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# A Core Curriculum in the Biological and Biomedical Sciences for Dentistry

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**Abstract**

**Introduction**

The biomedical sciences (BMS) are a central part of the dental curriculum that underpins teaching and clinical practice in all areas of dentistry. Although some specialist groups have proposed curricula in their particular topic areas, there is currently no over-arching view of what should be included in a BMS curriculum for undergraduate dental programmes. To address this, the Association for Dental Education in Europe (ADEE) convened a Special Interest Group (SIG) with representatives from across Europe to develop a consensus BMS curriculum for dental programmes.

**Curriculum**

This paper summarises the outcome of the deliberations of this SIG, and details a consensus view from the SIG of what a BMS curriculum should include.

**Conclusions**

Given the broad nature of BMS applied to dentistry, this curriculum framework is advisory and seeks to provide programme planners with an indicative list of topics which can be mapped to specific learning objectives within their own curricula. As dentistry becomes increasingly specialised these will change, or some elements of the undergraduate curriculum may move to the postgraduate setting. So, this document should be seen as a beginning and it will need regular review as BMS curricula in dentistry evolve.

**A. Introduction**

Biomedical science (BMS) is a cornerstone of the contemporary dental curriculum. It underpins all aspects of clinical practice and equips new graduates for 40 or more years of lifelong learning. Many aspects of contemporary BMS are at the evolving front of scientific understanding, whilst others are more stable and form a foundation of core knowledge on which dental practice is based. Yet, both are important in preparing new graduates for safe, patient-centred practice, and help to equip them to deal with change.

The Association for Dental Education in Europe (ADEE) (Cowpe *et al*, 2010; Field *et al*, 2017) the U.K. General Dental Council (GDC, 2015) have published guidelines to assist planners in the design of dental curricula fit for the 21st century. However, these are overarching and outcome based, and do not give the level of detail required to allow for curriculum development in individual topic areas. In this context, ADEE specifically encourages *'…the utilisation of existing and contemporary curricula published by specialist societies and organisations…'* (Field, Cowpe and Walmsley, 2017). Examples include Genetics (Johnson *et a*l, 2008), Cariology (Anderson *et al*, 2011; Schulte *et al*, 2011), Radiology (British Society for Oral and Maxillofacial Radiology, 2015), Oral Pathology (Odell *et al*, 2004; Darling and Daley, 2006), Anatomy (Moxham *et al*, 2018), Clinical Medical Sciences (Atkin *et al*, 2018), Oral Medicine (Mighell *et al*, 2018) and Oral Surgery (Macluskey *et al*, 2008). Curriculum development is further informed by guidelines prepared to assist in medical curriculum planning in areas of overlap such as Anatomy (Smith *et al*, 2017) or Pharmacology (Ross and Maxwell, 2012). Against this background, curriculum guidelines in the biomedical sciences for Dental curricula are long overdue.

A Special Interest Group (SIG) was constituted by ADEE to explore the requirements and principal components of a Core Curriculum in the Biological and Biomedical Sciences for Dentistry. This SIG closely aligned with the mission and working methods of ADEE (Reynolds *et al*, 2008; Harzer *et al*, 2017; Field *et al*, 2017). It aimed to produce a consensus document with a comprehensive proposal for a series of structured learning outcomes for the Biomedical Sciences to be included in the new undergraduate curriculum framework as defined by the existing ADEE consensus documents (Cowpe *et al*, 2010) as well as the 'Graduating Dentist' (Field *et al*, 2017). After being proposed in a special session held in 2011, the SIG was constituted in 2012 and then met at four successive ADEE Meetings (Birmingham, 2013; Latvia, 2014; Szeged, 2015). The initial consensus document was reviewed by the rapporteur and circulated to be critically reviewed and agreed by the SIG members at the 2016 and 2017 ADEE meetings following a process similar to the Nominal Group Technique

described by McMillan *et al* (2016). The group was informed of the final version of the proposal by discussions at a workshop entitled *'The Impact of Scientific & Technological Advances'* which formed part of the Joint ADEE/ADEA meeting - *'Shaping the Future of Dental Education'* held in London in 2017.

