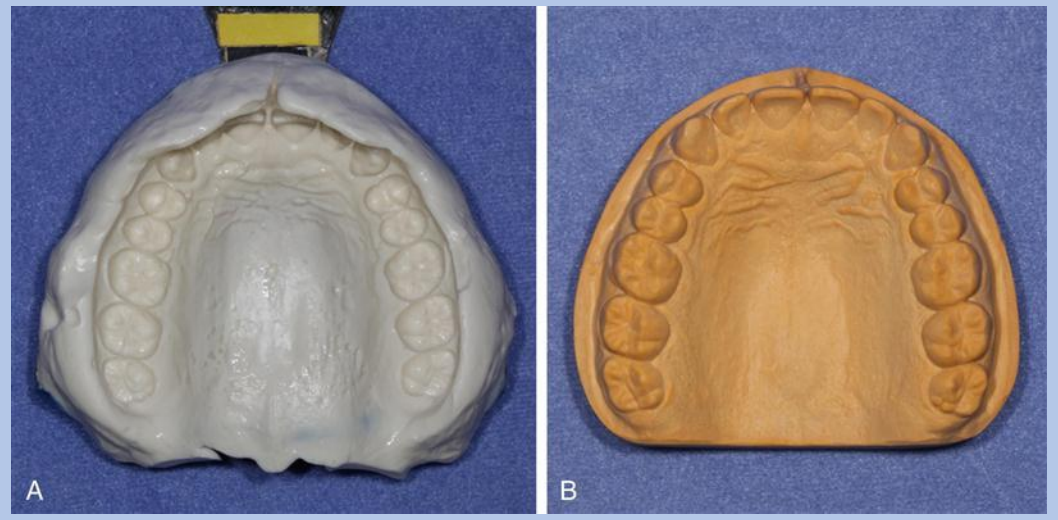
THERAPEUTIC/PREVENTIVE

RESTORATIVE

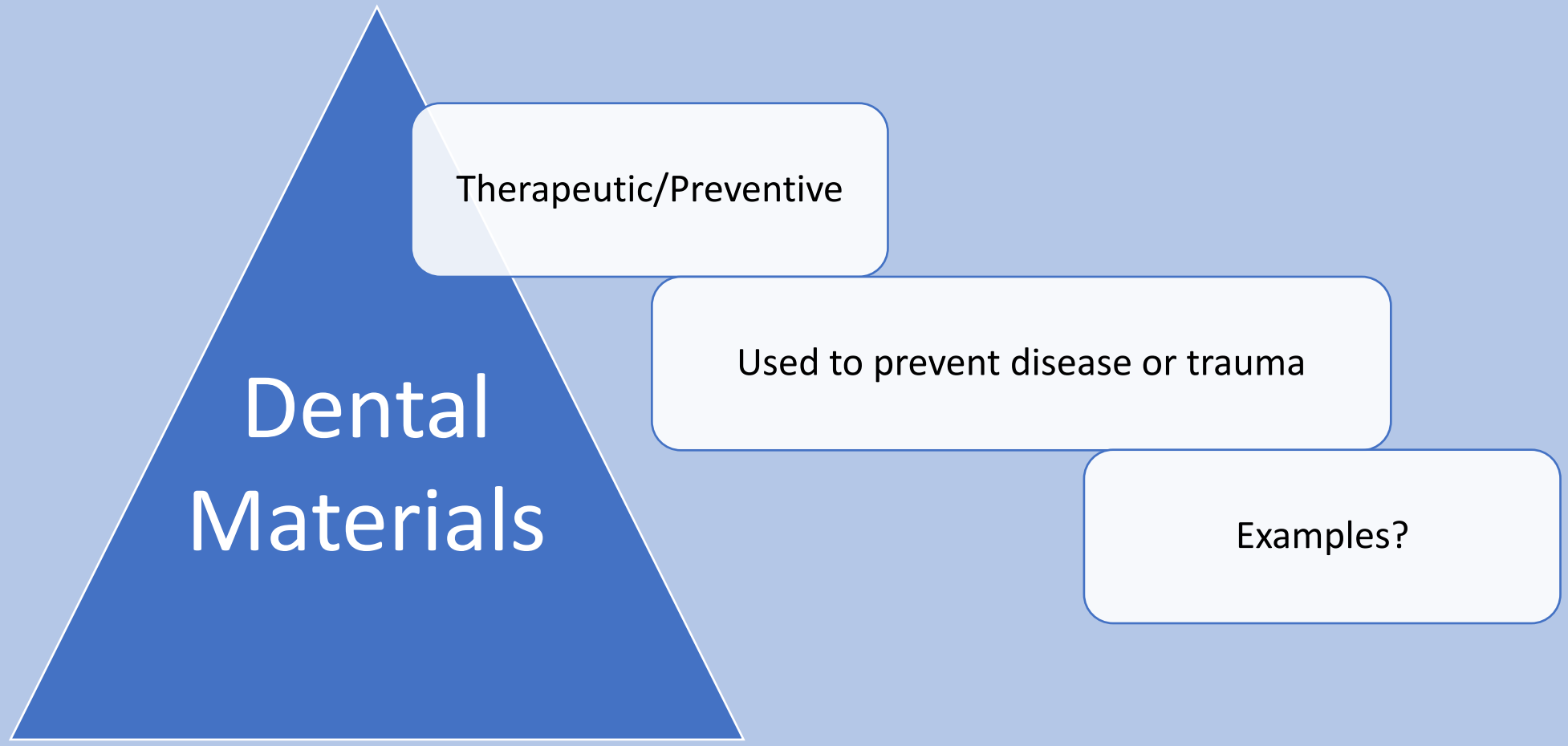
AUXILIARY MATERIALS

Preventative & Therapeutic / Restorative / Auxillary

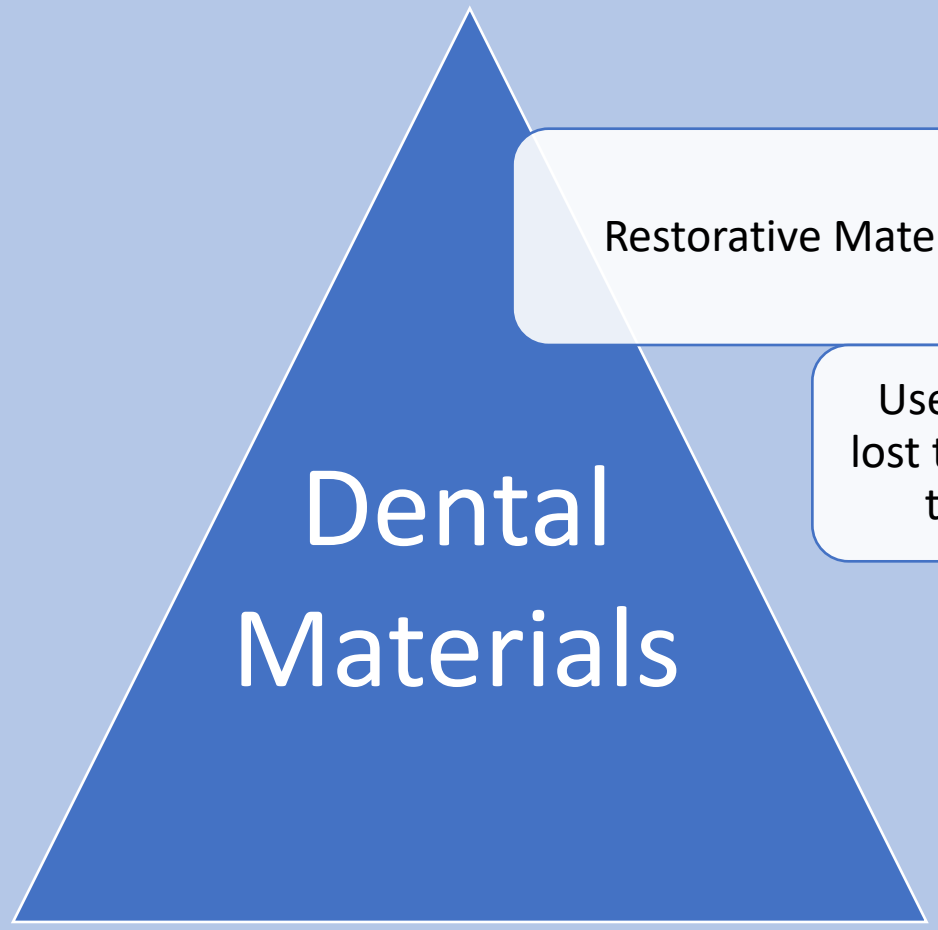




Therapeutic / Preventative



Restorative

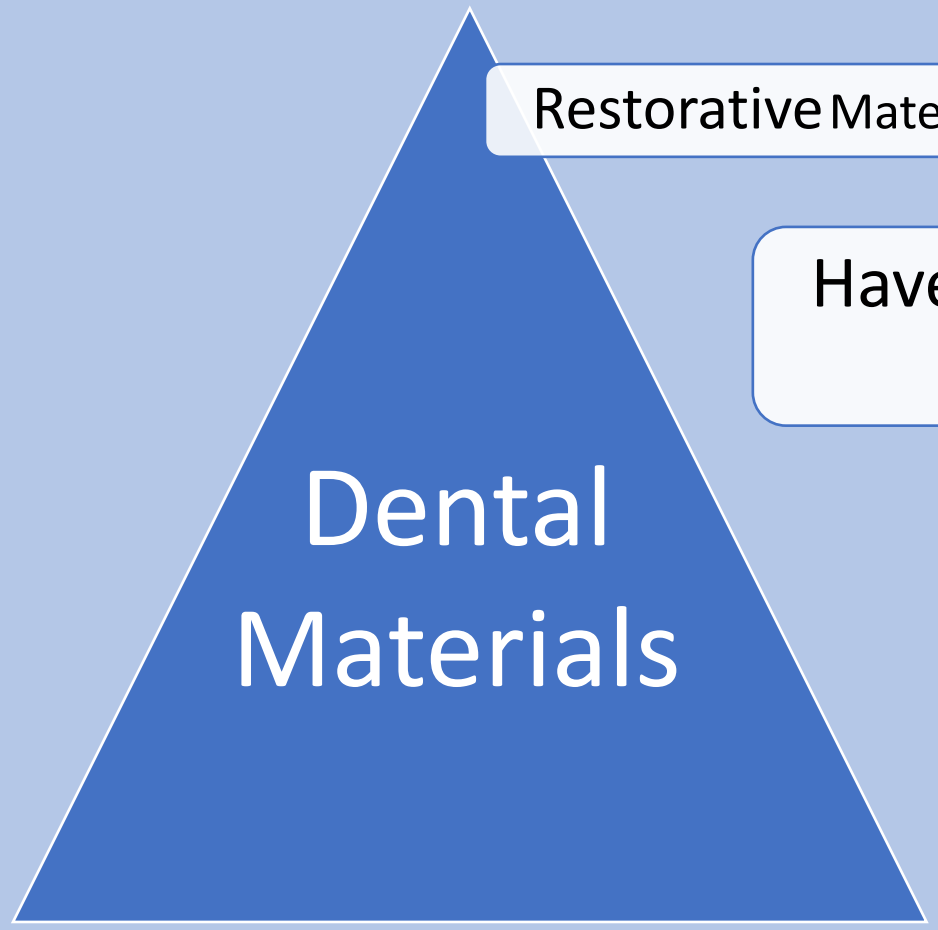


Restorative Materials

Used to repair or replace tooth structure lost to oral disease or trauma or to improve the appearance of malformed teeth

Examples?

Restorative (Cont.)



