Answers to self-assessment questions

SECTION I: GENERAL PRINCIPLES

Chapter 1 Dental materials in the oral environment

1. The environment in the mouth is harsh with changes in temperature of at least 40 °C with the intake of hot/cold foods and drinks. Any restorative material will also undergo cyclical loading. Additionally, the materials are subjected to immersion in a fluid, saliva, which undergoes significant changes in pH on a regular basis throughout the day.
2. With hand-mixed powders and liquids, it is difficult to dispense the exact proportions of the two components. Powders compact while in the container and can separate. Thus the scoops or cups provided will hold variable amounts of powder at different times and many of the dropper bottles will deliver only to within 10% of the requisite volume required.
3. Pre-dispensed materials avoid the variation in proportions which can occur with hand mixing. However, the storage conditions of the container are critical. Additionally, where the pre-dispensed material requires activation by mixing, it is essential that the instructions for mixing are followed fastidiously, otherwise the mixed material will not perform satisfactorily.
4. It is essential that the clinic temperature should be maintained within a narrow range of around 22 °C, as this provides the optimum temperature for performance of most materials. It matches the temperature maintained in manufacturers' laboratories. In very hot weather, some form of cooling device is advisable, which will also control the humidity.

Chapter 2 Clinical manipulation of materials

1. The amount of energy provided to excite the camphorquinone is reduced and the level of conversion of the material will be reduced, unless the exposure time is extended.
2. All materials are affected to some extend by water or saliva contamination. This is a particular problem with resin-based material as the water or saliva will adversely affect the polymerization reaction. The only materials where water is less of a problem are the conventional glass ionomer cements but even here the final restoration will have inferior mechanical properties if it is contaminated with moisture.
3. Manufacturers can vary the concentration of both the photo-initiator and the amine in the composite paste to allow the material to set more quickly. The disadvantage of this is that it frequently prevents the polymer chains growing to the fullest extent and the set materials are not as strong as those with a slower set.
4. The light guide should be cleaned after each use and inspected regularly for any damage to the glass fibres in the light guide. Any fracture will be clearly seen as the fibre will be black when the light guide is held up to the light and ambient light is allowed to pass down the guide. The light output should be checked regularly with a photometer. In the case of a halogen light the bulb should be changed on a regular basis since the filament will age.
5. Halogen lights have long track record of reliability. However, the reflector requires regular cleaning and the bulb filament ages with time. The result of this is that the wavelength of the light emitted changes over time, and this can adversely affect the curing of the composite. This is offset to some extent by the wider range of excitation compared with an LED light.
6. The shade should be taken early in the appointment before the eyes become tired. The patient should remove any make-up and bright clothing should be covered with a neutral drape. Ideally the tooth should viewed in natural light, preferably at a north-facing window. It is unwise to take the shade late in the afternoon. Both the dentine and enamel shades should be taken.

Chapter 3 Biological effects and safety aspects of dental materias

1. There is a risk of causing pulpal trauma in deep cavities as the heat generated will diffuse through the tooth. The effect is not transient as the thermal properties of the resin-based material means that they retain the heat for some time. The rate of dissipation of the heat is slow.
2. In the UK, there is an obligation on the clinician to report to the MHRA any adverse reactions which have occurred. They should also contact the manufacturer with a full history of the incident and retain the material so that it may be returned for evaluation.
3. Dental team members should fully familiarize themselves with the handing and manipulation of the material. They should also carry out a risk assessment for the use of the material including filling out a COSHH form. To do this thoroughly, they should check the MSDS form on the manufacturer's website for details of the chemicals in the material which could be hazardous. This form also provides information about how to deal with the hazard.

Chapter 4 The role of the manufacturer

1. When the patient applies a compressive load on the restoration but within the material, the two halves of the filling are put under tension and the mesial and distal parts separate. Additionally, the amalgam surface adjacent to the cavity floor is also under tension.

2. It is essential that any restorative can be differentiated radiographically from the radiolucent carious lesion and preferably from natural tooth tissue such as enamel and dentine.
3. Such tests provide a guide to performance in comparison with other materials, which are already in use in the mouth. However, the tests do not represent either the size or shape of restoration and as such are more a guide to quality rather than performance predictors.
4. The success of any material is determined by its clinical performance and, in particular, its handling, of which the dental practitioners are the only true arbiters. It is also essential with any material to have some form of clinical appraisal of performance for a period of time prior to launch. This ensures that at least some unforeseen short-term problems can be eliminated.
5. Obtaining CE marking is an obligation of the manufacturer before a material can be marketed in any of the countries of the European Union. The manufacturer must ensure that the material is classified according to the medical device directive and provide the necessary evaluations and quality control requirements for inspection by the notified body in the country in which the material is first marketed. This provides a quality check for the material.
6. A manufacturer would first develop the concept for the material and then carry out laboratory tests on a range of experimental materials to determine the most appropriate one for the intended purpose. The material would then be evaluated further in the laboratory. Should the material be entirely new, there is a requirement that the manufacturer examines the biological response to the material using a series of toxicity and biocompatibility tests. Once these have been completed, the manufacturer can apply for the material to undergo a clinical evaluation.
7. Much advertising and promotion literature compares a new material with existing ones used for a similar purpose currently on the market. There is an increasing tendency for manufacturers to demonstrate that very small differences are significant. This can be done in a number of ways. Many of the bar charts used in the promotional literature do not show the degree of variation (error bars) on comparative illustrations. Similarly the y axis in graphs can be truncated to start closer to the values observed. This means that the scale is stretched and the differences become much more significant visually than they really are.