The SIG was made up of 25 ADEE delegates from 24 Dental Schools (12 from UK, 3 from France, 2 from Turkey, 2 from Spain, and one from Belgium, Holland, Iceland, Ireland and Romania, respectively). The group was diverse in terms of gender (15 males/10 females) and Academic background (17 basic science teachers/10 clinical sciences teachers). Their seniority (24 seniors/1 junior) was evaluated based on the number of publications (>10), and academic years (>10) calculated as the interval between the 'oldest' and the 'newest' publication, as reported in scientific databases (Scopus) or social media (Researchgate).

The BMS component of any dental undergraduate programme will invariably focus on the oral tissues, but coverage must have sufficient breadth to allow development of an understanding of the physiological and pathological processes which underpin broader aspects of oral care in the wider context of general health and human disease. It should emphasise how pathological processes reflect abnormalities in body structure and function, and that understanding the pathogenesis of disease, oral or systemic, depends on a sound appreciation of normal anatomy and physiology. In an increasingly specialised world, a BMS curriculum must help equip students to participate as part of a team with other healthcare professionals in managing complex medical conditions.

In addition, study of the biomedical sciences is important in introducing students to the principles of scientific logic and reasoning, and to critical appraisal of the broader scientific literature. Teaching informed by scientific research helps to motivate and develop students, fosters a 'deep approach' to learning and the development of transferrable skills, and encourages the student to engage with contemporary advances and innovation.

There is broad consensus over the need for coverage in key areas such as the surgical anatomy of local anaesthesia, oral histology or tooth morphology. But, there is a growing emphasis on the requirement to equip new graduates with the skills necessary to cope with the translation of scientific advance to the clinic (Iacopino, 2007; Johnson *et al*, 2008). Increasingly, oral healthcare professionals are becoming involved with emerging areas such as risk assessment or precision medicine (Polverini and Krebsach, 2017), making a basic appreciation of molecular and cell biology, genetics and genomics an essential element of any dental BMS curriculum (Zhang *et al*, 2016; Costa-

Silva *et al*, 2018). Staffing constraints and curriculum overload mean that schools often lack the time and expertise necessary to cover these disciplines, or they devolve this teaching to their paired Medical or Science faculties (Best *et al*, 2016). Often this leads to course content which is poorly matched to the needs of the dental programme or inadequately contextualised. This leaves its relevance unclear to students, despite their interest (Scheven, 2012). A BMS curriculum for Dentistry must ensure that its content is relevant and of appropriate depth.

Bodies in Europe and North America involved with the development of Dental curricula, have recognised that the explosion of knowledge has made it impossible to cover all topics (Manogue *et al*, 2011; Ferracane *et al*, 2017), and that traditional, lecture based models of education, effective in the past, do not always meet the needs of contemporary clinical practice (Henzi *et al*, 2007). Several educational models have emerged to address this involving case based, problem based or hybrid approaches (Fincham and Shuler, 2001; McHarg and Kay, 2008). These have moved away from dependence on didactic delivery towards pedagogic models which foster the development of self-directed learning, problem solving and critical appraisal skills. Coupled to this, there has been a move towards greater integration, both horizontally between topic areas, and vertically across successive years of a programme (Plasschaert *et al*, 2006). The traditional division into basic science coverage in the early years of the programme, progressing to clinical training in the senior years in a '2+3' model is no longer universally applicable, and programmes are increasingly characterised by clinical involvement in the early years with continuance of basic science coverage into the senior years and beyond (Manogue and Brown, 2007). Furthermore, these changes have been accompanied by the adoption of new and innovative integrated written or clinical exams which are designed to test knowledge and understanding across multiple aspects of the curriculum (Bennett *et al*, 2010; Ali *et al*, 2016), or to involve the presentation of project work based on guided independent study which crosses the boundary between BMS and the clinical disciplines. This integration of BMS and clinical aspects of the curriculum is highly desirable as it facilitates application and reinforcement of core knowledge alongside a broadening clinical experience (Mattick and Knight, 2007), and helps to prepare new dentists to apply the scientific basis of Oral Healthcare to their clinical practice on graduation (Field *et al*, 2017b). However, any curriculum in BMS must allow for a range of pedagogic strategies as some schools still retain traditional, topic based approaches. For this reason, this document does not consider how, or in what order BMS topics are covered or assessed. Instead, our objective was to provide a consensus list of what the BMS content of an undergraduate dental curriculum might reasonably include. This list of topics can then be mapped to a school's own curriculum regardless of pedagogic strategy and give flexibility to allow institutes to decide how individual topics might best be adapted to their own situation.

