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Review Article

BIOMIMETICS - A REVIEW

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INTRODUCTION

Bio: meaning life and mimesis meaning imitation are derived from Greek. Biomimetics is the field of scientific endeavor which attempts to design system and synthesize materials through biomimicry. It's the concept of taking ideas from nature and implementing them in another technology such as engineering design computing etc. The subject matter of biomimetics is known by several names bionics, biognosis etc .

The concept is very old but the implementation is gathering momentum only recently because the science base can cope with the advanced techniques and our civilization is in ever increasing need of sympathetic technology.

Biomimectics is an emerging inter disciplinary field that combines information from the study of biological structures and their function with physics mathematics chemistry and engineering in the development of principles that are important for the generation of novel synthetic materials and organs.

HISTORY

The name biomimeitcs was coined by Ottoschmit in the 1950s. The term bionics coined by JackE.Steele in 1960 at a continence in Dayton.
The foundation of this broad new field has ancient roots. Replacing body parts goes back at least 2,500 years when bridges made them artificial teeth carved them the bones or oxen . Evidence of crude dental implants dates back to roman population of the first or second century AD and to pre-Columbian cultures of central and south America . The firs use of dental amalgam to repair decayed teeth was recorded
in the Chinese literature in the year 659. The middle of 20the century same sophisticated inventions in the heart pacemaker the artificial heart valve and hip and knee joint replacement historically organ and tissue loss have been treated by surgical reconstruction and more recently the use of mechanical devices such as kidney dialyzers and the transplantations of organs from one individual to another.

REGENERATION OF DENTAL STRUCTURES

Regeneration of the dentin pulp complex :- The recombinant human BMP2 and BMP4 can induce new dentin . Recombinant BMP delivered in a scaffold of demineralized dentin matrix induces classic tubular dentin in amputated pulp where as BMP delivered using reconstituted type I collagen matrix induces instead osteodentin . Reparative dentin is also induced on freshly cut healthy pulp tissue in nonhuman primate using recombinant human BMP7 with an insoluble type I collagen matrix. The size and shape of the inductive material controls the size and shaped of the reparative dentin. The reparative dentin appears initially with cellular and soft tissue inclusions a portion of which (comprising only about 20% of the reparative dentin) subsequently changes into a more tubular form of matrix with associated odontablast like cells attached to the mass of a tubular matrix. Therefore the extra cellular matrix scaffolding is a critical component and a prerequisite to odontoblast differentiation and tubular dentin formation.
Periodontal regeneration :- The periodontium which consist of cementum PDL and alveolar bone functions to anchor the teeth to the jaws. The morphogenetic potential of BMPs makes them ideal candidates for use in periodontal regeneration optimizing the response of stem cells to BMP induction requires the use of a delivery system that is conducive to the migration and attachment of the responding stem cells on to the scaffolding using a baboon model recombinant BMP7 and baboon type I collagen has been used as a biomimetic scaffold to regenerate surgically created function defects in molars. The formation of alveolar bone and the creation of cementum and sharpey's fibers inserted at the optimal orientation into the root surface. Platelet rich plasma (PRP) used in different surgical procedures. It consists of thrombocyte concentrates and high amounts of growth factors (GFs) especially platelet desired growth factor (PDGF), insulin like growth factor (IGF -I) and transforming growth factor (TGF- beta) which are important in wound healing and regeneration combination of PRP and tricalcium phosphate can be

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used in the treatment of periapical inflammatory lesion. Platelet gel biotechnology a method which has all the components of "tissue engineering" techniques with healing process of guided tissue regeneration procedures (GTR) by multiplying the number of molecules that activate the healing response and by grafting in the host site various cell types among which stem cell ho is applied to regenerative surgery of intrabony defects in patients with refractory generalized aggressive peridontitis.

THE BIOMIMETIC PRINCIPLE IN RESTORATIVE DENTISTRY

- The goal of biomimetics in restorative dentistry is to return all of the prepared dental tissues to full function by the creation of a hard tissue bond that allows functional stresses to pass through the tooth drawing the entire crown into the final functional biologic and esthetic result . Bonded porcelain restorations are recommended to treat the most perilous situation (non vital or fractured teeth) thus avoiding the use of intraradiucular parts or full coverage crowns e.g.- inlay onlay laminates cemented with the adhesive resins .

- The low elastic modules of most composites can never fully compensate for the loss of strong proximal enamel ridges especially in extremely large class II restorations . In these situations including those with cusp coverage indirect ceramic inlays onlays seem to be best alternative . In case of total occlusal coverage invital teeth with a short clinical crown ceramic indirect overlays are indicated.

