SYLLABUS

COURSE:	DENS 1671 Biomaterials I: Direct Restorative Materials
SEMESTER:	Spring
CREDIT HOUR:	0.5
REVISED:	2007
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COURSE DIRECTOR:	Cynthia Trajtenberg, D.D.S., M.S.

GOAL

Direct Restorative Materials provides an applied science foundation for understanding important physical, chemical, and mechanical properties of dental materials. The effects of composition and manipulation on the properties and clinical success of selected dental materials will be emphasized. Appropriate biological properties will be described. The materials in this course include: amalgam and mercury, bases and liners, composites, bonding agents for teeth, glass ionomers, hybrid ionomers, compomers, and pit and fissure sealants. These are dental materials that you will use in the UTDB preclinical laboratories and clinics as well as in clinical practice following your graduation.

When you have successfully completed this course, you will know how the composition and manipulation of selected dental materials affect their properties and clinical success.

OBJECTIVES

I. MECHANICAL PROPERTIES, FORCES AND STRESSES

1. Define force and indicate its units.

2. List magnitudes of typical human biting forces and explain how these magnitudes are influenced by dental restorations and prostheses.

3. Define stress and indicate its units.

4. Define strain and give its relationship to stress. Include:

   4.1 applied force
   4.2 thermal change
   4.3 setting reaction

5. Provide a simple analysis of the stress and strain in a common dental restoration. Include:

   5.1 tension versus compression versus shear
   5.2 stress concentration

6. Describe the clinical importance of the following properties:

   6.1 modulus of elasticity
   6.2 proportional limit (yield strength)
   6.3 ultimate strength
   6.4 elastic behavior (resilience)
   6.5 plastic behavior (toughness)
   6.6 flexural strength and modulus

7. Describe specifications (ANSI/ADA, ISO) and MSDS in dentistry.

II. DENTAL AMALGAM AND MERCURY

1. Differentiate between dental amalgam and amalgam alloy.

2. Describe the range of composition of high-copper amalgam alloys. Include the silver, tin and copper content of:

   2.1 admixed
   2.2 unicompositional (spherical)

3. Describe the amalgamation process. Include:

   3.1 wetting
   3.2 solution
   3.3 crystallization
   3.4 microstructure (unreacted particles and matrix)

4. Describe and compare admixed and unicompositional high-copper amalgams as to:

4.1 metal content of phases with Greek symbols
4.2 relative strength of the phases of the amalgams

5. Describe the corrosion products of amalgam. Include:

5.1 corrosion resistance of phases
5.2 relation of corrosion to marginal sealing
5.3 how corrosion may be reduced by proper manipulation

6. Describe galvanism and list its short-term and long-term effects on metallic biomaterials and on the dental patient. Include:

6.1 dissimilar metals
6.2 short circuits (galvanic shock)

7. Rank the galvanic activity of various oral biomaterials. Include in the ranking:

7.1 stainless steel
7.2 gold alloy
7.3 dental amalgam
7.4 Co-Cr alloy

8. Describe how environmental factors may influence electrochemical corrosion. Include variations in:

8.1 patient diet
8.2 oxygen concentration

9. Describe ANSI/ADA Specification No. 1 for dental amalgam.

10. Describe the clinical significance of the properties of a high-copper amalgam. Include:

10.1 net dimensional change
10.2 thermal conductivity
10.3 thermal expansion and contraction
10.4 early and final compressive and tensile strengths
10.5 creep and its relation to compressive strength
10.6 static vs. dynamic properties
10.7 bond strength to tooth structure (with bonding agent)

11. Rank various oral biomaterials according to their linear coefficient of thermal expansion. Include in the ranking:

11.1 composite restorative material
11.2 tooth enamel
11.3 dental amalgam
11.4 dental porcelain
11.5 inlay wax

12. Describe the proper mercury proportions recommended for admixed and spherical amalgam alloy and explain the properties affected as a result of having:

12.1 insufficient mercury in the finished amalgam
12.2 excess mercury in the finished amalgam
12.3 reasons why amount of mercury depends on alloy

13. Describe the effects of under-mixing, normal mixing and over-mixing on:

    13.1 working time
    13.2 dimensional change
    13.3 compressive strength
    13.4 creep
    13.5 ease of manipulation (removal from capsule, condensation, carving)

14. Compare the condensation force and condenser tip size recommended on amalgam made from admix and spherical alloy.

15. Describe the effects of delaying condensation after amalgamation.

16. Cite the effect of excess residual mercury in an amalgam on:

    16.1 compressive strength
    16.2 creep
    16.3 corrosion resistance

17. Describe the chemical reaction and effect of moisture contamination during manipulation of a:

    17.1 zinc containing amalgam
    17.2 non-zinc containing amalgam

18. Describe mercury toxicity as to:

    18.1 sources of mercury in the environment
    18.2 forms of mercury
    18.3 concentrations of mercury
    18.4 mercury in urine and blood
    18.5 release of corrosion products
    18.6 local and systemic reactions

19. Describe 15 recommendations in mercury hygiene to minimize risks to personnel in the dental office.

20. Summarize current statements and the position of the ADA Council on Scientific Affairs, the FDA, and the NIDCR about safety of dental amalgam as a restorative material. Be able to state opposed and critical views on the use of amalgam by some professionals and the public.