ADEE has recommended that dental programmes should be based around a core curriculum which defines fundamental competencies, to be complemented by a catalogue of elective courses which give an opportunity to broaden the student experience to suit individual interests (Manogue *et al*, 2011; Field, Cowpe and Walmsley, 2017a). This document fits this model. Some topics are 'core' issues and an essential component of all dental programmes (e.g. the surgical anatomy of inferior-alveolar nerve anaesthesia). But, there are other areas where a foundation of knowledge is necessary, in which schools may have more flexibility in the scope of coverage. For example, a basic coverage of genetics is a fundamental requirement, but the explosion of knowledge in this area allows for elective opportunities for interested individuals to explore aspects in greater depth. Schools have different strengths and this approach gives students the opportunity to engage with and benefit from particular areas of expertise within their own institutions.

Our curriculum is presented as 8 domains of learning. (1) Anatomy and Embryology, (2) the Molecular Basis of Oral Function, (3) The Physiological Basis of Body Function, (4) Microbiology and the Control of Infection, (5) Key Disease Processes, (6) Pharmacology, (7) The Oral Biosciences and (8) Biomaterials in Dentistry. Whilst the SIG strongly supported the contemporary move towards integrated teaching in which BMS is taught in a contextualised, integrated manner alongside the clinical disciplines, it recognised that integration of teaching BMS within dental curricula is a complex and critically important area to be considered elsewhere in its own right.

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**B. The Curriculum**

***1. Anatomy and Embryology***

*1a: General Principles of Anatomy*

I. General principles of anatomical description; anatomical terminology.
II. An overview of the axial and appendicular skeleton, joints and sutures
III. An overview anatomy of the…
    - thorax and abdomen;
    - heart and cardiovascular system;
    - liver;
    - renal system;
    - gastrointestinal tract;
    - gall bladder and biliary system.
IV. An overview anatomy of the lymphatic system.
V. The anatomy of the autonomic nervous system – the parasympathetic and sympathetic supply to the head and neck and their functions
VI. An appreciation of neuroanatomy appropriate to an understanding of general physiology and oral biology, the principles of clinical diagnosis and human disease processes
VII. The anatomy of venous access.

*1b: Head and Neck Anatomy*

I. The osteology of the skull, mandible, palate and facial skeleton
II. The intra- and extra-cranial course of the cranial nerves; examination and recognition of their normal and abnormal function and its application to wider understanding of disease processes
III. The surgical anatomy of the $V^{th}$ and $VII^{th}$ nerves with an emphasis on how it relates to dental procedures
IV. The regional anatomy of the teeth, jaws, tongue and perioral soft tissues (to include the muscles of facial expression) together with their functional significance
V. Structure/function correlations in the floor of the mouth and the infra-temporal fossa
VI. The functional anatomy of the temporomandibular joint (TMJ) and muscles of mastication
VII. The anatomy of the salivary glands

VIII. The structure of the nose, paranasal air sinuses, pharynx and velopharyngeal apparatus

IX. The architecture of the neck to include the fascial planes, the anterior triangle and its sub-divisions, the hyoid bone and the supra and infra-hyoid musculature

X. The anatomy of the thyroid and parathyroid glands and related structures.

XI. The anatomy of the orbit, ocular muscles and periorbital tissues (to include the eyelid and lacrimal gland)

VIII. The arterial blood supply to and venous drainage from the head and neck to include an overview of the intra-cranial blood supply

IX. The functional anatomy of the larynx.

XII. The anatomy of the head and neck as it relates to…

- clinical diagnosis
- common oral surgical procedures
- local anaesthesia
- lymphoid tissue and lymph drainage
- management of medical emergencies which may occur in the dental surgery
- spread of serious infections from the teeth and other tissues

*1c: Core Embryology*

I. Key events in early embryology from conception to gastrulation

II. An overview of foetal and post-natal development

III. A detailed understanding of pre-natal head and neck development

IV. Post-natal growth of the head and neck

V. An appreciation of the embryological mechanisms behind the pathogenesis of key developmental anomalies (e.g. cranial synostoses, disturbances of branchial arch development. cleft lip and palate, neck cysts etc.)