- With the development of improved adhesives and immediate dentin sealing the use and indications for base lines have decreased. This group of materials traditionally performs many different function including the partial lining as a biologic protection for deep preparation areas the total lining for the dentin insulation against chemical or thermal injuries and the dentin replacement as a base prior to further restoration procedures. The indication for placing a linear under on adhesive restoration is mainly for pulp protection in the form of a partial lining using Ca (OH2) cements. Modern adhesives are capable replacing the total living function of
- former varnishes and cements. Base materials are mainly indicated to reduce the volume of the inlay/ onlay (e.g.- excessive depth) and to create an adequate preparation geometry by providing an even cavity floor and filling up internal undercuts .
- Endodontically treated teeth are more susceptible to fracture not because of pulp removal but due to the increased strain resulting them tooth substance loss. For posterior teeth total cuspal coverage with porcelain is recommended as it will significantly stiffen the crown and increase cusp stabilization for vital teeth .A composite resin base in indicated to reduce the volume of the inlay/onlay and to create an adequate preparation geometry (by providing an even cavity floor and filling up internal undercuts)

DEVELOPMENT OF ARTIFICIAL SALIVARY GLAND

Many people suffer a loss of salivary gland function as a result of radiation treatment for head and neck cancer, and also many people affected for sjogren's syndrome an autoimmune disease whose symptoms include dry mouth and dry eyes without adequate saliva patient may experience difficulty in speaking, chewing and swallowing.

The application of state – of – the- art methodologies include the use of adult and embryonic stem cells for the regeneration of the salivary glands, parenchyma and restorations of its secretary functions.

Efforts have focused on creating a rather simple device a "blind- end-tube" suitable to graft in the buccal mucosa of patients whose salivary parenchyma has been destroyed. The lumen of these tubes would be lined with compatible epithelial cells and be physiologically capable of unidirectional water movement. A realistic opportunity to develop a first generation artificial salivary gland suitable for clinical testing is believed to exists.

BIOMATERIALS

Synthetic Polymer: The polymer can be biodegradable or non degradable .biodegradable polymers include polylactic acid and polyglycolic acid and co polymers. These polymers are used as suture materials but are also being examined for usage such as bone ,skin and liver substitutes. These polymers are broken down in the body hydrolytically to produce lactic acid and glycolic acid. Newer biomaterials are polyanhydrites, Polyphosphazenes. Polymethyl Methacrylate (PMMA), Polytetrafluoroethylene (PTFE) and PMMA, polyhydroxyethylmethacrylate (PHEMA) may be described as alloplastic , synthetic, Nonbiodegradable polymers. PMMA used for dentures and as a cement for many orthopedic prosthesis. PTFE used for augmentation and guided bone regeneration.

CERAMICS

It is used in dental applications and are being examined for bone tissue engineering application. Two common ceramics used in dentistry and hip prosthesis are alumina and hydroxyapatite. Alumina has excellent corrosion resistance, high strength, high wear resistance. Hydroxyapatite is a calcium phosphate based ceramic and it is a major component of inorganic compartment of bone.

BIOMIMETIC PRINCIPLES IN DENTAL IMPLANT

Ceramics such as the calcium phosphate hydroxyappatite and various types of aluminum oxides are proved to be bio compatible and they are coated to implant which increases osteointegration.

SCOPE

- Biologist study biomimetics not only for an understanding of the biological processes but also to trace the evolution of various classes of organism biochemist have interest in the field due to the complexities associated with the interaction of biopolymers with ions of metal leading to the mineralization in living organisms.

- On the whole the field of biomimetics addresses more than one issue those engaged in this field of research activity try to mimic natural method of manufacture of chemicals in order to create new ones, learn new principles from phenomenon observed in nature, reproduce mechanism found in nature and copy the principles of synthesizing materials under ambient conditions and with easily available raw materials. Design of biodegradable scaffolds to serve as platforms for cells to organize tissues for repair and regeneration of teeth and periodontal tissues. Develop biodegradable synthetic polymers for gene therapy identify isolate culture and characterize multipotent stem cells for adult tissues type for repair of TMJ associated structures.

CONCLUSION

There is a need for a firmer scientific and technical basis in order to develop the next generation of medical implants that are safe reliable

smart and long lasting integrated and multidisciplinary research should advance our understanding of biological system and provide the basis for the design and development of normal synthetic medical materials that are compatible with the environment of the host and significantly increase the functional life time of implants. Future advances in this field will require materials and computer scientist, physicists, bioengineers, clinicians, biologist and industries working together towards a shared vision rather than pursuing their separate objectives.

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Souce of Support: Nill, **Conflict of Interest:** None declared