21. Provide information to the patient regarding the use of mercury in the dental amalgam.

III. LINERS AND BASES

1. Define and compare the role of varnishes, liners and bases

2. Describe cavity varnishes and liners as to:

    2.1 applications and purpose
    2.2 composition
    2.3 manipulation
    2.4 properties
    2.5 incompatibility with some restorative materials

3. List and describe the cements used as low- and high-strength bases as to:

   3.1 composition
   3.2 properties
   3.3 whether reinforcing or therapeutic in use
   3.4 manipulation

IV. COMPOSITES

1. Describe the various classifications of direct composites and their typical clinical uses. Include:

   1.1 all-purpose (microhybrid)
   1.2 packable vs. flowable vs. microfilled
   1.3 laboratory (indirect)

2. Describe the five major components in a composite, give examples of each and indicate their function. Include:

   2.1 oligomer
   2.2 diluent monomer
   2.3 filler particles - composition and size (fine vs. microfine)
   2.4 coupling agent
   2.5 accelerator-initiator system

3. Describe the polymerization of composites. Include:

   3.1 three methods of acceleration
   3.2 inhibitors of polymerization that occur clinically
   3.3 degree of cure
   3.4 factors that influence depth of cure

4. Describe the clinical importance of the following properties of composites:

   4.1 viscosity and viscoelasticity
   4.2 polymerization shrinkage
   4.3 water sorption and solubility
   4.4 radiopacity
   4.5 compressive strength and modulus
   4.6 flexural strength and modulus
   4.7 fatigue strength
   4.8 hardness
   4.9 wear resistance
   4.10 thermal conductivity and thermal expansion
   4.11 color stability

5. Describe the significance of hardness and wear between natural dentition and dental materials. Include comparisons between

   5.1 tooth enamel
   5.2 dental composites
   5.3 gold alloys
   5.4 dental ceramic

6. Characterize the clinical wear resistance of posterior composites.

7. Describe the biocompatibility of composites. Include:

   7.1 results of histological studies
   7.2 materials that are indicated and not indicated for pulpal protection

8. Describe the characteristics of light-curing units. Include:

   8.1 types - QTH vs. PAC vs. laser vs. LED
   8.2 peak wavelength
   8.3 factors that affect light output and output required

9. Describe the clinical uses of pit and fissure sealants.

10. Indicate the components of amine-accelerated and visible light-cured sealants and their functions.

11. Describe the mechanism of retention of a sealant.

12. Describe the six basic steps involved in the application of a visible light-cured sealant.

13. Describe factors that can influence the success of acid-etched enamel prepared for the application of a sealant. Include:

   13.1 typical time of etching
   13.2 type of acid
   13.3 clinical appearance of acid-etched enamel
   13.4 effect of contamination by saliva and appropriate treatment

14. Describe the clinical success of sealants and the criteria used to determine success or failure of treatment.

15. List several clinical situations in which sealants should not be used.

16. Describe what happens to dental caries left beneath a sealed fissure.

V. BONDING AGENTS FOR TEETH

1. State five requirements for formation of an optimally bonded interface.

2. State the clinical applications of bonding to tooth structure.

3. Describe the structure and morphology of human tooth structure before and after acid etching. Include:

   3.1 enamel
   3.2 dentin

4. Describe the bond between composite and enamel and give a range of reported bond strengths.

5. State three advantages of an etched enamel surface.

6. Describe the difficulty in forming a bond between composite and acid-etched dentin in the absence of a bonding agent.

7. Recognize the types of bonding agents. Include:

7.1 fourth vs. fifth vs. sixth vs. seventh-generation products
7.2 mechanisms of bonding - role of microretention

8. Describe the function and composition of typical components of a bonding agent. Include:

8.1 conditioner (etchant)
8.2 primer
8.3 adhesive - resin and filler
8.4 initiators and accelerators

9. State three methods for measuring bond strength.

10. Describe the two primary causes of bond failures between composites and tooth structure.

11. Describe the manipulation of a typical light-cured bonding agent to tooth structure. Include:

11.1 fourth generation
11.2 fifth generation
11.3 sixth generation
11.4 seventh generation