Chapter 5 Control and use of materials in practice

1. A stock control system will minimize the amount of stock held and thus the capital cost born by the practice. It will ensure that the stock of one material is used in correct order so that the use-by date is not exceeded. It will also ensure that the DFUs are readily accessible and that ordering is done on a regular and informed basis.
2. Compules provide a unit dose of the restorative material, which means that there is no risk of cross-infection between patients. There is little or no risk of the light-curing material being prematurely activated. Additionally, the compule system permits the material to be delivered directly to the cavity rather than pre-dispensed. Syringes can provide variable quantities which are determined by the clinician.
3. Wastage can be cut to a minimum by holding only one type of material for each application. The selection of this material should take into consideration any other applications of the material. It is wise not to order too much material as some less frequently used materials may become time expired before they are ready for use. In the clinic the amount dispensed should only be sufficient for the task in hand. It is worth considering the amount of wastage (particularly with hand-mixed materials) which can cost money.
4. It is essential to read the DFU to use the material to its best effect. It is important to regularly check the DFU as manufacturers may modify products over time, resulting in changes to the DFU. Failure to use the materials correctly may lead to premature failure.
5. Many modern materials have an outer packaging which is designed to prevent contamination by water. This means that if a compule is removed from its airtight sachet, there is a risk of the material starting to degrade before use.

SECTION II: DIRECT RESTORATIVE DENTAL MATERIALS

Chapter 6 Dental amalgam

1. A galvanic cell is caused by contact between dissimilar metals in a wet environment. One of the restorations could be removed and replaced with the same material as the other restoration. Alternatively, the patient can be advised to eat eggs for a few days. The sulphides from the egg will form a film on the surface of the metals so disrupting the galvanic cell. The pain should then resolve.
2. The amalgam has been overtriturated. Check the mixing time, suitability of the machine (throw, frequency and motion) and adjust the settings accordingly.
3. Evidence from most large-scale evaluations has shown no adverse effects of amalgam use. If the patient still persists, then explain the consequences of removal of old amalgam and the advantages and disadvantages of the alternative restorative materials.
4. The diameter of the tip of the plugger should be sufficiently wide to condense rather than penetrate the cohesive mass. The admixed alloy has a range of particle sizes and a small diameter tip may be used initially to condense the amalgam into the corners of the cavity. A large diameter tip is better for spherical amalgam as less force is required to condense it.
5. Polishing is carried out to produce a smooth surface to prevent the ingress of fluid, bacteria and debris, which potentially reduces the risk of corrosion. However, this may increase the electrochemical activity of the surface, which itself carries a risk of break down of the restoration and release of mercury vapour.
6. Inadequate cavity preparation will lead to insufficient bulk of amalgam for strength. If amalgam is the only choice of restorative material, the cavity should be deepened to provide bulk. Alternatively, another restorative material which is less susceptible to brittle fracture may be used.

Chapter 7 The tooth-coloured restorative materials I: Resin composites

1. The key points in the placement of a Class II resin composite restoration are:
   - Case selection
     - Consideration of the size of cavity
     - Occlusal factors
     - Ability of the clinician and their confidence in using the material
     - Patient's oral hygiene and caries rate
   - Cavity design
   - Moisture control (rubber dam)
   - Correct selection of the resin composite material
   - Correct selection of an appropriate matrix system
   - Compatibility of the bonding and resin composite systems
   - Incremental placement
   - Sufficient curing (and compatible systems)
   - Post cure.
2. The reasons for debond include:
   - Poor bonding technique
     - Incompatibility between the bonding system and resin composite
     - Failure to follow the manufacturer's instructions accurately
     - Poor moisture control
   - Insufficient material placed
   - Unfavourable occlusal forces
   - Parafunction
   - Incorrect selection of resin composite material.
3. The clinician has taken the shade after the application of the rubber dam. The effectiveness of the rubber dam to establish excellent moisture control dehydrates the teeth and they lighten in colour. This colour change is not apparent to the clinician, who matched the shade at the lighter (dehydrated) value. The shade match is excellent immediately postoperatively but when the rubber dam is removed and the teeth rehydrate, so going back to their normal darker colour, the composite restoration appears too light. Thus, the shade should always be taken prior to the application of rubber dam.
4. A hybrid resin composite contains particles of various sizes and shapes. This offers a higher filler density as the particles can come closer together and fit into each other so they interlock. This decreased amount of resin (and therefore increased bulk of filler) reduces polymerization shrinkage and coefficient of thermal expansion, and increases wear resistance and improves the mechanical properties.
5.

Shortcoming	Solution
Polymerization shrinkage	Incremental placement Use of the correct matrix system
Hydrophobic material	Excellent moisture control such as rubber dam
Incomplete curing in the presence of oxygen	Post-cure use of a matrix strip/index
Contains HEMA	Use of a no-touch technique during placement and manipulation
More technique-sensitive to place than other dental materials	Experience of the dentist, i.e. practice!
Photophilic material	Placement and manipulation under an orange-filtered operating light

6. The finishing of composite should be delayed for 24 hours as the final setting phase of the restoration stretches over several hours. If the material is finished immediately, the setting polymer will be disrupted and the final restoration will be weakened, leading to a reduction in durability and therefore longevity.

Chapter 8 The tooth-coloured restorative materials II: Compomers

1.