## *2. The Molecular Basis of Oral Function*

*2a: Basics of Cellular Organisation*

I. Prokaryotic and eukaryotic cells – structural levels of organisms
II. The structure and function of major subcellular structures and organelles.
III. Cellular metabolism – major pathways for synthesis/turnover of macromolecules and energy metabolism, including carbohydrate metabolism
IV. Biological membranes – molecular structure
V. The principles of transport and communication across cell membranes

*2b: Major Molecules of the Cell*

I. The basic molecules of the cell and the bonds which link them.
II. The structure, main characteristics and function of carbohydrates, lipids and proteins
III. Proteins – structure function relationships, principles of enzyme action
IV. Protein biosynthesis, post-translational modification and secretion.

*2c: Nucleic Acid and Protein Synthesis* (to integrate with Section 3f – Reproduction, Growth and Development)

I. Nucleic acid structure (to include an appreciation of the different types of nucleic acid and their biological significance)
II. The role of nucleic acids in information transfer from DNA to protein
III. Genes and the regulation of gene expression.
IV. An overview understanding of key strategies used to study DNA, RNA and protein and how these are applied in situations appropriate to the management of oral disease

*2d: Emerging Technologies*

I. An appreciation of how development of novel technologies and an enhanced capacity for data management is leading to the emergence of the new disciplines of genomics, proteomics, metabolomics etc.
II. An overview of how this is driving progress towards personalised medicine

### *3. The Physiological Basis of Body Function*

*3a: Architecture and function of principle body tissues*

I. Cells and their extracellular matrices
II. Connective tissue characteristics – fibrous, tendons and ligaments, cartilage, bone
III. and other mineralised tissues
IV. Formation and architecture of major organ systems relevant to dentistry

*3b: Support and Movement*

I. The structure and function of skin and its appendages (hair, nails, glands); its role in the control of body temperature and maintenance of the *'milieu interieur'*
II. The composition, function and turnover of bone and cartilage
III. The range and characteristics of contractile tissues – smooth muscle, skeletal muscle and myofibroblasts; key molecules associated with contractile function – actin and myosin;
IV. Structure/function of skeletal muscles including attachment, actions & lever systems; the control of neuro-muscular function (to integrate with Section 1b: Anatomy of the TMJ and Section 7a: TMJ, mastication and occlusion, deglutition and speech).

*3c: Communication, Control and Integration*

I. Homeostasis- the principles of physiological control; autocrine, paracrine, endocrine and neural control of body functions
II. Basic principles of neural structure and function – microscopic structure of neural tissue, generation and propagation of the action potential, peripheral synaptic transmission, neurotransmitters
III. Organisation of the central nervous system (CNS)- brain, spinal cord and cerbro-spinal fluid; somatic sensory pathways including pain in the CNS; somatic motor pathways in the CNS, somatic nervous system.
IV. Organisation of the peripheral nervous system -autonomic and somatic, autonomic (spinal) reflexes, sensory and motor pathways, comparison of the trigeminal and spinal afferent pathways
V. Pain: acute and chronic; inflammatory and neuropathic, hyperalgesia and neurogenic inflammation
VI. Plasticity and repair in nerve tissues

VII. Sense organs – sensory receptors; somatic senses; special senses (smell, taste,
VIII. hearing & balance, vision)
IX. Endocrine system – the main endocrine glands and biology of the major hormone systems
X. Neural and endocrine response to stress