VI. GLASS IONOMERS, HYBRID IONOMERS AND COMPOMERS

1. Describe the clinical applications of fluoride-releasing restorative materials. Include:

1.1 traditional glass ionomers
1.2 metal-reinforced glass ionomers
1.3 hybrid ionomers
1.4 compomers

2. Describe the components of glass ionomer restorative materials and indicate their function. Include:

2.1 traditional glass ionomers
2.2 metal-reinforced glass ionomers
2.3 hybrid ionomers
2.4 compomers

3. Describe the setting reaction of glass ionomer restorative materials. Include:

3.1 traditional glass ionomers
3.2 hybrid ionomers and compomers
3.3 initial and final development of the matrix
3.4 dual-cure vs. tri-cure polymerization reactions

4. Describe the important clinical properties of glass ionomer, hybrid ionomer and compomer restorative materials. Include:

4.1 fluoride release
4.2 wear resistance
4.3 bonding to tooth structure
4.4 biocompatibility

5. Describe critical features in the manipulation of glass ionomer, hybrid ionomer and compomer restorative materials. Include:

5.1 dispensing and spatulation of hand-mixed products
5.2 treatment of the smear layer
5.3 recognition of the end of the working time
5.4 prevention of dehydration and early solubility
5.5 delay in finishing

RESOURCES

I. Media Resources

A. Printed media

1. Required textbook

Craig, R.G. and Powers, J.M., eds.
Restorative Dental Materials, 12th ed
Mosby, 2006
Chapter 3, Optical, Thermal, and Electrical Properties
Chapter 4, Mechanical Properties
Chapter 8, Preventive Materials
Chapter 9, Composites
Chapter 10, Bonding to Dental Substrates
Chapter 11, Amalgam
Chapter 20, Cements

2. Supplemental text

Craig, O'Brien, and Wataha
Craig's *Dental Materials: Properties and Manipulation,* 8th ed
Mosby, 2004

3. Handouts for each lecture are available via Blackboard and may be printed at the discretion of the student.

B. Electronic media
Blackboard Course Info
Website address: http://Blackboard.uth.tmc.edu

II. Human Resources

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Email: Cynthia.Trajtenberg@uth.tmc.edu

STUDY PLAN AND REQUIREMENTS

PowerPoint lectures will be posted on Blackboard on the Monday preceding each lecture. You are responsible for printing (if you wish) the lectures and handout posted in Blackboard.

Class Assignment: Critique of Advertisement in Dental Magazine

DUE DATE: February 27, 2007

Criteria for assignment:

1. You will select an advertisement in any dental magazine or journal for a material related to those discussed in the course (composite, glass ionomer, adhesives, sealants, amalgam, etc.).

2. You will write a one-page (only) critique of the advertisement. It should be brief but complete, relevant, and critical. Do not restate what the manufacturer has said in the ad. Be inquisitive and try to find comments that are not supported by science.

3. The critique will contain the following information:

   - Name and brief description of product and category of material it belongs to (eg. amalgam, composite, etc).
   - Claims the ad makes about the product (eg. highest strength).
   - Reasons you agree or disagree with the claims based on references from books, journals, web sites.
   - A minimum of two references must be cited in the critique.

4. You must turn in the ad (or a copy of it) with your critique. Online submissions will not be accepted.

5. You must turn in the assignment on or before February 27, 2007.

DENS 1671 BIOMATERIALS I: DIRECT RESTORATIVE MATERIALS
2007 Spring Semester Schedule

Jan 2 – Feb 27, Tuesdays, 11:00-11:50 am
Final exam, March 13

Reading assignments will be provided on Blackboard.

DATE	TOPIC
Jan 2	Mechanical Properties, Forces and Stresses
Jan 9	Composition, Properties of Amalgam
Jan 16	Manipulation of Amalgam; Mercury Toxicity and Hygiene
Jan 23	Bases and Liners
Jan 30	**Mid-term Exam** **Room 207**
Feb 6	Composition of Composites
Feb 13	Properties of Composites; Sealants
Feb 20	Adhesives and Bonding to Enamel and Dentin
Feb 27	Glass Ionomers, Hybrid Ionomers, and Compomers **Class Assignment Due** ***Course Evaluation***
Mar 13	**FINAL EXAM** **Room 207**

EVALUATION METHODS

There will be two examinations in this course, each worth 50% of the course grade. Each exam will consist of 25 multiple-choice questions.

The class assignment will be pass/fail. If a student fails, the student will have to redo the advertisement critique before the final, or the student will be unable to take the final exam.