Restorative Materials

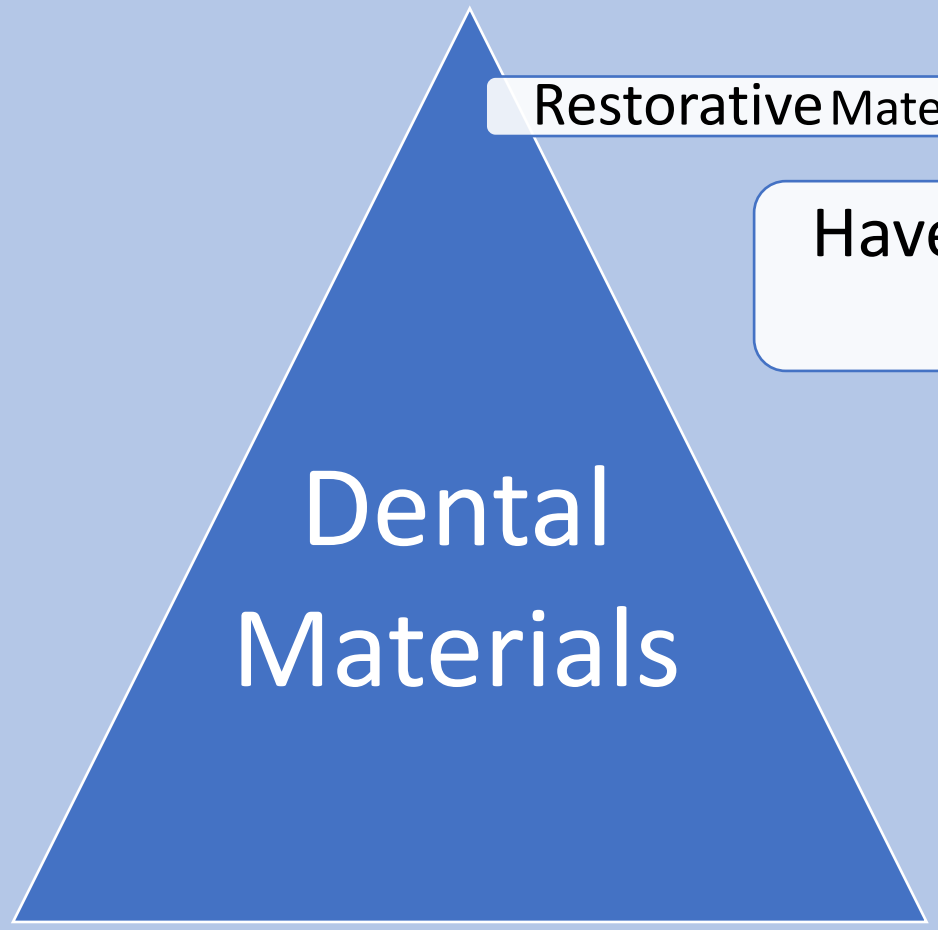
Have subcategories based upon application

Direct

Indirect

Expected Longevity (Temporary or Permanent)

Restorative (Cont.)

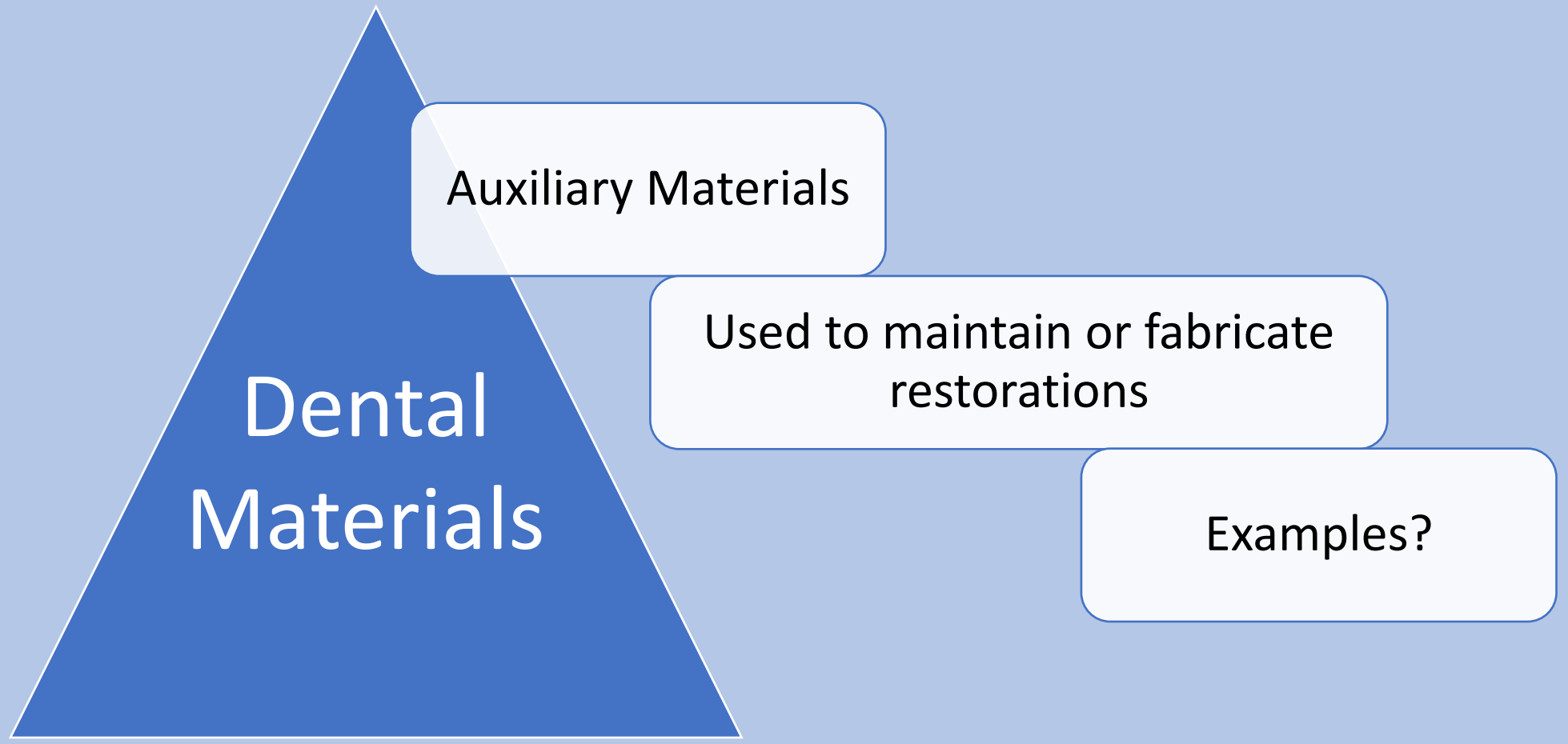


Restorative Materials

Have subcategories based upon how they set

- Chemical set (self cure)
- Light-activated (light cure)
- Dual set (dual cure)

Auxillary


Dental Materials
Auxiliary Materials
Used to maintain or fabricate restorations
Examples?

Terminology of How Dental Material Reactions Occur

Before the material reaches its ultimate solid state, the process goes through stages:

- ***manipulation stage*** (mixing and working time)
- ***reaction stage*** (initial set/final set)

Both stages are defined in units of time. Reaction stage times:

Initial set time*:* Begins when the material no longer can be manipulated in the mouth.

Final set time: Occurs when the material has reached its ultimate state.

Types of reactions:

Chemical reaction*:* *materials* are those that set through the timed chemical reaction of the catalyst and base. The clinician has little or no control of the time.

Light-activated reaction: *materials* use a blue light source to initiate the reaction stage. Both components are present in the material, but do not react until the material comes in contact with the blue light. This gives the clinician more working time; however, the ambient light may cause the material to begin to set.

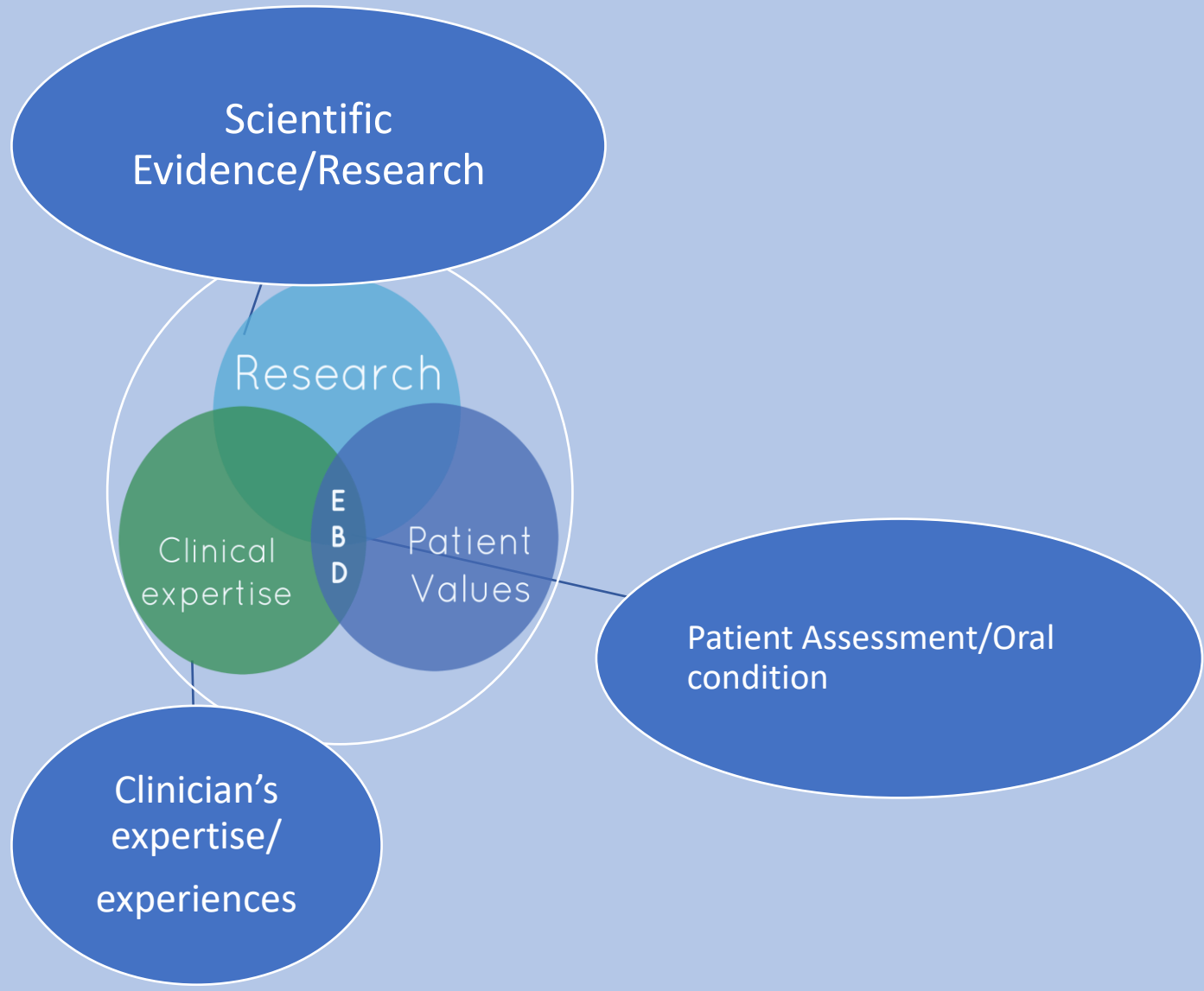
Dual set reaction*:* *materials* begin with the initiation of the blue light source and then continue with a chemical set reaction. This gives the clinician more control of the working time and gives assurance of complete setting in deeper or more difficult-to-access areas.

Each material has a set mixing time, working time, and setting time.

Evidence Based Decision Making

In Dentistry:

the dental professional must be able to incorporate new concepts/skills/materials/ techniques supported by research and patients needs/ oral condition/preferences



What is a Biomaterial?

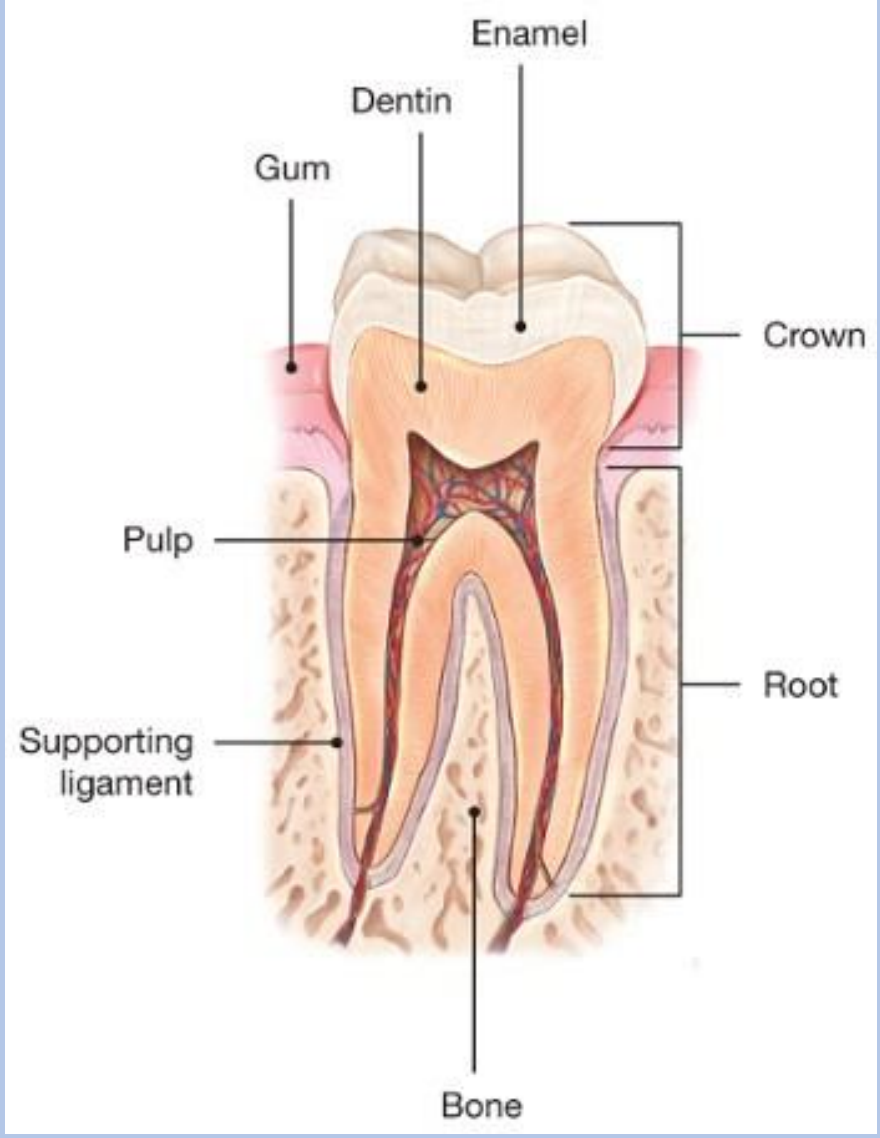
Biomaterials

- are man-made materials that are used to replace tissues or that function in intimate contact with living tissues.