*3d: Ventilation, transportation and fluid balance*

I. The composition and function of the blood
II. Haemostasis and fibrinolysis; the evaluation of haemostatic function.
III. The cardiovascular system – heart; blood vessels: structure/function of the arterial and venous systems; capillary function
IV. Physiology of heart; control of circulation & blood pressure; velocity of blood and pulse, anastomoses and collateral circulations
V. The respiratory system; ventilation, gas exchange and gas transport and the regulation of breathing
VI. Urinary system – overview; anatomy of urinary system; renal physiology
VII. Fluid and electrolyte balance – body water and fluid compartments, mechanisms of homeostasis of body fluids, regulation of body fluid electrolytes, respiratory and renal regulation of pH
VIII. The architecture of lymphatic system – lymph and interstitial fluid; lymphatic vessels; circulation of lymph; lymph nodes; tonsils, thymus, spleen, MALT and its significance for the oral cavity

*3e: Nutrition and Excretion*

I. The functional anatomy and physiology of mastication, swallowing, speech and upper respiratory protective reflexes
II. An overview of the Digestive system – anatomy of mouth, pharynx, oesophagus, stomach, small & large intestines, peritoneum, liver, gall bladder and exocrine pancreas;
III. The physiology of digestion, digestive gland secretion, absorption and elimination of waste
IV. Nutrition – overview; dietary sources, body needs and handling of carbohydrates, lipids, proteins, vitamins, minerals; metabolic rates, energy balance, regulation of dietary intake

*3f: Reproduction, Growth and Development (to integrate with Section 2c)*

I. Understanding of the terms genotype and phenotype
II. The genetic basis of disease, disorders of chromosome form and number with key examples, single gene defects, hereditary and sex-linked traits, complex, polymodal patterns of inheritance.
III. Patterns of inheritance (autosomal and X linked disorders with key examples, complex patterns of inheritance)
IV. Somatic cell and germ cell mutations

### *4. Microbiology and the Control of Infection*

I. Microbial classification and diversity - bacteria, fungi, viruses and prions; key features of the major microbial groups
II. Transmission of infectious disease; Principles of sterilisation and disinfection.
III. Dental plaque; oral bacterial ecology; oral biofilms
IV. Microbial biochemistry (where relevant e.g. sugar, protein metabolism, etc.
V. The human microbiome, colonisation, resistance and systemic diseases
VI. Virulence factors – colonisation, evasion of host defence, tissue damage.
VII. Bacteraemia, septicaemia and infective endocarditis
VIII. Anti-microbial agents and resistance mechanisms.
IX. The microbiology of key oral diseases
X. Emerging and re-emerging diseases relevant to Dentistry
XI. Microbial sampling and characterisation techniques

### *5. Key Disease Processes*

*5a: Immunology and Defence against Infection*

I. The development and structure of the immune system, primary and secondary lymphoid tissue and the lymphatic system
II. Innate immune response and host-microbe interactions
III. Adaptive immune response (cell mediated and humoral immunity)
IV. Allergy, hypersensitivity and immunodeficiency and their oral manifestations
V. The immune system and the oral mucosa (MALT)

VI. Development and aging in the immune system

VII. Immune tolerance

VIII. The immune response in autoimmune disease,

IX. Immunity and tumours,

X. Iatrogenic influences on immune function to include immunosuppression, vaccines and vaccination

XI. Application of immunology to diagnosis and laboratory investigation (Immunohistochemistry, ELISA etc.

*5b: Inflammation and Repair*

I. Tissue homeostasis; cell growth and division and death (mitosis, apoptosis and necrosis); labile, stable and permanent populations of cells
II. The acute inflammatory response
III. Chronic inflammation and its consequences
IV. Healing of a small skin wound
V. Specialised forms of wound healing (e.g. fracture repair or repair of a tooth following root fracture)
VI. Senescence and degenerative processes

*5c: Blood and Cardiovascular*

I. Abnormalities in haemostasis therapeutic modulation of clot formation and breakdown, congenital and acquired disorders of haemostasis
II. Blood loss and its consequences; hypovolemic and other forms of shock
III. Anaemia – an appreciation of its causes and consequences
IV. Atheroma and its sequelae; thrombosis including consideration of Virchow's triad, embolism and its consequences,

*5d: Pre-neoplasia and Neoplasia*

A detailed description of key neoplastic diseases of the oro-facial region will normally form part of curricula in Oral Medicine or Pathology. A BMS curriculum should provide an understanding of the neoplastic process sufficient to underpin this discussion.

