**BASIC DENTAL BIOMATERIALS SCIENCE**

**RDS 132**

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                           BASIC DENTAL BIOMATERIALS SCIENCE

                                                        RDS 132

                             \*        RDS 132

                             \*        One Credit Hour

                             \*        No Pre-requisites

                             \*        First Year Dental

                             \*        For Dental Students Only

**BASIC DENTAL BIOMATERIALS SCIENCE**

**RDS 132**

**I.          Course Description**

            A dental material has always been a fascinating and challenging area for the dental practitioner.  During the past several years dental materials science has undergone a virtual explosion of new knowledge.  The advent of new polymeric and ceramic restorative systems, bonding and adhesive materials, implant materials, glass ionomer cements, precious and non-precious metal restorative systems and impression materials have virtually revolutionized the practice of modern dentistry.  Therefore, dentist uses the largest number of materials from different classes.  Materials are used in dentistry to prevent disease, restore parts of the teeth and associated structure, as well as replace and reconstruct whole teeth and associated hard/soft structures of the jaws and face in a functionally acceptable and esthetically pleasing manner.

            This course is meant to teach the student of dentistry aspects of materials science necessary to enable him to understand and continue to learn dental biomaterials.  Also, to develop an appropriate understanding of the criteria for the selection of materials for specific dental procedures.

**II.        Course Educational Goal**

The student will be exposed to those aspects of materials science applicable to clinical dental practice and will     understand the basic scientific principles pertaining to proper manipulation of Dental Biomaterials.

            1.         The student will have a working knowledge of the nature, structure and properties of metals, polymers and ceramics as they apply to dental practice.

2.         The student will be able, upon completion of this course, to justify selection of the most appropriate materials possession the physical properties that are suitable for a particular functional situation.

            3.         The student will appreciate the underlying principles for the strengthening of materials and the need for specific laboratory and clinical manipulation.

            4.         The student will be capable of rationally consider new dental materials as they are developed during his professional career.

**III.       Specific Educational Objectives:**

1.                   1.        Demonstrate the importance of studying basic dental materials as an essential component of the dental     curriculum.

            2.         Expose the student to a knowledge base for an understanding of the basic physical, chemical and mechamical properties of all dental materials and relate these to clinical applications.

            3.         Understanding the crystal structure and the relationship between the physical mechamical properties and the changes in the crystalline structure.

4.         Explain the significance of the phase diagram and how phase transformation can affect the physical/mechamical properties of different alloys.

5.         Develop an appropriate understanding of how materials fail in the oral cavity.

**IV.       Detailed Course Outline**

**1.         Introduction – Materials in Dentistry and Crystal Structure**

                       1.1       Necessity for learning Dental Materials and Basic Dental Biomaterials Science.

                        1.2       Atomic structure

                        1.3       Inter-atomic bonding

                        1.4       Atomic arrangements and crystal structure

**2.         Crystal Structure II**

                        2.1       Point imperfections

                  2.2       Line defects (dislocations)

                        2.3       Area defects

                        2.4       Dislocation motion

                                         2.4.1    Edge dislocation

                                                                         2.4.2    Screw dislocation

**3.         Physical Properties**

**3.1       Mass related properties**

3.1.1   Weight

                                                       Mass

            3.1.2     Composition

                         Weight per cent

                                                          Atomic per cent

                                            3.1.3     Density and specific gravity

**3.2       Temperature related properties**

                                    3.2.1   Melting temperature

                                    3.2.2    Specific heat

                                    3.2.3    Thermal expansion

                                    3.2.4    Thermal conductivity

                                    3.2.5    Thermal diffusivity

**4.         Optical Properties**

                        4.1       Light related properties

                                    4.1.1    Nature of light

                                    4.2.2    Refractive index

                                    4.2.3    Color

                                    4.2.4    Munsel color system

                                    4.2.5    Color selection

**5.         Surface Chemistry and Capillary Rise**

                        5.1       Surface energy and surface tension

                        5.2       Wetting

                        5.3       Capillary rise

**6.         Mechanical  Properties  I**

                        6.1       Definition

                        6.2       Types of Stress

                        6.3       Tensile properties determination

                        6.4       Tensile properties

                                    6.4.1    Proportional limit

                                    6.4.2    Elastic limit

                                    6.4.3    Offset yield strength

                                    6.4.4    Clinical applications

                                    6.4.5    Ultimate tensile strength

                                    6.4.6    Breaking strength

**7.         Mechanical Properties II**

                           7.1       Strain

                                    7.1.1    Elastic strain

                                    7.1.2    Plastic strain

                                    7.1.3    Flexibility & ductility

                           7.2       Modulus of elasticity

                                    7.2.1    Rigidity

                                    7.2.2    Flexibility

                         7.3.      Energy Terms

                                    7.3.1    Resilience

                                    7.3.2    Toughness

                        7.4       Hardness

                                    7.4.1    Brinell

                                    7.4.2    Rockwell

                                    7.4.3    Vickers

                                    7.4.4    Knoop

**8.         Mechanical Properties III**

                        8.1       Viscosity

                        8.2       Viscoelasticity

                        8.3       Creep

                        8.4       Fatigue

**9.         Nature of metals and alloys**

                        9.1      Chemical and atomic structure of metals

                                    9.1.1     Atomic Structure

                                    9.1.2    Physical properties of metals

**10.         Alloys and Principals of Metallurgy**

                        10.1     Phase Diagram and Dental Alloys

-         Solid Solution Alloys

-         Eutectic Alloys

-         Intermetallic Compounds

                        10.2     Alloy Microstructure

                                                -    Grain, Grain Boundaries, and Dendrities

                                                -    Cast Microstructure

                                                -    Cold Worked (Wrought) Microstructure

**11.         Properties of Alloys**

                        11.1     Alloy Strengthening Mechanisms

                        11.2     Properties of Casting Alloys

                        11.3     Properties of Wrought Alloys

**12.       Introduction to Ceramics**

                        12.1     Basic nature

                                    12.1.1  Crystal structure

                                    12.1.2  Glasses

                                    12.1.3  Silicates

                        12.2     Mechanical Properties

                                    12.2.1  Brittle nature

                                    12.2.2  Porosity

                                    12.2.3  Tempering of strength

                   12.3     Concepts in ceramic fabrication

                                    12.3.1  Sintering

                                    12.3.2  Dental porcelains:  basic concepts

**13.       Introduction to Polymers**

                        13.1     Basic concepts – Polymer, mer, monomer

                        13.2     Classification of polymers

                                    13.2.1  Thermal behavior

                                    13.2.2  Type of reaction

13.2.3  Spatial orientation

                        13.3     The polymerization process

                                    13.3.1  Conditions for polymerization

                                    13.3.2  Stages of polymerization

                                    13.3.3  Inhibition of polymerization

                        13.4     Mechanical properties of polymers

**Student Evaluation**

            The students shall have two written continuous assessments, one written final exam.  Each of the continuous assessments shall count for 20% of the grade and given at the completion of the 5th and 11th lectures.  20% will be given to homeworks and\or researches during the course. The final written exam shall count for 40% of the grade.

            Written exams shall be objective, multiple choice, true or false, match sets, short essays and schematic drawings.

**Principal Reference**

                           Restorative Dental Materials.

                                    Edited by Robert Craig, 11th edition