Dental Materials

- **Dental materials** are biomaterials used in or around the oral cavity therefore, DM must be:
    - Biocompatible with the oral fluids, tissues and tooth components
    - Benefit the patient to improve esthetics and function
    - The biomechanics of the material must be compatible with:
        - Forces within the Oral Cavity
        - Moisture and pH
        - Compatible with the oral temperature
        - Have good retention (stay in the mouth)

Oral Tissues



As Dental Health care professionals, it is important to remember that even though we have good dental materials, ***Nothing*** functions as well as the natural tissues in the mouth.

Ideally, we always strive to preserve the natural oral tissues.

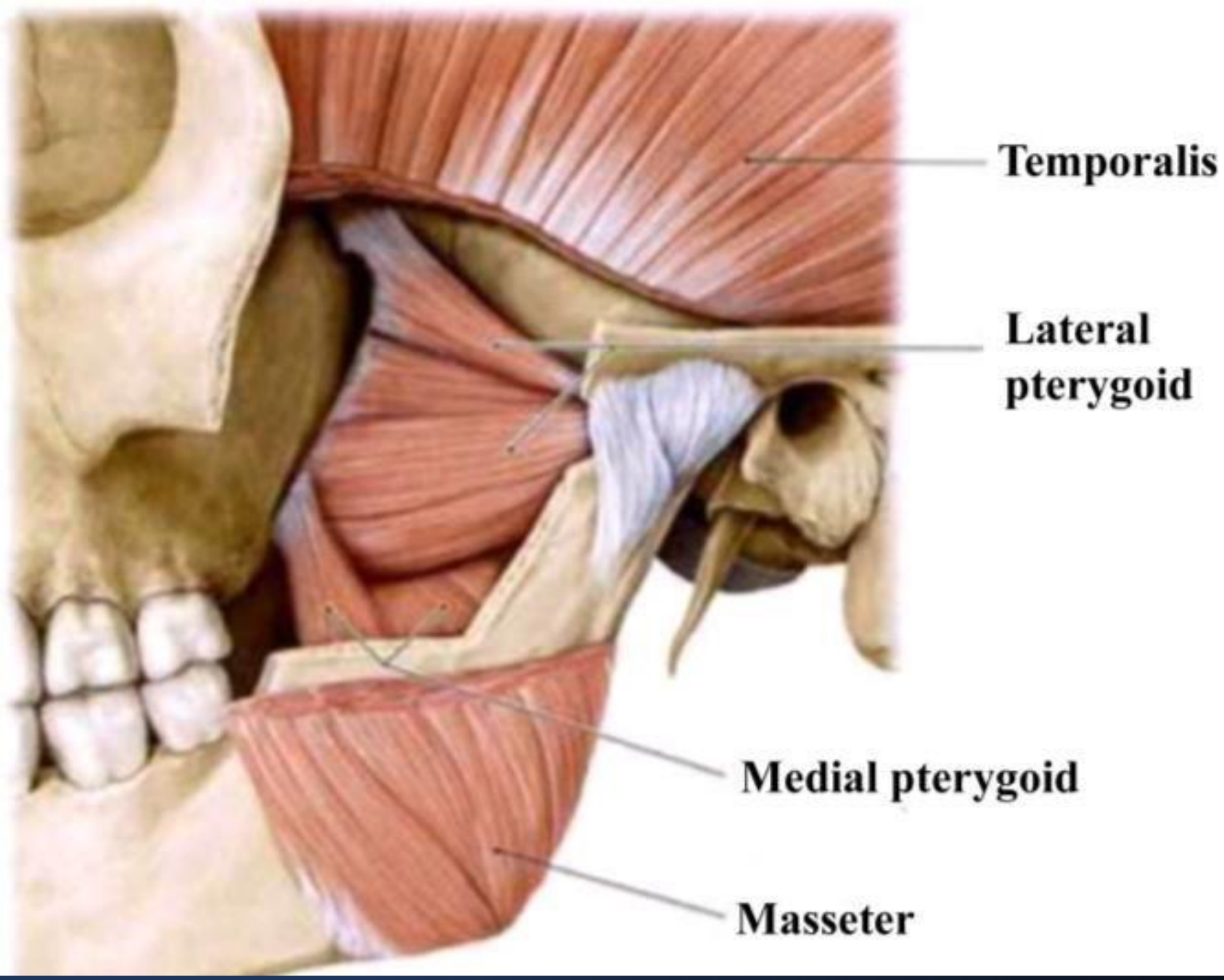
Biocompatibility

- Materials must benefit the patient
- Must *not* adversely affect living tissue
- Biocompatibility along with short-term and long-term functionality must be considered when new dental materials are developed

Courtesy of Dr. Stephan Eakle.

Dental Materials will wear overtime related to the effects of continuous exposure to:

- Biomechanical forces
- Stress
- Strain
- Moisture (from saliva/ beverages and blood)
- pH fluctuations



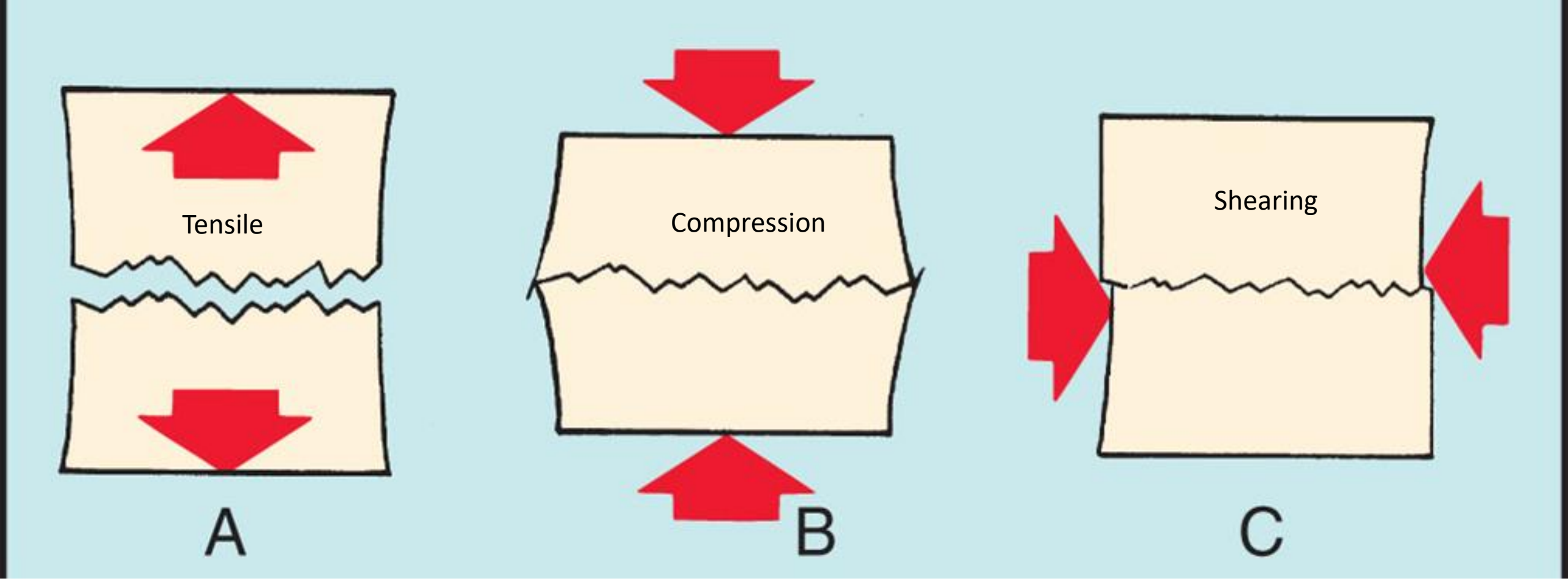
A little bit of Physics!

The Muscles of Mastication

are extremely strong muscles

Therefore, any dental material is going to be subjected to:

- Posterior occlusal forces
- Anterior biting forces
- Compressive force
- Tensile force
- Shearing Force
- Torsion or Torque Force

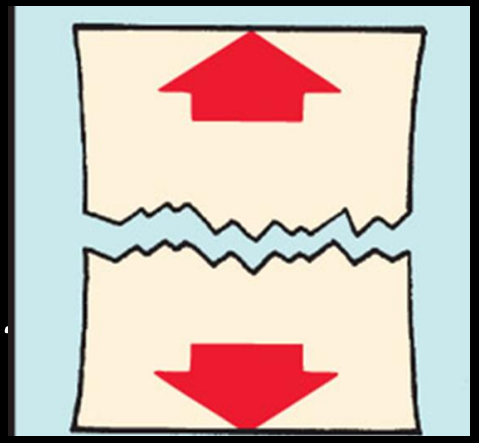


Forces on Dental Materials

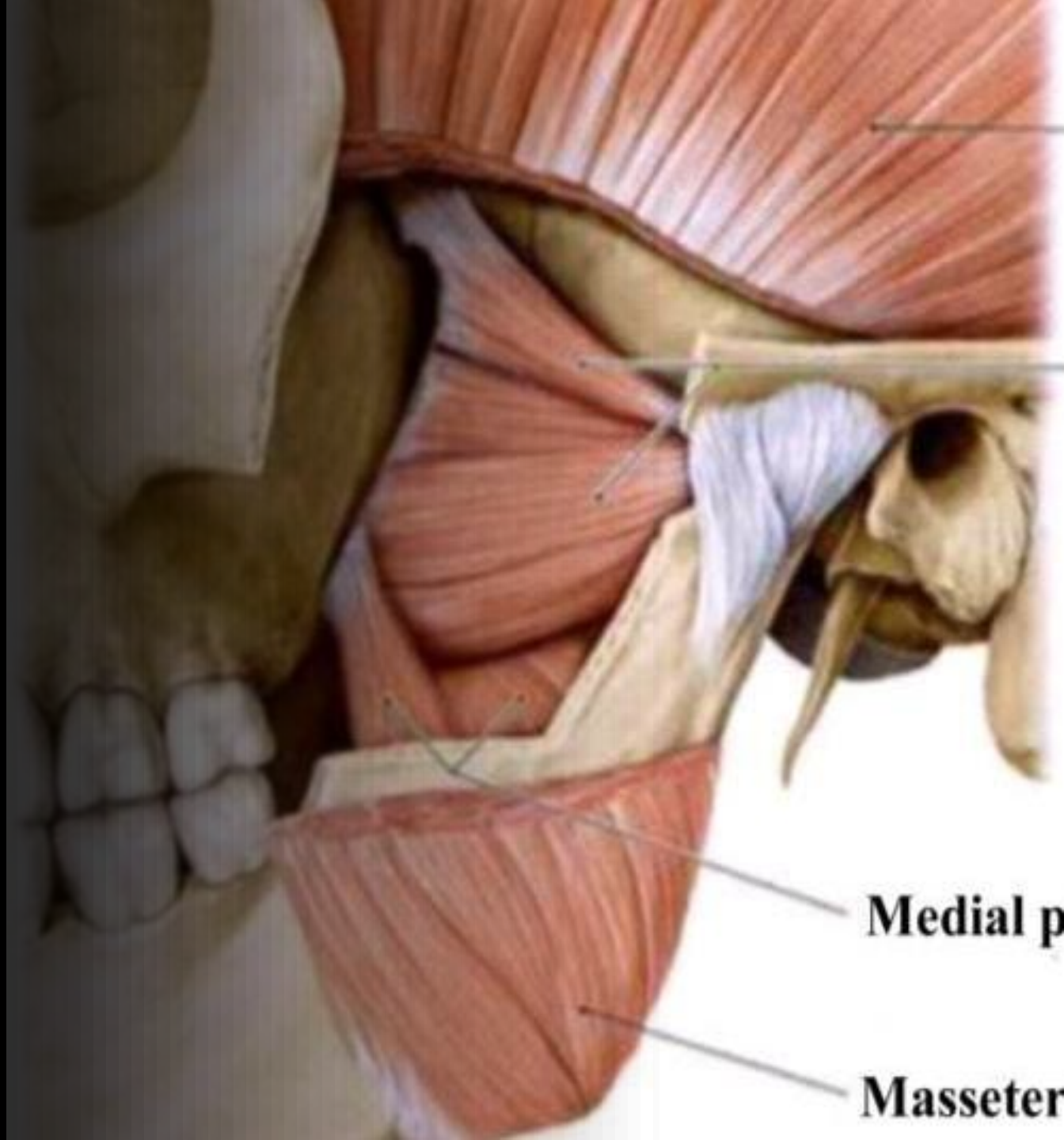
For most adults, the bite force of their natural teeth is on average 162 psi (lbs/sq inch)

Force relates to
the direction of the movement

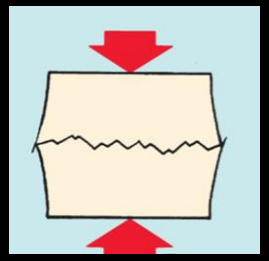
A little bit of Physics.