I. The characteristic features of benign and malignant disease; tumour nomenclature and classification; major groups of human tumours
II. The molecular and cellular basis of neoplastic processes
III. Metastasis and the mechanisms of tumour spread

IV. An overview of contemporary scientific advances and their potential impact (to integrate with Sections 3c and 3f)

*5e: Tissue Damage by Ionising Radiation*

I. Biological mechanisms of radiation induced damage; background radiation, acute and chronic effects on the tissues, deterministic and stochastic effects

II. Biological responses to diagnostic and therapeutic doses of ionising radiation – an overview.

### *6. Pharmacology*

*6a: Basic Principles*

I. Pharmacokinetics; the absorption, distribution, biotransformation and excretion of drugs.
II. Pharmacodynamics; the nature of receptors and transduction mechanisms
III. Targets for drug action (receptors, ion channels, enzymes, transporters and DNA)
IV. Selectivity, agonism, antagonism, quantitative effects of drugs (dose-response relationships)
V. The process and mechanisms involved in neurotransmission with particular reference to cholinergic and noradrenergic neurotransmission
VI. Adverse reactions to drugs, including immunological hypersensitivity reactions and with particular regard to anaphylactic shock.
VII. Adverse drug interactions of importance in Dentistry

*6b: Groups of Drugs- core knowledge*

I. Adrenoceptor agonists and antagonists
II. Antimicrobial agents to include antibacterials, antifungals and antivirals
III. Benzodiazepines
IV. Drugs which affect haemostasis
V. Local anaesthetics
VI. Non-steroidal anti-inflammatory drugs, paracetamol and carbamazepine
VII. Steroids – their mechanism of action and uses

*6c: Groups of Drugs – general awareness*

I. Anti-asthmatic drugs
II. Anticonvulsants; antidepressants; anxiolytics and hypnotics
III. Chemotherapeutic agents used in the management of malignant disease
IV. Recreational drugs; drugs of abuse
V. Drugs used in the treatment of cardiovascular diseases
VI. Drugs used in the treatment of Parkinson's disease and other neurological conditions
VII. General anaesthetics and neuromuscular blocking agents
VIII. Immunosuppressants
IX. Inhibitors of gastric acid secretion
X. Insulin preparations and oral hypoglycaemic drugs
XI. Muscarinic and histamine receptors antagonists

XII. Neuroleptic drugs

XIII. Opioid analgesics

XIV. Oral contraceptives

### *7. Oral Biosciences*

A programme in the oral biosciences must generate an appreciation of the complex relationship between the oral environment, the diagnosis and the management of oral disease. It should provide a foundation for deeper understanding of caries, periodontal disease and disorders of the oral mucosa, and facilitate an appreciation of the complex relationship between oral and general health. It should be sited within the context of clinical situations and inform an understanding of contemporary issues and their consequences for oral health.

*7a: Oral Anatomy and Embryology*

I. A detailed understanding of the morphology of the deciduous and permanent (successional) crown and root morphology; an appreciation of the relevance of an understanding of crown and root morphology to Restorative Dentistry and Endodontics and Oral Surgery
II. Composition, structure/function relationships of dental and periodontal tissues to include enamel, dentine, cementum, pulp, the periodontal ligament and alveolar bone
III. Development of teeth and their supporting tissues, dentinogenesis, amelogenesis, cementogenesis and periodontal development
IV. Tooth eruption, resorption and exfoliation
V. Post-eruptive tooth movements
VI. The development of the dentition, calcification and eruption dates, dates of completion of root formation
VII. Development of the occlusion and the mixed dentition
VIII. Structure & function of oral mucosa
IX. TMJ, mastication and occlusion, deglutition and speech (to integrate with Section 1b and Section 3b).
X. Salivary gland structure and composition
XI. The concept of labile, stable and permanent populations of cells; turnover and regeneration in the oral tissues; an awareness of possible applications of regenerative medicine to the clinic