Similarities	Differences
Contain resin	Contain different glass materials
Are light cured	Aesthetics better with the composite
Are tooth coloured	Compomers stain more readily
Undergo hygroscopic expansion during function	Differences in setting mechanism
Most commonly supplied in compules	Compomers release fluoride
Undergo polymerization shrinkage	
Adhere to tooth tissue by micromechanical retention	
Require good moisture control to place	

2.

Indication	Advantage	Disadvantage
Class III cavities	Material strong enough for purpose Aesthetics acceptable Bonds to tooth tissue	More aesthetic material available (resin composite) Staining with time
Class V cavities	Matrix more flexible so able to be retained in abfraction lesions Aesthetics acceptable Bonds to tooth tissue	More aesthetic material available (resin composite) Staining with time
Fissure sealants	Available in flowable form	
Luting of metal-based indirect restorations and orthodontic brackets	Available in luting form Bonds to tooth tissue	
Restoration of deciduous teeth	Bonds to tooth tissue	Moisture control may be a problem

3. Compomers take up water from the oral environment in order to fully set and this cannot be done if they are completely isolated from the oral environment, i.e. under a crown. Furthermore they are not as strong as other materials (such as amalgam or resin composite), and as they are tooth coloured it may be difficult to distinguish between the core and tooth.

4.

Advantages	Disadvantages
Water uptake allows fluoride to be released	Hygroscopic expansion due to water sorption
May help to equalize polymerization shrinkage	Staining of material

5.

Setting mechanism	Clinical relevance
Free radical polymerization	Command set Shrinkage due to polymerization (leading to problems)
Acid/base reaction	Water needed Allows steady release of fluoride from the set material

Chapter 9 The tooth-coloured restorative materials III: Glass ionomer cements

1.

Advantages	Disadvantages
Dynamic bond which can regenerate so useful for the restoration of abfraction lesions	Poorer aesthetics compared with resin composites
Chemical adhesion to tooth so can be used in unretentive cavities	Weaker, so not recommended for cores/large cavities
Cariostatic due to fluoride release	Susceptible to wash out
Does not require hardware, for example curing lights	Can be damaged by early finishing
Can be used for domiciliary visits and in non-'ideal' situations	Requires long time to set
Does not need to be used with rubber dam	Needs protection to prevent desiccation
Requires only limited cavity preparation	Early low mechanical strength

2. It is deleterious to finish glass ionomer cement restorations at the placement visit because:
   - The material has a slow maturation phase and considerable damage may occur to the forming cement matrix
   - Damage to the surface of the restoration will result
   - Desiccation of the material may also occur so disrupting the matrix and, again leading to damage of the surface of the restoration.
3. Indications of glass ionomer cement are:
   - Atraumatic restorative technique (ART)
   - Restoration of deciduous teeth
   - Restoration of permanent teeth
     - Tunnel preparations
     - Class 3 cavities
     - Class 5 (especially non carious tooth surface loss lesions) cavities
   - Inter-visit endodontic access cavity restorations (especially with respect to resin based composite as above)
   - Long-term intermediate restorations
   - Core construction (provided sufficient tooth tissue remains to support the material)
   - Preventive resin restorations
   - Bases
   - Dressings
     - Non-retentive cavities
     - When it is envisaged that resin composite will be used as the definitive restorative material (instead of the use of a zinc oxide eugenol cement whose eugenol constituent may inhibit the setting reaction of the resin composite)
   - Fissure sealants
   - Luting of crown and bridge retainers
   - Orthodontic cements.
4. Glass ionomer cement adheres to tooth tissue by chemical adhesion via the polyacrylic acid in the material and calcium chelation with subsidiary collagen bonding in the tooth tissue. The cavity surface is often conditioned to remove the smear layer and so priming the dentine to accept the restorative material. Resin composite adheres micromechanically to enamel and dentine. This is produced by acid etching which creates pits in the surface and no chemical bonds are formed.
5.

Similarities	Differences
Same material at the end point of mixing	Cannot vary the powder/liquid ratio with capsules
Both presentations need to be shaken prior to mixing	More predictable mix with capsules Capsules are easier to mix Capsules are more expensive Capsule mixing is quicker Cannot vary amount of material mixed with capsules

6.

Similarities	Differences
Same glass filler	Better aesthetics with compomer
Both undergo an acid-base reaction	Compomers are light cured
Both leach fluoride	Compomers more likely to stain with time Compomers need to take up water in order for fluoride to be released Cavities usually etched first for compomers Mechanical properties superior for compomers

Chapter 10 The tooth-coloured restorative materials IV: Resin-modified glass ionomer cements

1. Some of the presentations of this type of material are based on microcapsule technology. These microcapsules must be broken down in order to release chemicals so that the material can set properly. This is only achieved by vigorous spatulation or proper mixing in a mechanical mixing machine.
2.

Indication	Advantage	Disadvantage
Restoration of small Class I cavities	Bonds to tooth tissue	May be more difficult to place in the cavity
	Releases fluoride	Tends to stain with time
	Cured by the application of light, so saving time	Polymerization shrinkage

(*Continued*)

Indication	Advantage	Disadvantage
Restoration of Class III and V cavities	Bonds to tooth tissue Releases fluoride Cured by the application of light so saving time	May be more difficult to place in the cavity Tends to stain with time Polymerization shrinkage
Core build-ups when a substantial amount of tooth tissue remains	Available in a shade other than tooth Bonds to tooth tissue and other materials Cured by the application of light, so saving time	Polymerization shrinkage Not as strong as other materials which could be used
Sandwich (open and closed) restoration	Bonds to tooth tissue and other materials Releases fluoride Cured by the application of light, so saving time	Polymerization shrinkage
Dressings	Bonds to tooth tissue Releases fluoride Cured by the application of light so saving time	
Definitive cementation (luting) of cast metal restorations Metal bonded to ceramic restorations Strengthened core ceramic restorations Metal posts Orthodontic bands	Bonds to tooth tissue and other materials Releases fluoride	
Restoration of deciduous teeth	Bonds to tooth tissue Release fluoride Cured by the application of light, more convenient with child patients	
Linings	Bonds to tooth tissue and other materials May be etched without detriment Cured by the application of light, so saving time	Exothermic setting reaction

3.