Tensile force= the force direction is in opposite directions, causing the object to stretch and can pull it apart.

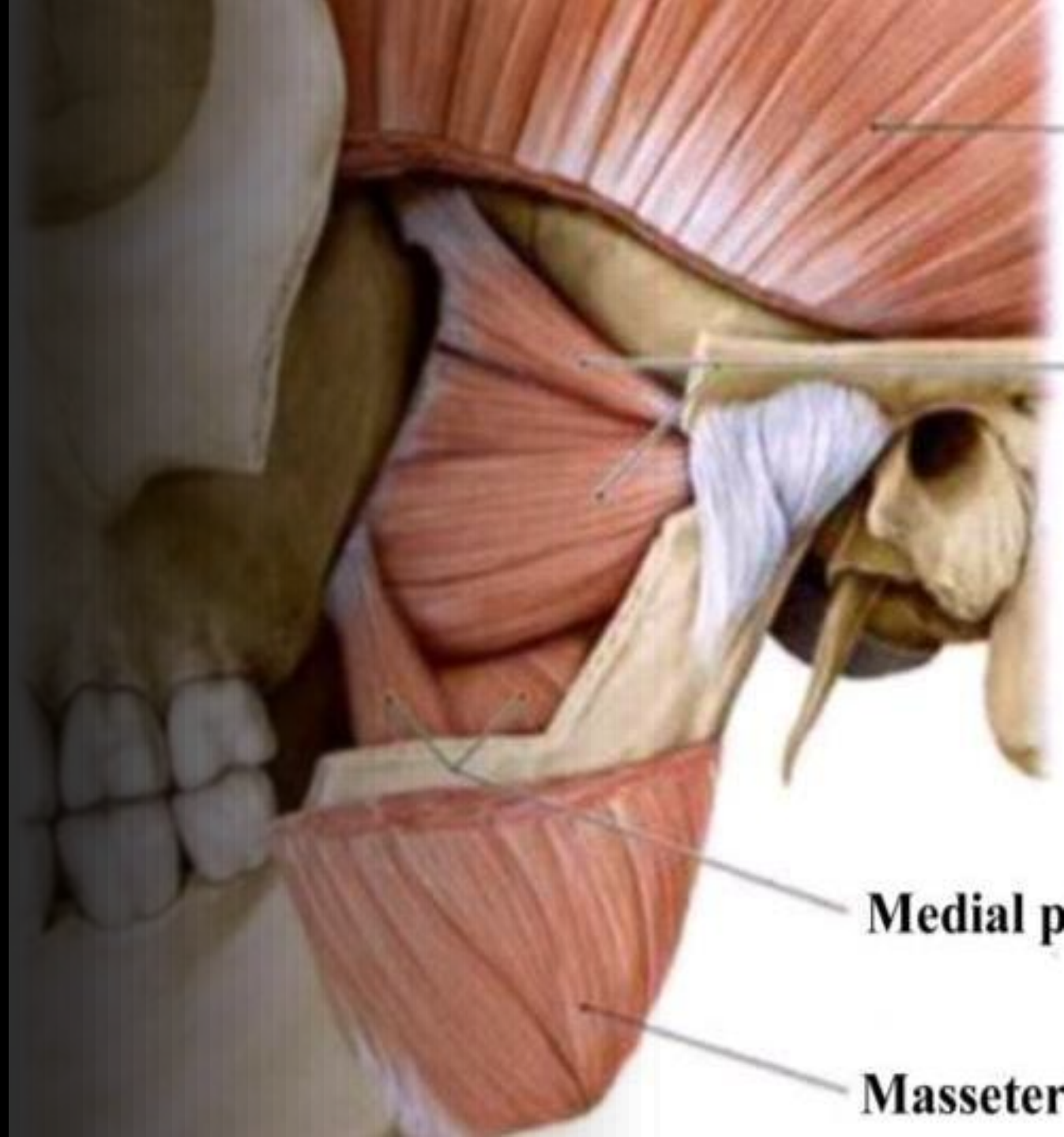


A little bit of Physics!

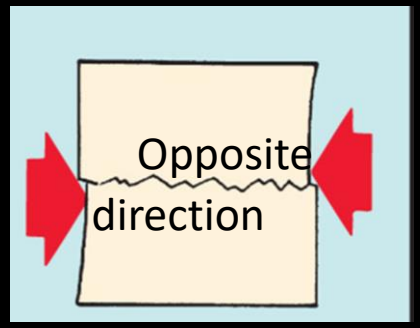


Compressive force= the direction of the force is compressive (or squeezes) an object.

In the oral cavity, biting force is a compressive force.

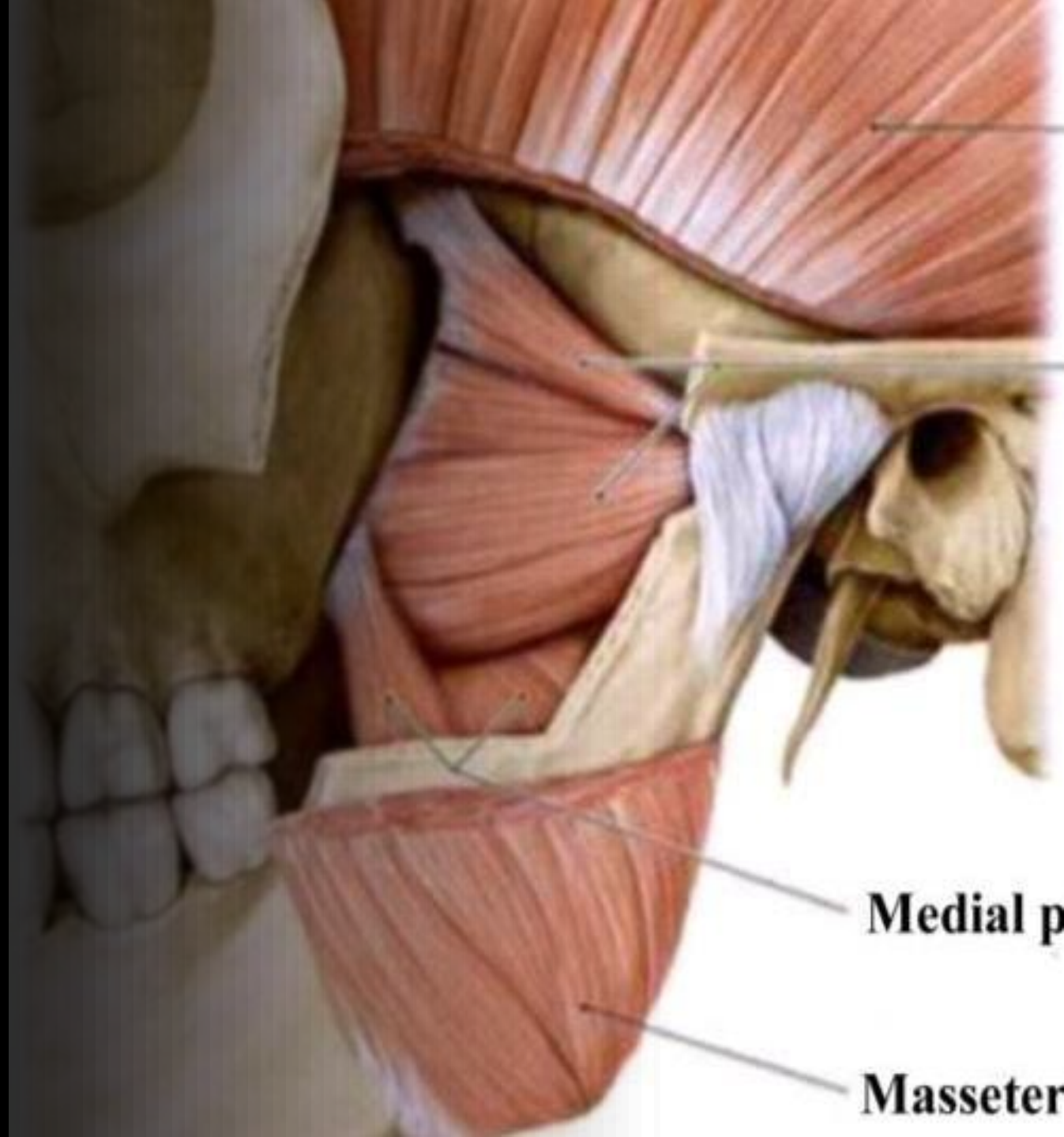


A little bit of Physics!

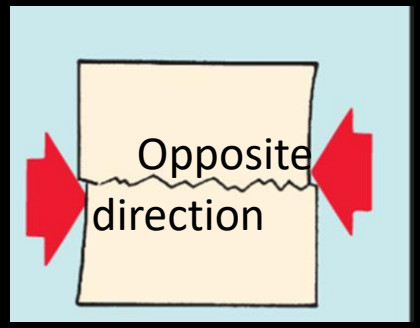


Shearing force= is a lateral sliding force direction going in opposite directions.

In the oral cavity anterior teeth use a shearing force when you incise food.

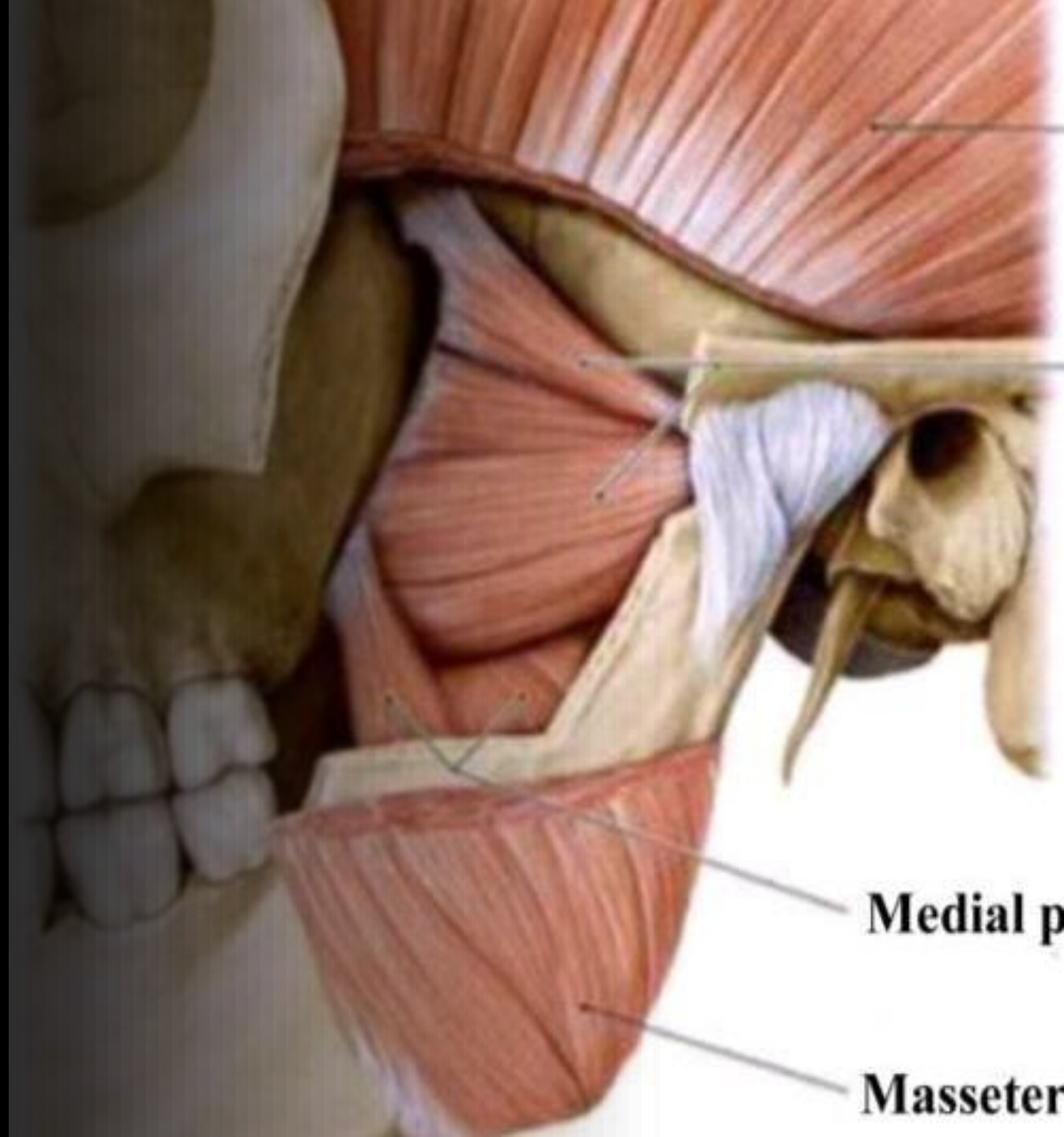


A little bit of Physics!