*7b: Oral Biosciences*

I. The major components of saliva and their function; the interface between salivary secretion, oral function and the maintenance of the oral hard tissues
II. The control of salivation; diurnal variations in salivary flow rate
III. Gingival crevicular fluid – source, composition and function
IV. pH changes and acid-base balance in the oral environment; its consequences for biomineralisation
V. Dental plaque formation, metabolism and properties
VI. Functional inter-relationships of oral & dental tissues and secretions and importance in defence and homeostasis of the oral cavity
VII. Effect of fluoride on host tissues and bacterial metabolism.
VIII. Taste and olfaction
IX. Pain and sensory responses from the teeth and peri-oral tissues; mechanisms of dentinal sensitivity
X. Dental caries - microbiology, biochemistry, molecular aspects of caries formation and inhibition.
XI. Control of dental caries : fluoride, antimicrobial agents, alternative sweeteners, novel therapies
XII. Periodontal disease - microbiology, immunology, molecular aspects, virulence factors of periodontopathogens
XIII. Non-carious tooth surface loss (attrition, erosion and abrasion)

### *8. Biomaterials in Dentistry*

Students will be expected to have a broad understanding of the range and uses of biomaterials in Dentistry. The Biomedical Sciences curriculum must provide a foundation of basic principles which will spiral into subsequent contextualised consideration of specific materials as part of a clinical programme. This should include…

I. An appreciation of the diverse range of oral environments in which dental materials have to function
II. Knowledge of the properties of oral tissues as they relate to the use of dental materials
III. An understanding of the parameters used to describe and evaluate the physical properties of dental materials (e.g. hardness, elasticity etc.)
IV. Knowledge of the mechanisms, both chemical and mechanical, by which materials may bond to the dental hard tissues and to each other
V. An understanding of the properties of resin and glass ionomer restorative materials
VI. Knowledge on the composition of amalgam alloys and of the issues relating to their contemporary use
VII. Knowledge of the properties of precious metals, base metals and metal alloys and their application to dental situations
VIII. The properties of ceramics used in Dentistry
IX. Knowledge of the chemistry and properties of impression materials
X. An appreciation of the particular characteristics of materials which make them suitable for use in clinical situations in orthodontics and endodontics
XI. An awareness of the characteristics of materials which make them suitable for use as denture base materials

**C. Conclusion and Discussion**

Given the broad nature of BMS applied to dentistry, this curriculum framework is advisory and aims to give programme planners an indicative list of topics, which they can map to specific learning objectives in complex, contemporary integrated curricula. In many respects it is arbitrary, as it is difficult to define where the BMS curriculum ends and overlapping parts of curricula in the clinical disciplines begin. For example, at what point does consideration of the inflammatory response cease to be BMS and start to become part of periodontology or oral pathology. Similarly, the topic of Biostatistics is important to the biomedical sciences, but it is also central to a range of other curriculum areas, Public Health, Evidence Based Dentistry etc. For this reason, it has been regarded as a topic to be considered separately rather than as pat of the biomedical sciences.

As Dentistry becomes increasingly specialised, and timetabling pressures on undergraduate curricula grow, there are advantages to moving from more traditionally based approaches to integrated teaching in which biomedical sciences are considered alongside their clinical application. In addition to contextualisation, this may allow for rationalisation, avoidance of duplication and and more efficient use of resources. Furthermore, it may be possible to move some elements of the undergraduate curriculum to the postgraduate setting which will require greater integration between undergraduate and postgraduate providers. So, this document should be seen as a beginning, and it will need regular review as BMS curricula in dentistry evolve.

Finally, several authors have pointed to the advantages gained by involving students in the curriculum planning process (Bull and Mattick, 2010), and we had the opportunity to engage in discussion with European dental students at ADEE meetings. This emphasised the need to place greater emphasis on integrating the biological and clinical sciences in order to provide a co-ordinated appreciation of structure-function-disease relationships. For example, students inputting into the SIG thought it premature to consider some of the more esoteric parts of Anatomy, as part of topic-based teaching in the earliest stages of the curriculum. Their relevance may only be appreciated in a clinical context later on. For this reason, if for no other, coverage of the biomedical sciences must involve student input if it is to remain a central part of a fully integrated, contextualised, clinically relevant 21st century dental programme.

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