Similarities	Differences
Same glass filler	Compomers presented in compules
Both light cured	For compomer restorations, the cavities are usually etched and bonded
Both release fluoride	
Both susceptible to stain with time	
Polymerization shrinkage	

4. The benefits of RMGICs compared with conventional glass ionomer cements are:

- Command set
- May be etched without detriment
- May bond to resin composite.

5.

Possible material	Pros	Cons
Glass ionomer cement	Ability to form dynamic bonds Leaches fluoride Adheres to tooth tissue	Chemical cure so must wait for this to occur, which may be inconvenient Needs to be protected against moisture contamination until fully set Cannot finish at same visit
RMGIC	Leaches fluoride Adheres to tooth tissue Light cured	
Compomer	Leaches fluoride Light cured Adheres to tooth tissue with a bonding agent	Good moisture control essential
Flowable resin composite	Light cured Adheres to tooth tissue with a bonding agent	Does not leach fluoride Good moisture control essential
Resin composite	Light cured Adheres to tooth tissue with a bonding agent	Does not leach fluoride Good moisture control essential
Amalgam	Longest track record	Does not bond to tooth tissue Does not leach fluoride Needs undercut cavity to retain it, so more tooth tissue has to be removed

6.

Possible material	Pros	Cons
Glass ionomer cement	Ability to form dynamic bonds Leaches fluoride Adheres to tooth tissue Some flexion in the material to withstand flexion of the tooth	Aesthetics not as good as some other materials Chemical cure so takes longer to set
RMGIC	Leaches fluoride Adheres to tooth tissue Light cured Some flexion in the material to withstand flexion of the tooth	Tends to stain with time
Compomer	Light cured Adheres to tooth tissue with a bonding agent Leaches fluoride Good aesthetics Some flexion in the material to withstand flexion of the tooth	Tends to stain with time

(*Continued*)

Possible material	Pros	Cons
Flowable resin composite	Light cured Adheres to tooth tissue with a bonding agent Good aesthetics Some flexion in the material to withstand flexion of the tooth	Does not leach fluoride
Resin composite	Light cured Adheres to tooth tissue with a bonding agent Good aesthetics	Does not leach fluoride Matrix too rigid so may be lost when tooth flexes during function

7. HEMA is a powerful dermatological sensitizing agent, so clinic staff must handle any material containing this chemical using a 'no-touch technique'.

Chapter 11 Bonding systems

1. Luting grouts, i.e. fills up the potential gap between the restoration and tooth preparation. Very often no bonding occurs either chemically or micromechanically. Bonding means either micromechanical or chemical bonds have been formed between the restoration and the tooth tissue. The latter approach is useful when insufficient retention is available.

2.

Similarities	Differences
Both effective at bonding resin composite to tooth tissue	Self-etch quicker as fewer steps required Better sealing of dentine with self-etch Less postoperative sensitivity with self-etch Self-etch cannot be used with dual-cured or chemically cured resin composites Less good etch pattern produced with self-etch Higher bond strengths gained with etch and bond Greater consistency with etch and bond

3. The reason for debond could be:
   - Poor bonding technique
     - Poor moisture control
     - Incompatible bond and resin composite
     - Failure of the dentist to follow the directions for use
     - Enamel margins not bevelled
   - Incorrect selection of resin composite material
   - Insufficient bulk of material for strength
   - Recurrent trauma.

4.

Material	Pros	Cons
Chemically cured phosphonated ester	Longest track record Good bond strengths	Long wait for the material to set
Light (dual)-cured phosphonated ester	Light-cured Good bond strengths	
Dual-cured resin composite cement	Light-cured	
Self-etched composite resin	Light-cured Fewer stages in the process	Poorer bond strengths compared with other materials

5. The dentist should reprepare the tooth and start the process again, preferably under rubber dam.
6. The treatment options would be:
   - If the defect is minimal – do nothing, perhaps polish surface
   - Bond resin composite after treating the surface with Cojet or etching the ceramic and using a silane coupler prior to bonding
   - If there is a large defect – remove the ceramic by preparing a veneer, roughen the metal surface and take impression, get a ceramic veneer made by the laboratory and bond as above.

Chapter 12 Other dental cements

1.

Factors controlled by manufacturer	Factors controlled at the chairside
Liquid – buffering capacity	Powder/liquid ratio
Water content of the liquid	Mixing temperature
Powder – composition	Rate of incorporation of powder
Amount of calcination	Manner of spatulation
Particle size	Amount and quality of water in liquid

2.

Similarities	Differences
Long track record	Zinc polycarboxylate adheres chemically to tooth tissue
Poor aesthetics	Compressive strength less for zinc polycarboxylate Zinc phosphate more acidic Zinc polycarboxylate more viscous Zinc phosphate has a thinner lute thickness Zinc polycarboxylate more sedative

3.