Torque force= is a combination of force directions (tensile and compressive) causing a twisting force direction.

In the oral cavity torque force is how we move the mandibular teeth against the maxillary teeth to chew.



OH NO! NO MORE PHYSICS

Last 3 terms: Stress & Strain are interdependent actions. Elasticity

Stress: an internal force, which resists the applied force

Strain: Distortion or deformation that occurs when an object cannot resist a force (shape is changed related to a force).

Elasticity: is a phenomenon of change in shape and returns to the original shape.

Key Terms to Know

- **Hardness- The ability to resist indentation**
- **Fatigue- Object tires and gives in**
- **Creep- Gradual dimensional change in a dental material/restoration due to compression of the opposing dentition.**
- **Adhesion- Used to describe the bonding or cementation process (surface to surface)**
- **Cohesion- adhesive forces bind the luting agent to the restoration on one side and to the tooth on the other side**

Key Terms to Know

- **Tarnish- Discoloration that results from oxidation of a thin layer of metal at its surface (not as destructive as corrosion)**
- **Corrosion- Deterioration of a metal caused by a chemical attack or electro-chemical reaction with dissimilar metals.**
- **Percolation- Movement of a fluid within the microscopic gap of the restoration margin. Can occur from temperature changes in the oral cavity.**
- **Micro Leakage- Leakage of fluid and bacteria caused by microscopic gaps that occur at the interface of the tooth and the restoration margins.**
- **Galvanism- an electrical current transmitted between two dissimilar metals in a solution of electrolytes (ie.- saliva).**

Moisture & pH can influence the lifespan of dental materials.

Ideal pH for the oral cavity if 6.8 to 7.2

Desired features of a good Dental Material:

- Low solubility
- Does not absorb moisture
- Will not corrode
- Most dental materials function best at neutral range of pH

How are Dental Materials Retained in the mouth ?

Retention- is the ability of the dental material to maintain its position and not be displaced by Stress

For Optimal retention of Dental Materials the tooth surface should be free of debris

Dental Materials are retained by:

- Mechanical adhesion
- Chemical adhesion/ bonding

Can anyone define bonding ?

How well Bonding will occur is influenced by:

- **BONDING properties:**
  - Wetting- the ability of liquid to wet or intimately contact a solid surface.
  - Viscosity- the ability of liquid material to flow.
  - Film thickness- the minimal obtainable thickness of a layer of material. (important with cements)

Physical & Mechanical Properties of Dental Materials Chapter Three *Highlights*

Physical Properties of Dental Materials

Physical Properties That We Will Review:

- **Thermal Conductivity**
- **Coefficient of Thermal Expansion**
- **Viscosity**
- **Electrical Conductivity**
- **Abrasion Resistance**
- **Interaction with X-Rays**

Thermal Conductivity

- **The rate of heat flow through a material.**

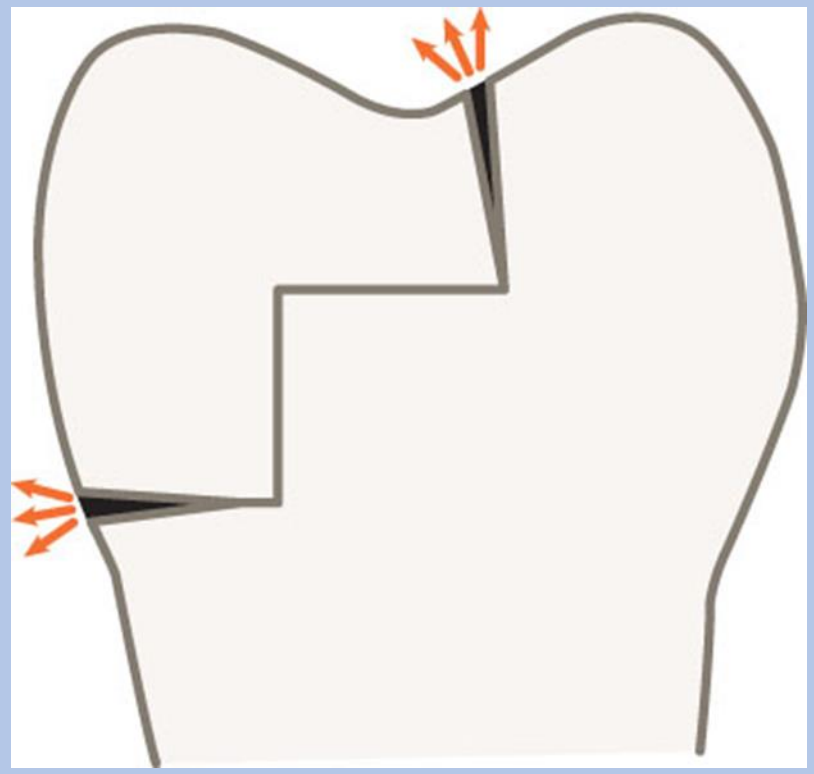
- Pulpal sensitivity is likely if conductive materials, such as metals, are placed in close proximity to the pulp.

- If caries are deep and close to the nerve our options are:
  1) Place a restoration that has a lower thermal conductivity
  2) If a metal restoration is planned, an insulating base is placed beneath the metal restoration to insulate the pulp from hot and cold stimuli, reducing pulpal sensitivity (ex. Dycal).

Coefficient of Thermal Expansion

Coefficient of thermal expansion: a measure of the change in volume or length in relation to the change in temperature.

Percolation: The process of heating and cooling, and the accompanying opening and closing of the gap between tooth structure and restorative material. There is a movement of fluid within this microscopic gap.



****Enamel, dentin, and composite materials have similar coefficient of thermal expansion. (They are in relationship of each other).**

Viscosity

- The **viscosity** of a material is its ability to flow.
- Thick or high viscosity liquids flow poorly.
- Thin or low viscosity liquids flow easily.

- Example: Lava vs. Water
- Example:
  Heated Packable Composite versus
  Room Temperature Packable Composite

Liquids

- Molecules are not confined to a specific pattern because they flow
  - *Viscosity*
  - *Thixotropic materials*

Abrasion Resistance

- **Abrasion resistance** refers to the ability of a material to resist wearing due to contact with another surface.

- In dentistry, we are interested in the **abrasion resistance** (wear resistance) of dental restorations to food, opposing teeth, and other dental materials such as ceramic crowns or porcelain denture teeth.

Interaction with X-Rays

- Some materials will prevent x-rays from passing through.
- Example: Zirconia Crown
- X-rays will pass through some materials.
- Example Lithium Disilicate Crown

Mechanical Properties

Mechanical Properties That We Will Review

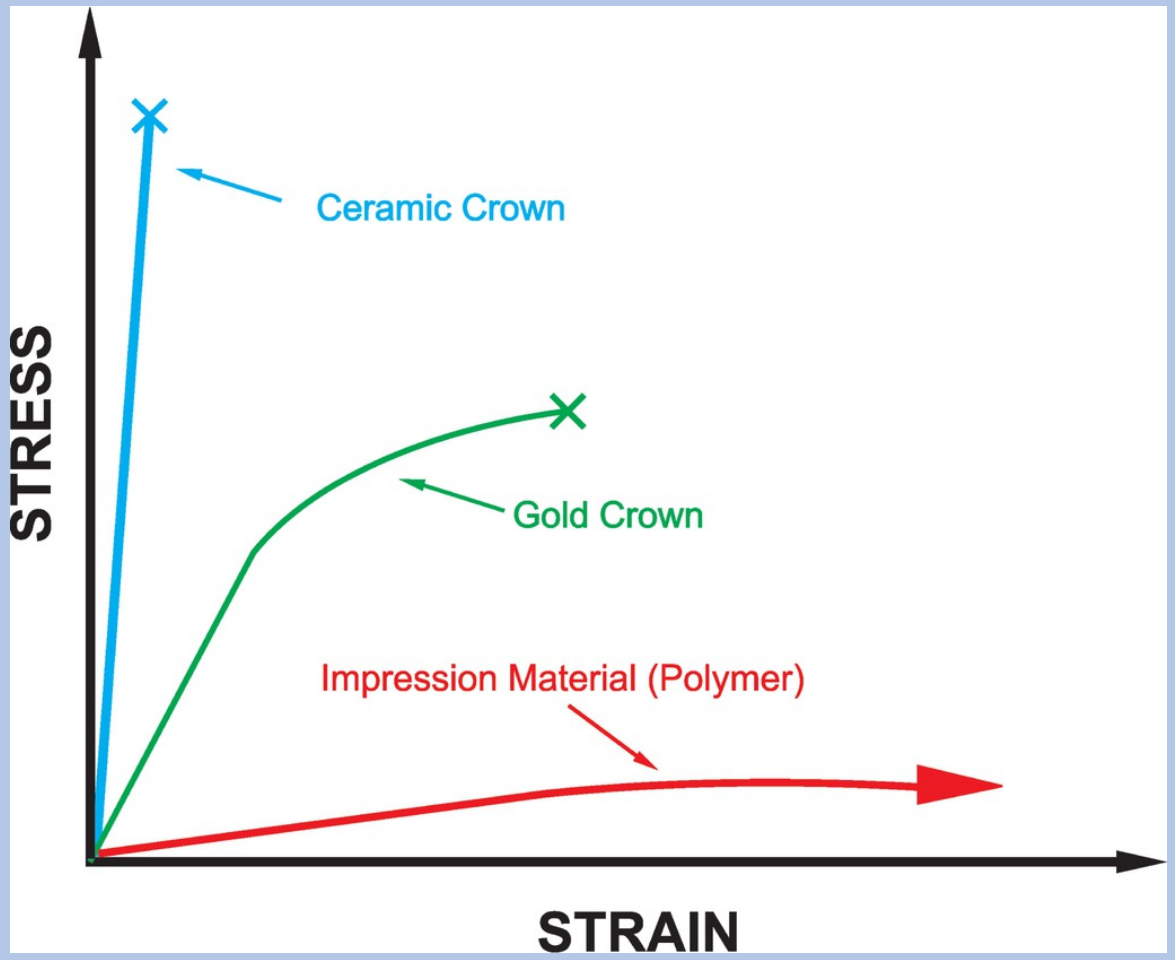
- **Stress-** the internal force which resists the applied force.
- **Strain**- the distortion or deformation that occurs when an object cannot resist a force.
- **Elasticity**- the ability of a material to recover its shape completely after deformation from an applied force.
- Relationship of Stress and Strain:
  Modulus of Elasticity- measures the stiffness of a material.