Advantages	Disadvantages
Sedative	Difficult to mix
Bactericidal	Opaque
Adequate mechanical properties	No bonding to tooth tissue or restorative materials
Inexpensive	Eugenol interacts with resin composite
Good and long track record	Soluble in the mouth
	Poor wear resistance in unreinforced material

4. Materials which could be used are:
   - Setting calcium hydroxide over the exposure, covered with a resin-modified glass ionomer
   - Non-setting calcium hydroxide, covered with setting calcium hydroxide over the exposure and then with resin-modified glass ionomer placed over this
   - Tricalcium silicate cement could be placed directly over the exposed pulp tissue
   - MTA could be placed directly over the exposed pulp tissue.

The procedure should be done under rubber dam if possible to prevent ingress of oral bacteria into the pulp.

5.

Similarities	Differences
Adheres chemically to tooth tissue	Different fillers
Leaches fluoride	Better aesthetics with glass ionomer
Can be used to lute casts and used as dressings	Zinc polycarboxylate only available as a powder and liquid

6. The procedure is as follows:
   1. Shake the bottles. Consider cooling the glass slab to increase working time. Place one scoop of powder and two drops of liquid close together on slab.
   2. Incorporate all the powder into the liquid as rapidly as possible over a small area of the slab. Mix for 30–40 seconds until a creamy cement has formed.
   3. Load the cement into the full gold crown, sparingly coating the sides.
   4. Seat the crown onto the preparation axially, then remove the force on the cast before reapplying it. This may be done twice or thrice. Maintain a constant pressure on the crown until the cement has set.

Chapter 13 Materials used in endodontics

1. The following materials may be used as endodontic irrigants to disinfect the root canal system:
   - Sodium hypochlorite
   - Iodine potassium iodide
   - Chlorhexidine
   - Hydrogen peroxide
   - Hypochlorous acid
   - Electronically activated water
   - MTAD.

   Ozone and photo-activated disinfection may also be used.

2.

Material	Pros	Cons
Glass ionomer cement	Good seal Can restore cavity with resin composite postoperatively Adheres to tooth tissue Wear resistance adequate	Tooth coloured so may inadvertently remove tooth tissue at the next appointment
Zinc polycarboxylate	Adheres to tooth tissue Good seal	Difficult to mix
Zinc oxide eugenol	Good seal	Contamination of dentine with eugenol, which may compromise subsequent restoration with resin composite Poor wear resistance
Reinforced zinc oxide eugenol	Good wear resistance Good seal	Contamination of dentine with eugenol, which may compromise subsequent restoration with resin composite.

(*Continued*)

Material	Pros	Cons
Zinc oxide putty material	Easy to place No mixing required	Poor wear resistance Poor mechanical properties Long setting time
Amalgam	Good wear resistance	May be difficult to pack into cavity as nothing to pack against More costly as takes more time
Resin composite	Good wear resistance	Tooth coloured so may inadvertently remove tooth tissue at next appointment More costly as takes more time

3. The consistency of MTA is like wet sand, so ensuring the correct moisture level to allow packing it into the cavity can be a problem.

4.

Material	Pros	Cons
Zinc oxide eugenol	Antibacterial Long track record	Weak Porous Breaks down with time
Calcium hydroxide	Antimicrobial	Breaks down with time More soluble than others Poor cohesive strength
Epoxy resin	Good flow Good sealing ability Dimensionally stable Long working time Adhesion to other materials and dentine Antibacterial	Lower solubility Greater film thickness
Glass ionomer cement	Low toxicity Induces little tissue irritation Adheres to dentine Leaches fluoride	Less good sealing properties More susceptible to dissolution
Polydimethyl siloxanes	Dimensionally stable Good flow Small film thickness	No antibacterial properties No bonding to dentine Cannot be used in deciduous teeth

5. Endodontic posts may be prefabricated or cast.
   - Prefabricated posts may be constructed of either non-metallic materials or metals.
   - Metallic posts may be constructed of stainless steel, titanium, titanium alloy or gold alloy.
   - Non-metallic posts may be constructed of:
     - Zirconia
     - Ceramic
     - Fibre-reinforced resins: carbon fibre; glass fibre; woven polyethylene ribbon reinforced composite.
   - Cast metal posts may be prepared directly or indirectly using a cast alloy or wrought metal.

6. Materials available are:
   - Steroid/antibiotic combination
   - Non-setting calcium hydroxide
   - Chlorhexidine
   - Phenol or phenol derivatives
   - Halogens
   - Formaldehyde.

SECTION III: MATERIALS USED WITH INDIRECT TECHNIQUES

Chapter 14 Materials used in temporization

1. Temporary restorations are designed to replace form and function while preserving the gingival health of the preparation. A good temporary restoration will also prevent adjacent or opposite teeth from migrating.
2. An effective temporary restorative should:
   - Be strong enough to withstand occlusal loads
   - Be aesthetically acceptable to the patient
   - Not discolour with time
   - Be easily adjustable and polishable
   - Be strong enough that it can be used in thin sections.
3. The materials available for temporization of an upper molar are:
   - Aluminium crown forms
   - Copper rings
   - Customized resin temporaries
   - Preformed polycarbonate crowns.

   The first two options provide only protection for the preparation and will not protect the gingival tissue. They will also not provide adequate occlusal references for the opposing teeth. The preformed polycarbonate crowns are difficult to adjust occlusally and frequently are insufficiently wide buccolingually. The customised resin-based temporary will provide an occlusal reference and the correct contour. However, it may need to be bulked up at the margin as the material is not strong in thin section.
4. The modifier used on occasions for temporary luting cements is designed to soften the cement and prevent it setting completely. It is frequently a petroleum jelly base, which assists in the removal of the temporary. If used to excess it may lead to loss of the temporary.
5. Temporization of an inlay may be carried out using a conventional cement or a resin-based material. Conventional cements, while sealing the cavity, provide no functional properties and can be associated with over-eruption of the opposing tooth. Resin-based materials provide both form and function.
6. Eugenol-based cements interfere with the setting reaction of resin polymers, leading to softening and discolouration of the temporary crown material, making the temporary restoration soft and unsightly.

Chapter 15 Impression materials

1. The tray for taking an impression for a fixed prostheses should be rigid, and have sufficient space between the walls and the dental arch to accommodate the appropriate thickness of impression material. It should be perforated or have other mechanical means of retention for the impression material. It should not engage on the soft tissue. It is desirable that the tray can be located accurately over the dental arch and will provide sufficient support to the impression material both buccally and lingually, such that the impression material will not distort. It should also be extended at the back, beyond the last standing teeth in the arch.
2. The probable causes of the stiff rapid setting alginate are:
   - Using the wrong powder/liquid ratio. This is particularly common if the powder container has not been shaken
   - Using water above ambient temperature. The use of a mixer tap where the hot tap may be just running can lead to this problem
   - Leaving the powder container incompletely sealed and allowing the powder to age as the efficiency of the retarder is reduced.
3. Separation from the tray on removal of the silicone rubber is most likely the result of inadequate time waiting for the tray adhesive to dry before the impression material is placed in the tray. Too thick a layer of adhesive which has pooled at the tray angles will also affect the union. Lack of tray perforations or other means of mechanical retention may also cause the impression material to be disturbed. This may be compounded when withdrawing the impression over deep undercuts.
4. Addition silicone materials are very accurate and there is a risk that the processes used to reproduce the cast restoration such as construction of the die and casting the metal work may not be carried out with the same accuracy. There is no tolerance in the impression material to accommodate this. The problem may be reduced to some extent by coating the die with a die spacer material, which can provide space of at least 25 μm.
5. Polyether rubbers are only available in one viscosity and once set are less flexible than the addition silicones. They are regarded as less suitable for impressions of narrow crown preparations. Some patients describe a burning sensation on their gums. They are, however, more hydrophilic and so may be more tolerant if the moisture control is not perfect. They are easy to mix and dispense.
6. It is essential that the clinician ensures that the impression is disinfected using a standard protocol before the impression is sent to the laboratory. This is obligatory, and it is wise to label the impression and its container stating that it has been disinfected and what disinfectant protocol has been used. Most laboratories do not rely on the clinician carrying out that process and will also disinfect the impression on arrival.
7. Gingival retraction may be achieved by mechanical or chemical means or by both methods. Mechanical methods include the use of cord impregnated with a variety of astringents, such as aluminium trichloride. Various proprietary clays may also be used to push the gum aside mechanically. Astringents if left for too long can cause permanent gingival retraction.

Chapter 16 Waxes and occlusal registration materials

1. Wax which has been worked will stress relieve. Thus a crown that is waxed up and left overnight will change shape. This phenomenon may be overcome by reheating the wax at the margins to ensure that the seal is retained. Ideally, a wax-up should be invested immediately to ensure that stress relief does not occur.
2. If inlay wax is heated and left in a liquid state for any length of time the more volatile constituents will be lost and the composition of the wax will change and with this its properties. In severe cases the expansion and contraction characteristics of the wax will be altered to the detriment of the final restoration.

3. A hard brittle wax is most appropriate for a bite rim with a transition temperature higher than the oral temperature. Even with these properties the wax bite rim needs to be reinforced with aluminium mesh to prevent distortion.
4. The most common bite registration materials are addition silicones. These materials do not impede the patient closing together as they are soft to start with and then set hard so that the material can be removed. The disadvantage of using a rubber material is that locating the plaster model in the rubber occlusal record can sometimes be difficult as the rubber is resilient. An alternative material is an acrylic resin which can be placed on strategic teeth and the patient asked to close together. The low viscosity polymer/monomer mix flows and then sets to a rigid mass.

SECTION IV: OTHER CLINICAL MATERIALS

Chapter 17 Preventive and periodontal materials, implants and biomaterials

1.

Fluoride preparation	Indication
Toothpaste	All patients, but lower concentrations for infants and young children and high concentrations for patients of all ages with high caries risk
Mouthwash	Patients with high caries risk, particularly children
Gel (surgery use)	Patients with high caries risk, particularly children
Gel (home use)	Patients with high caries risk, particularly children
Varnish	Patients with high caries risk, particularly where specific teeth require prevention, i.e. where white spot lesions are present or to arrest root caries
Tooth mousse	Patients with high caries risk, particularly children

2. Any patient in this group is likely to have a reduced salivary flow and therefore are at high risk of developing caries. All possible preventive measures should therefore be considered such as fluoride (high fluoride containing toothpaste, mouthwash or gel), chlorhexidine mouthwash or gel and those products developed for patients with xerostomia. The latter products supplement natural saliva and aim to provide the missing enzymes and proteins in hyposalivation. The patient may also be advised to chew chewing gum, which may help to stimulate saliva.
3. The features of dental implants which enhance osseointegration are the type of alloy the implant is constructed of, the threads on implant (which aid in retention and increase surface area for integration) and surface treatments to increase surface area such as roughening by sandblasting or acid etching. Coating of the surface with ceramic or hydroxyapatite or treating the surface with a biochemical (such as bone morphogenic protein) or fluoride will also enhance osseointegration.
4. Advise on which dentifrice to use should be tailored to the needs of the individual patient: fluoride for anticaries effect (careful with concentration, also type of fluoride such as sodium or stannous); triclosan for antibacterial effect; and an anticalculus agent such as pyrophosphate or sodium hexametaphosphate.
5. A high caries risk patient may be identified by the use of:
   - Disclosing solutions used in the surgery to identify mature cariogenic plaque
   - Kits which identify cariogenic bacteria
   - Kits which test for the ability of saliva to buffer intraoral acids
   - Lactic acid detection kits.
6.