Quick Review…

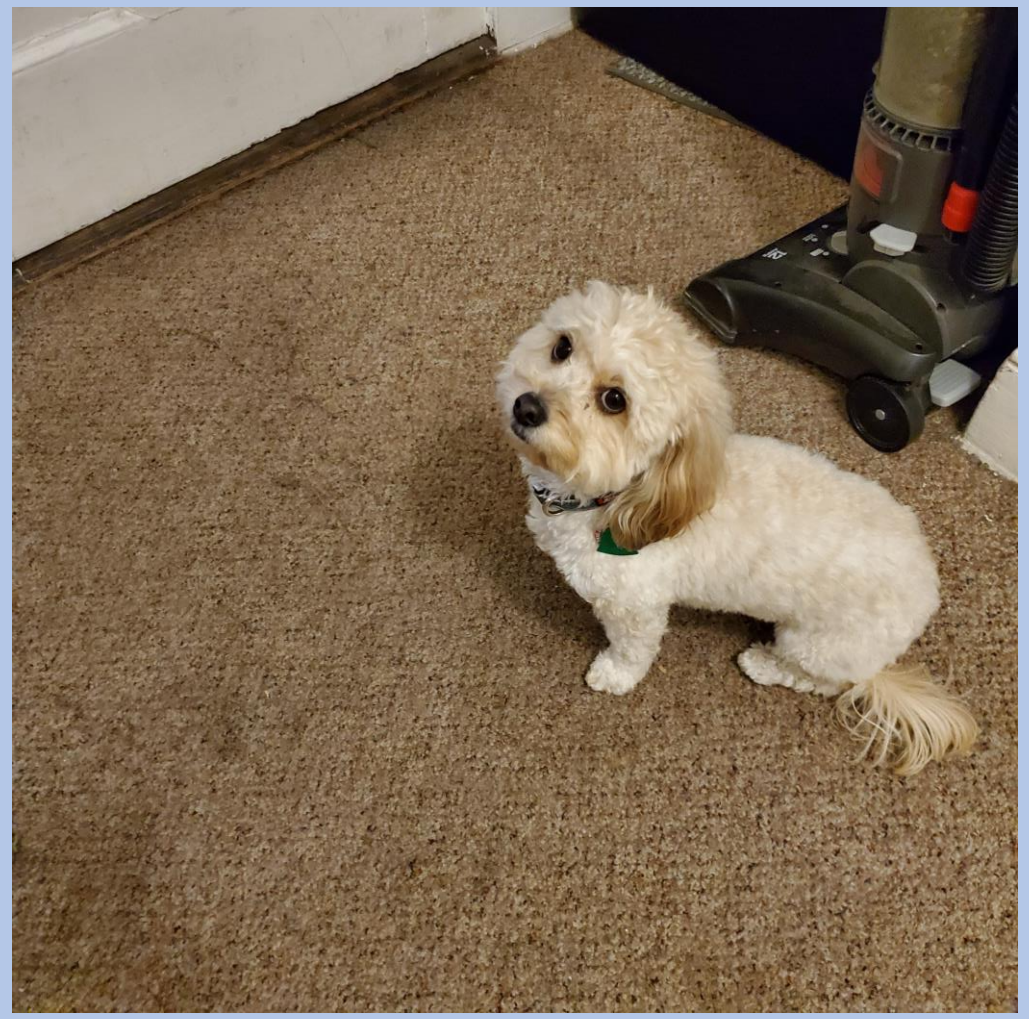
- Stress is?
- Strain is?
- Stress and Strain are interactive with each other
- Elasticity is?

Modulus of Elasticity

Stress vs Strain of Dental Materials



Break Slide



How do you handle Biomaterials?

- Handling
- Mixing
- Dispensing
- Dental Materials and Patient Allergies
- Contamination

Handling of Biomaterials

- It is very important to read and follow the directions.
- Understand why each step is performed in the manner directed by the instructions.
- When working with a new material, practice with the material at least once outside of the patient's mouth. Check the "feel" of the new product; how does it compare to other products?

Mixing and Setting Times

- Use a clock to time etching, mixing, setting, and other important time spans. This applies to the clinic and to the laboratory.

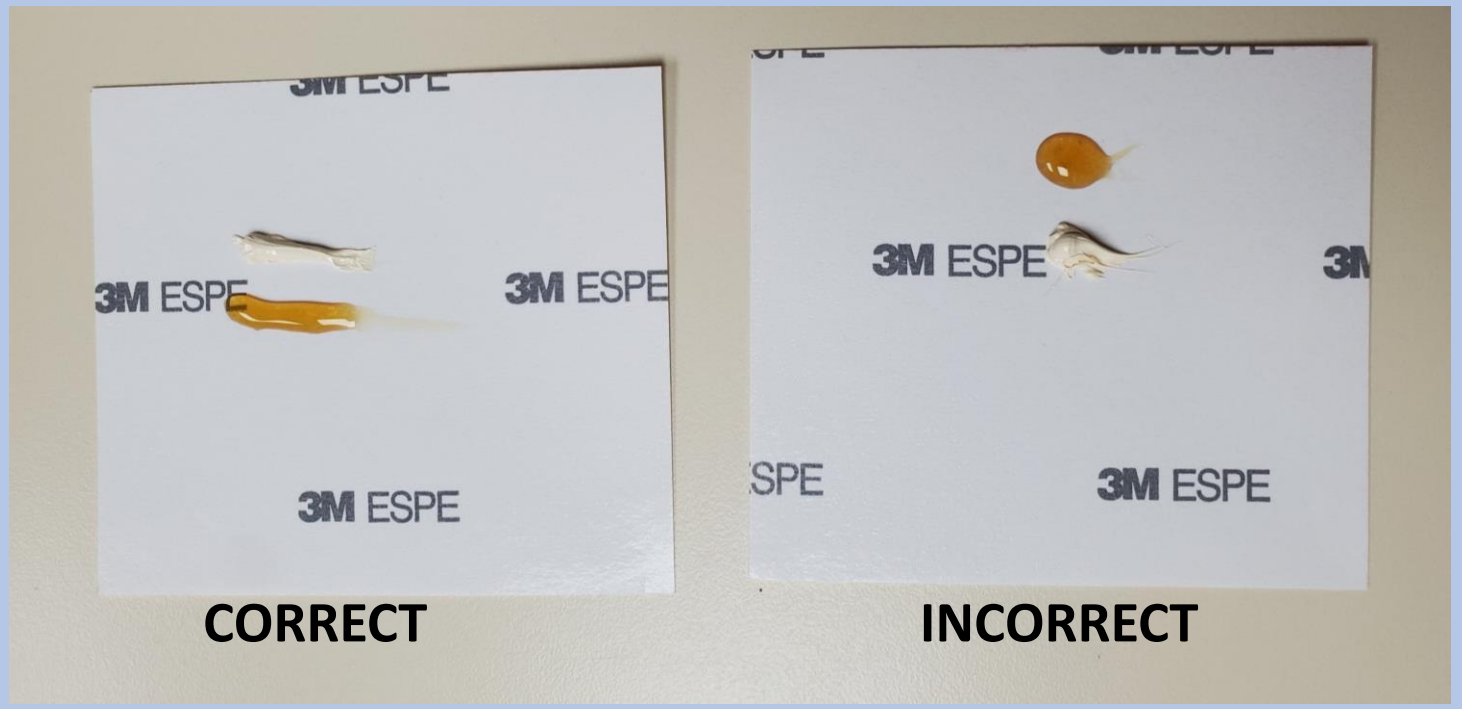
- The mouth is a warm environment. Materials set faster in the mouth than outside of the mouth.

- The setting of some materials is also accelerated by the humidity of the mouth.

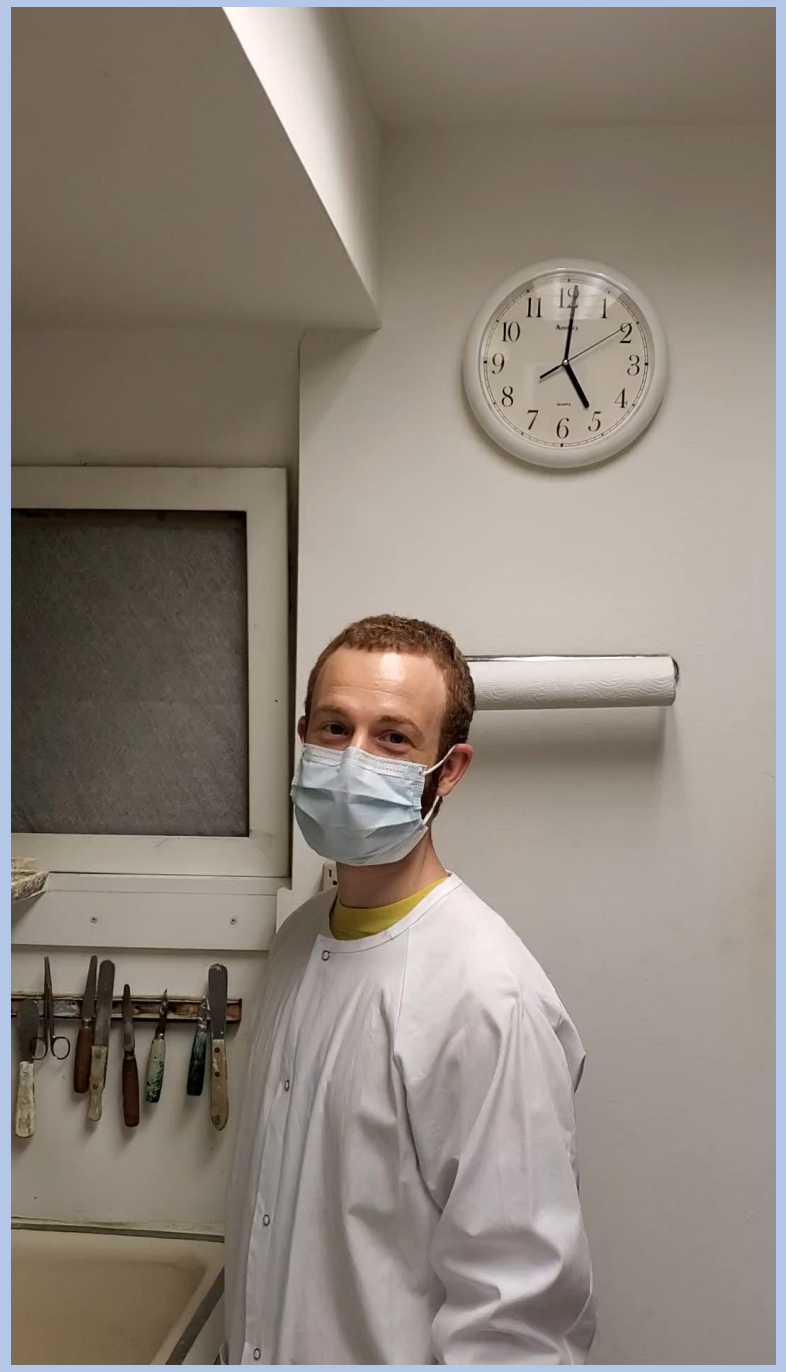
Dispensing Materials

- Follow the instructions.
- Recap tubes and bottles after dispensing materials.
- Dispense equal lengths, not equal volumes, of pastes.
- Dispense consistent drops.
- Fluff powders if recommended by the manufacturer (ie – alginate).
- Do not dispense materials too early; allowing them to sit out unused may be detrimental, especially if the humidity is high.

Dispensing on to Mixing Pad



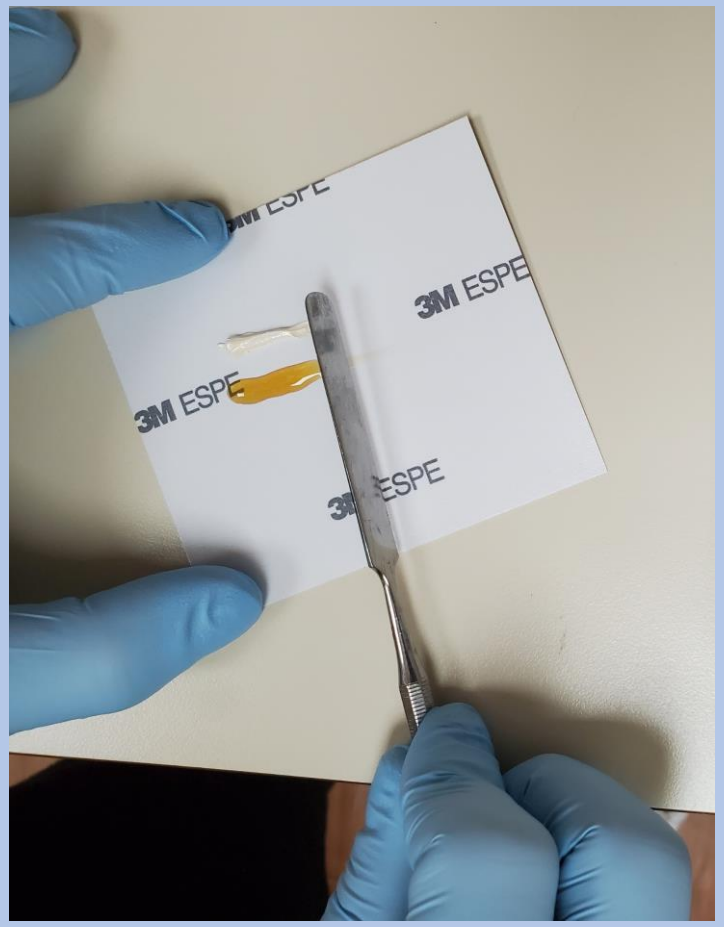
Scooping Alginate



Mixing

- Mix dental materials very thoroughly.
- The setting rate of some materials is affected by the mixing technique that is used.
- When mixing cements, force the powder into the liquid.
- When using a mixing pad, mix over the countertop.