Similarities	Differences
Chemically similar	Derived from different sources (autograft human and xenograft animal)
Physically similar Need to be treated prior to use Need to get informed consent from recipient patient prior to use	Proteins removed so purely mineral grafts

Chapter 18 Dental bleaching systems

1. Many factors will affect the outcome of a tooth lightening procedure:
   - Type of discolouration (tetracycline, physiological, pulpal haemorrhage, etc.)
   - Method of bleaching (night guard vital bleaching, power bleaching, etc.)
   - Concentration of the lightening chemical being used
   - Duration of contact of the active chemical with the teeth
   - Presence or otherwise of side effects
   - Patient compliance.
2. Hydrogen peroxide is the main tooth-lightening agent, and may be derived from carbamide peroxide or sodium perborate. Hydrogen peroxide decomposes to produce oxygen-free radical species, which breakdown long chain (discoloured) molecules into short chain (lighter shade) molecules that are then lost from the tooth.
3. For the bleaching chemicals to work they must penetrate tooth tissue, but this can have other effects on the tooth structure as follows:
   - The enamel may lose its aprismatic layer.
   - Osteoclasts may be stimulated, which may cause idiopathic cervical resorption.
   - Reduced bond strengths result if a bonding procedure is done within 2 weeks of bleaching as the tooth tissue is saturated with oxygen species.
   - Sensitivity may result as a consequence of oxygen species diffusing through the hard dental tissues as they eventually reach the pulp.
   - Increased translucency of some areas of enamel especially towards the incisal edge if used over the longer term.
4. The risks of bleaching are:
   - (Transient) thermal sensitivity
   - Gingival and soft tissue irritation
   - Gastric irritation
   - Altered taste sensation
   - Cervical resorption
   - Risk of mutagenic effects
   - Effects on dental hard tissue
   - Increase in translucency of enamel, especially incisally
   - Adverse effects on restorative materials.
5. A reduction of approximately 25% in bond strength results if a resin-based composite material is bonded to tooth tissue immediately after bleaching. This is due to the tooth tissue being saturated with oxygen species. If the procedure is delayed for at

least 2 weeks then this problem made be circumvented as the oxygen species are lost from the tooth tissue over time.

6. The role of the light in power bleaching may be to initiate and catalyse the reaction by light energy or by the heat given off by the light. Use of light is not essential, usually it is used to add flare to the procedure.

Chapter 19 Cutting instruments

1. Methods of removing tooth tissue are:
   - Hand excavation (with or without the use of chemicals)
   - Rotary instrumentation
   - Microbrasion
   - Laser energy.
2. Torque is the ability to maintain the rotary movement of a bur when applied to the tooth surface. Torque is important because for efficient tooth preparation, the bur needs to continue to move and cut in the face of the resistance that it encounters on being placed against the tooth surface being prepared.
3. Tungsten carbide burs grind and chip the surface as opposed to the abrading action of diamond burs, resulting in a smoother prepared surface.
4. The disadvantages of using a laser to cut tooth tissue are:
   - Much heat produced with possible detrimental pulpal sequelae
   - Expensive hardware
   - Collateral damage to surrounding tissues
   - Inefficient when removing large amounts of tooth tissue.
5. The aim of polishing is to produce finer and finer grooves and reduce surface irregularities. The groove depth must be below the wavelength of light for the surface to appear shiny. As a polished surface is smoother, it is less likely to accumulate (harmful) dental plaque.
6. Precautions which must be taken when using air abrasion or mini-sandblasting in the mouth are:
   - Protection of the patient's airway and nasal passages with the use of rubber dam
   - High volume aspiration
   - Protection of the eyes of the patient and operating staff
   - Protection of the airway and nasal passages of the operating staff by wearing masks.

SECTION V: LABORATORY MATERIALS

Chapter 20 Model and investment materials

1. The selection of the correct dental stone will reduce the risk of fracture of the model. The cast model should be allowed to dry out completely before removal of the impression. The model may be strengthened by using a slightly higher powder/liquid ratio.
2. The surface of the plaster model may be protected by impregnating the surface with a resin in a volatile solvent, which seals the porous surface of the plaster and prevents damage to the surface from the instruments used in the waxing-up process. A further mode of protection is the use of a die spacer material, which is applied to the die.
3. An investment material should be designed to have a measured percentage expansion prior to reaching the casting temperature of the alloy. It must also be sufficiently porous at that stage to allow the air in the casting space to pass out to the surface of the material as the metal is forced in by the centrifugal casting process. Investing materials must be stable and not break up during the heating cycle.
4. The powder to liquid ratio of the investment material is determined by the manufacturer. Any alterations to this will lead to changes both in the setting characteristics of the investment and also to the strength of the investment. Additionally, the expansion/contraction characteristics of the investment will be altered.

Chapter 21 Alloys used in dentistry

1. The clinician must decide whether to use a base metal alloy, which will be cheaper but potentially may result in the greening of the ceramic. If the alloy is used to construct the occlusal surface of the crown then the effect of use of the harder metal on the occlusal contacts should be borne in mind. Care must be taken with base metal alloys as they will build up a very thick oxide layer which may make the bond between the alloy and the ceramic unstable. The metal is harder to polish after any adjustment. Alternatively, the use of noble alloys means that a thicker subframe is required. Additional care must be taken to ensure a suitable oxide layer is formed.
2. Noble metals have increase mechanical properties compared with the high noble materials. They show reduce wear and can be used in slightly thinner sections. They do, however, share the properties of inertness which single out these alloys from the base metal alloys. They show good polishing properties and do not tarnish.
3. Silver and copper increase the strength of an alloy while at the same time reducing the melting temperature. They both increase the hardness and reduce the corrosion resistance. Silver whitens the alloy while copper reddens the final alloy. Silver can increase the risk of porosity.
4. There are three means of bonding the ceramic to the metal subframe, namely:
   - Mechanical: the metal surface is rough and the microscopic irregularities permit the ceramic to be mechanically locked to the surface.
   - Chemical: the oxide layer which is formed on the surface of the metal substructure will bond to the ceramic forming a chemical bond.
   - Compression: the shrinkage which occurs during the firing process means that the ceramic has a compression fit on the meal surface.
5. Nickel-chromium alloys contain nickel and beryllium, both of which can produce adverse reactions. Nickel is known to produce allergic reaction in approximately 10% of the population. Beryllium is significantly more dangerous as beryllium dust can cause lung disease which is a precursor to malignant disease. Dental technicians are most at risk. This has led to increasing use of cobalt-chromium as the alloy of choice. This alloy is much harder to cast and polish than the noble metals.
6. The button and sprue from previous castings may be reused with subsequent casting. However, with zinc-containing alloys some zinc may be lost during the casting process. To ensure that sufficient zinc is available there must always be a proportion of new uncast metal present in the crucible with the older button.

Chapter 22 Dental ceramics

1. The use of alumina or zirconia subframes will present a barrier to the passage of cracks from the outer to inner surface of the crown. The core acts as a crack stopper, providing reinforcement for the crown.

2. The decorative ceramics have a proportion of kaolin added to stabilize them. This is the reason for decorative porcelains have the classical milky opaque colour. Dental porcelains would not be aesthetically satisfactory if the composition was the same; to give the translucency required the kaolin is omitted.
3. Hot pressing ceramic provides a dense ceramic restoration, which may provide good occlusal morphology as the crown is produced from a wax. However the colour and shading of the pressed ceramic is limited. Unless the casting is cut back or only forms a subframe, the restoration is one colour and any characterization must be achieved by surface staining. In the long term, this surface layer is not stable and may very slowly be lost. Hand-constructed crowns permit the aesthetics of the crown to be built into the body of the crown.
4. The use of CAD-CAM technology permits the production of complete crowns or subframes from factory produced ceramics, which allows the ceramic to be much more consistent and less likely to contain air voids.
5. Unglazed ceramic is a very effective abrasive and can cause substantial tooth wear. This is a particular problem where the occlusal surface of a crown is ceramic. If the surface is adjusted but not polished the chewing movements produce the ideal abrasive system and the opposing tooth will wear very rapidly. Stress concentrations may also occur if the surface has not been reglazed after adjustment.
6. Both alumina and zirconia subframes are opaque. If they are used without glass infiltration, the subframe shows through the feldspathic ceramic covering and appears as a white shadow beneath the more aesthetic outer coating. Unless the physical properties of the two ceramics are matched precisely then there is a risk of the crown failing by shearing at the interface.

Chapter 23 Polymers in prosthodontics

1. Heat-cured acrylic has a better level of conversion than the chemically cured variants. The physical properties of the heat-cured material are enhanced and there is less long-term degradation. Additionally, less unpolymerized material will leach out.
2. Plasticizers are likely to leach out of the appliance, which makes the material harder. Additionally, plasticizers such as dibutyl phthalate are now regarded as carcinogenic in high concentrations and work is being carried out to find alternatives.
3. A patient will find it difficult to appreciate hot food as heat is not transmitted through the denture. Additionally, the mucosa becomes less keratinized with time and if the patient consumes hot food or drink without wearing the denture, this can burn the unprotected mucosa.
4. Plastic dentures are relatively friable and can break if dropped. Dentures should be cleaned over a basin filled with water so that if the denture is dropped the water will act as cushion. Care must be taken in selecting the cleaning agent as many of these proprietary materials contain bleaching agents which will, if used to excess, cause the pink acrylic to be slowly bleached.
5. The rate of heating and the final temperature at which curing takes place are critical in ensuring that porosity does not occur in the denture. The reaction is exothermic. While the plaster temperature follows that of the water, the temperature of the resin shows a slight lag in the rise initially. Once the polymerization reaction starts, heat production increases and the temperature rises very rapidly. The temperature of the curing resin then exceeds the temperature of the water by a substantial amount. Since the plaster is a thermal insulator, the temperature of the resin will rise further and go above the boiling point of the monomer. In thick sections of the denture this is likely to lead to porosity, which will weaken the denture. A slower and steadier heating process reduces the risk of porosity as the heat generated is allowed to dissipate uniformly and more readily.