Good Technique
(on countertop)



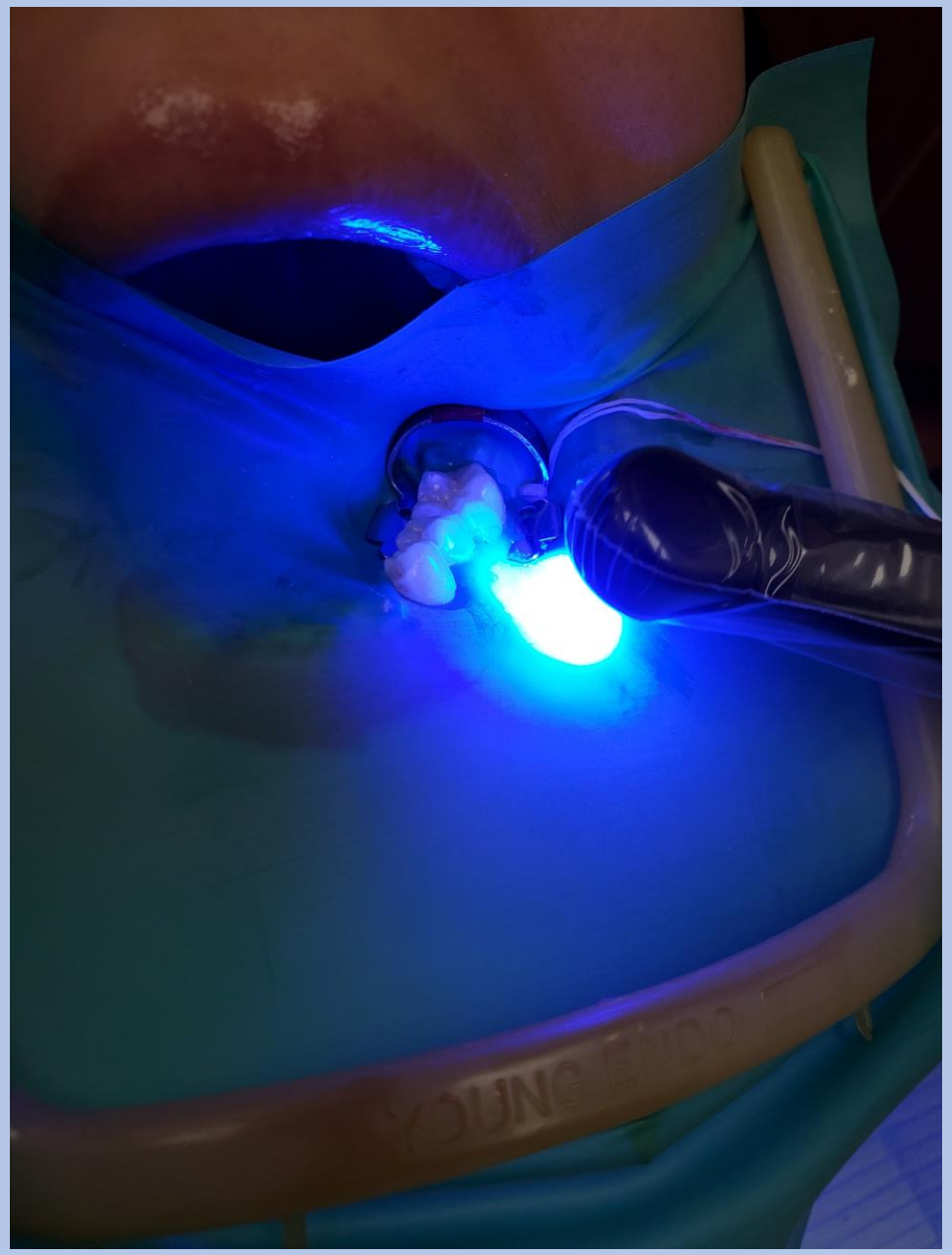
Bad Technique
(holding mixing pad)

Initiation of Setting

- Chemical Cure
- Light Activated Cure
- Dual Cure
- In dentistry, we tend to use the word “cure” instead of “set.”

Light-Activated Materials

- You can undercure, but you cannot overcure, light-activated materials.
- Maintain a space between the tip of the curing light and the oral tissues. Some light tips become quite warm and may overheat the tooth or soft tissues.
- Light-activated materials will begin to set in ambient room light. They should not be dispensed ahead of time and left exposed. Therefore, light-activated materials need to be protected from light if not used immediately.



Handling Dental Materials

- It is always preferred to handle dental materials with an instrument, rather than with a gloved hand.

- Latex gloves can interfere with composite resins and certain impression materials if touched directly.

Dental Materials and Patient Allergies

- Some patients will have allergies to certain dental materials
- Metal Allergies: Cobalt and Nickel
- Flavoring Agents in Toothpaste: Mint and Cinnamon flavors
- Sodium Laureth Sulfate: foaming agent in toothpaste can cause apthous ulcers
- It is important when gathering a medical history to screen for potential dental material allergies.

Break Slide

Examples of Dental Biomaterials

A “Dental Filling” is a direct restoration placed after the tooth decay has been removed.

Biomaterials in Dentistry

Direct restoration the following materials can be used:

Amalgam

Composite Resin

Glass Ionomer Filling

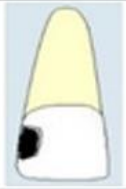
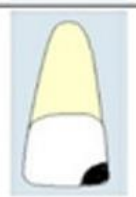
G. V. Black Classification of Dental Carious Lesions

categorize carious lesions based on:
type of tooth affected
(anterior or posterior tooth)
and the location of the lesion

- Class I: **Cavity in pits or fissures** on the occlusal surfaces of molars and premolars; facial and lingual surfaces of molars; lingual surfaces of maxillary incisors (Class I corresponds to surfaces of a posterior tooth you can clinically see—occlusal/lingual/buccal surfaces. Therefore, the interproximal surfaces are not classified as Class I)
- Class II: **Cavity on proximal surfaces of premolars and molars** (Class II corresponds to surfaces of a posterior tooth you cannot see clinically)
- Class III: **Cavity on proximal surfaces of incisors and canines that do not involve the incisal angle** (Class III corresponds to surfaces of an anterior tooth you cannot see clinically)
- Class IV: **Cavity on proximal surfaces of incisors or canines that involve the incisal angle** (Class IV lesion is the larger version of Class III that covers the incisal angle)
- Class V: **Cavity on the cervical third of the facial or lingual surfaces of any tooth** (Think of the neck of the tooth)
- Class VI: **Cavity on incisal edges of anterior teeth and cusp tips of posterior teeth** (Class VI corresponds to the very top surface of a tooth)

G. V. Black Classification of Dental Carious Lesions

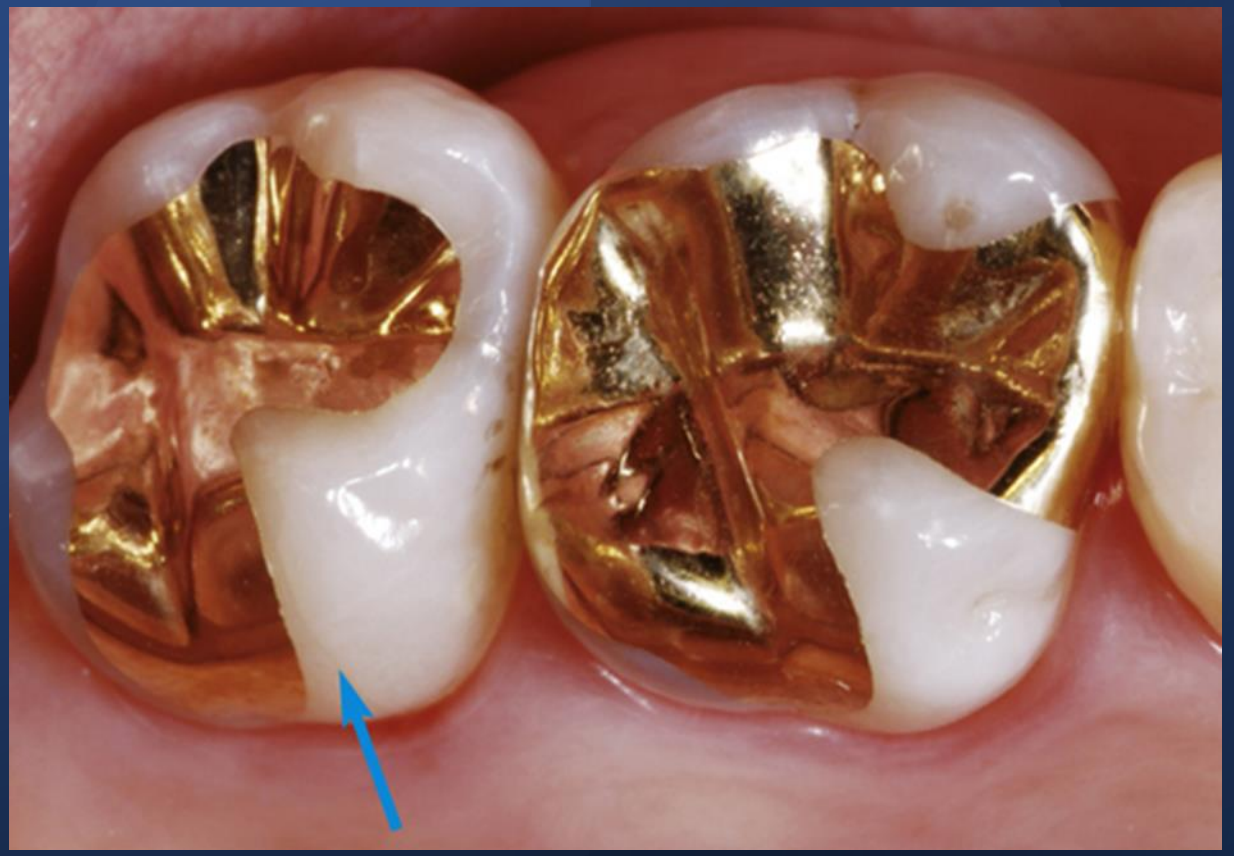
categorize carious lesions based on:
type of tooth affected
(anterior or posterior tooth)
and the location of the lesion

Classes	Illustration
Class I	
Class II	
Class III	
Class IV	
Class V	
Class VI	

StudentRDH

Biomaterials in Dentistry

Indirect restorations-Inlay/Onlay the following materials can be used:

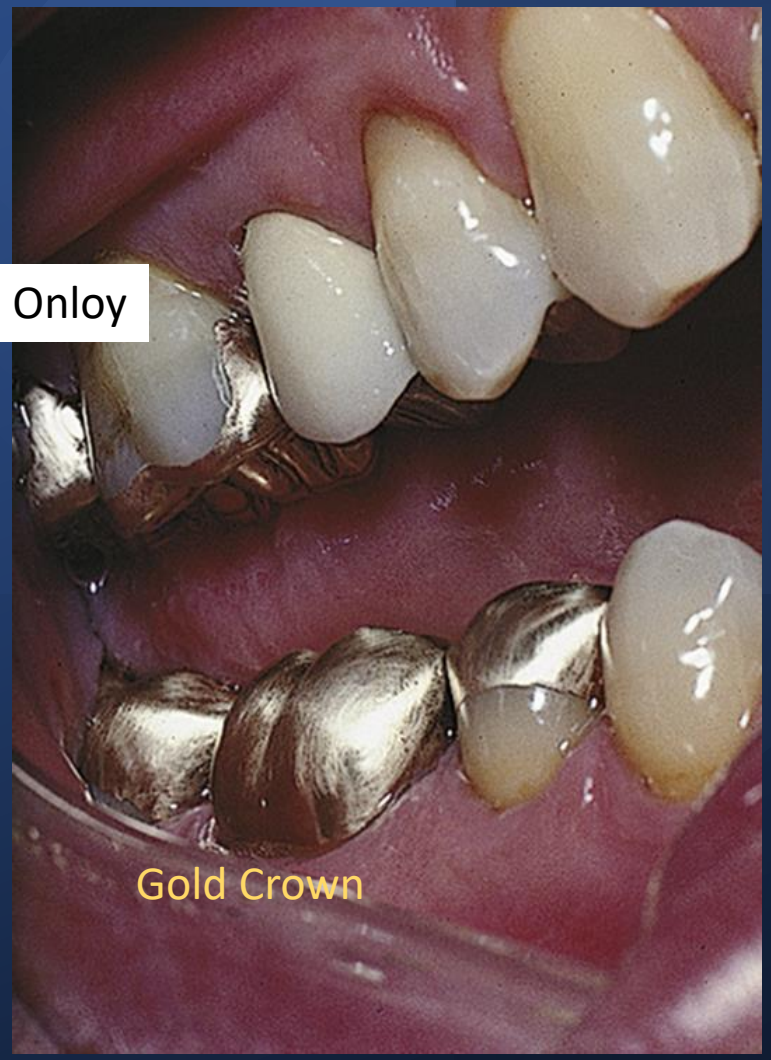


Biomaterials in Dentistry

Indirect restorations-crowns: the following materials can be used:

CROWN

Gold Onloy

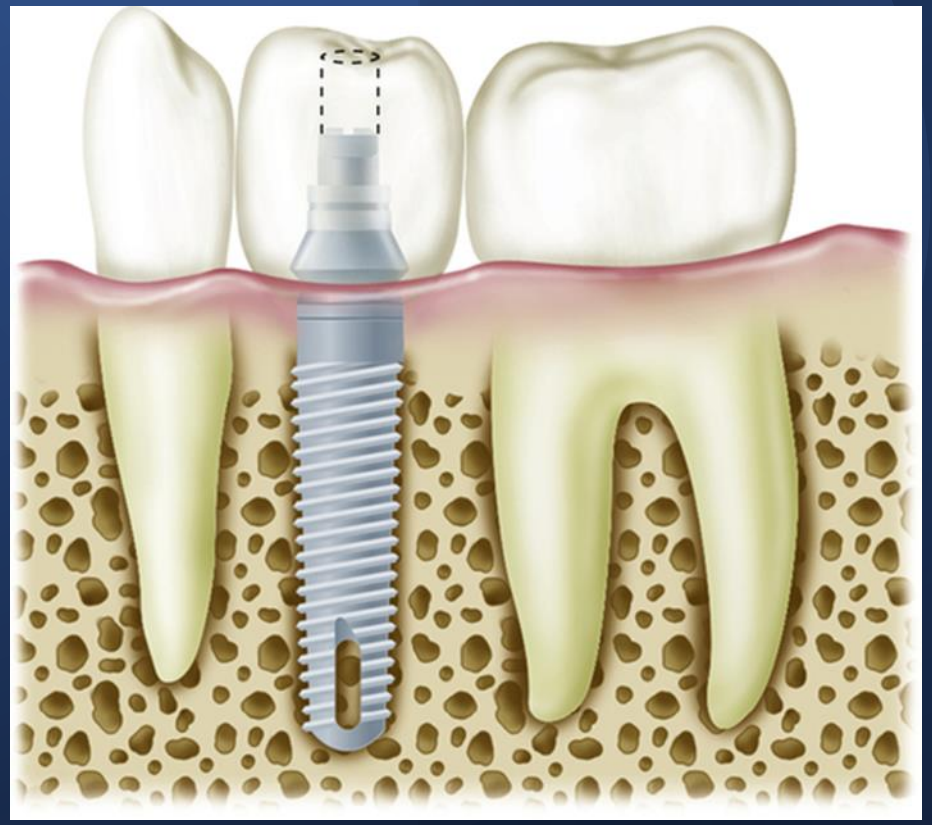


Biomaterials in Dentistry

Indirect restorations-crowns: the following materials can be used:

Biomaterials in Dentistry

Replacement of missing teeth with indirect restorations Bridges or Implants- the following materials can be used:

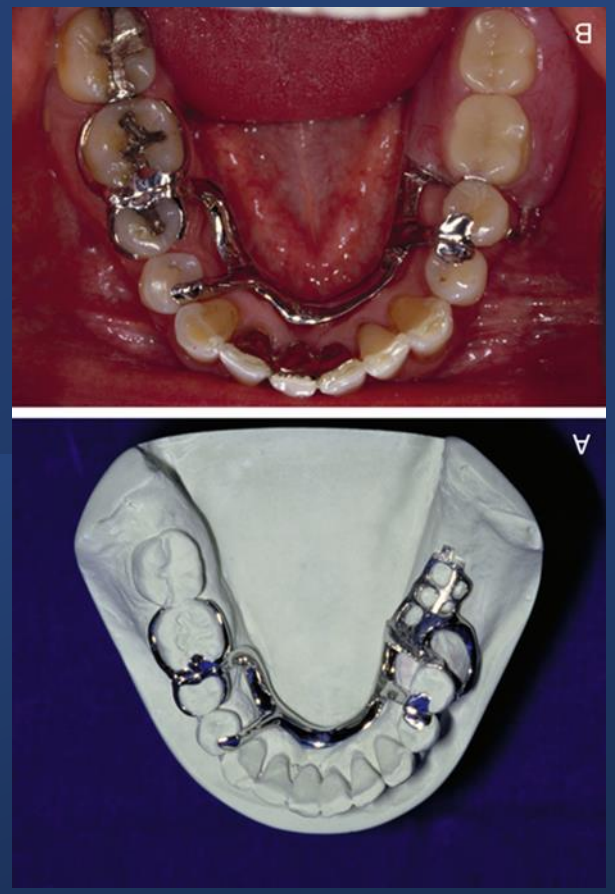


Biomaterials in Dentistry (Cont.)

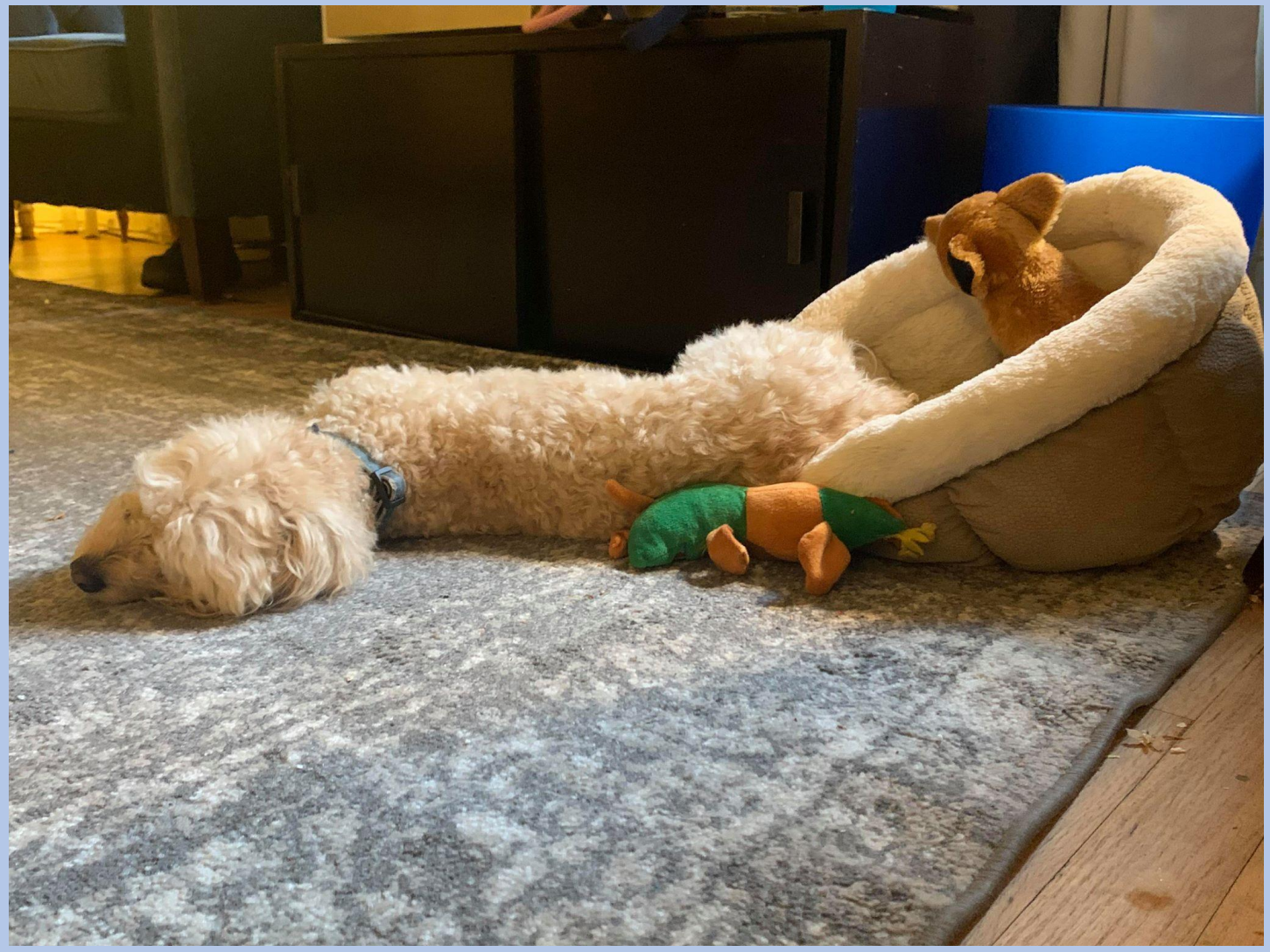
Replacement of missing teeth with indirect restorations

Removable Partial Dentures or Complete Denture

The following materials can be used:



Hang in there only a few more slides to GO!



When placing Dental Restorations, the success of the Restoration will be affected by Contamination.

Most dental materials are best placed in a dry field.

Glass ionomer sealants are one of the few dental materials that will tolerate slight moisture contamination.

Isolation Methods to Maintain a Dry Field

Isolation Methods

1. *Cotton Roll Isolation* should be used in conjunction with ***Dry Angle***

2. Optragate

3. Isolight/Isodry/Dryshield

4. Rubber Dam Isolation*-considered the “gold standard”

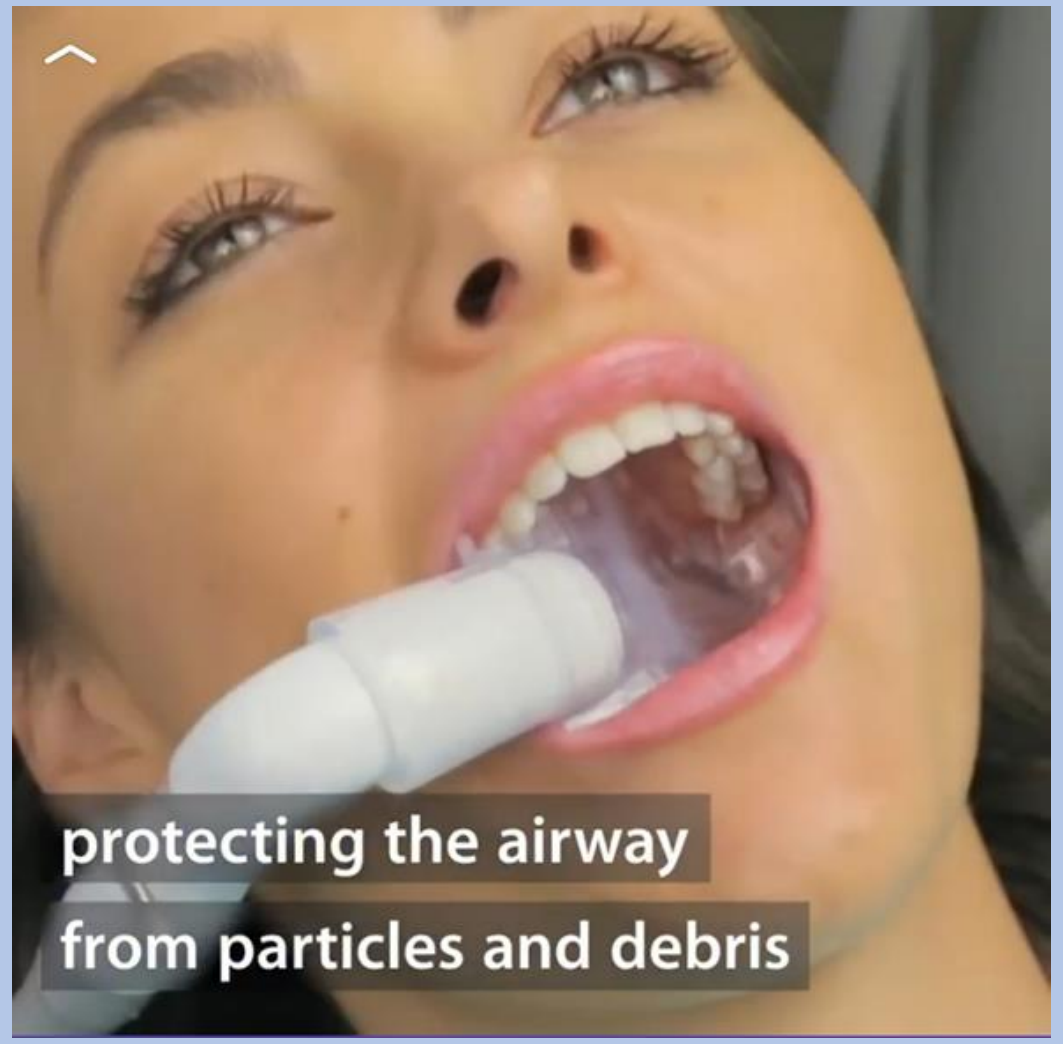
Cotton Roll Isolation

Dry Angle Isolation

At City Tech, we use Microscopy Dry angles

Optragate

Isolight and DryShield



Rubber Dam Isolation