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COMMON MATERIALS FOR USING BIO TISSUE ENGINEERING

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ABSTRACT

Many researches are presently beingconducted on several different types of tissues and organs, including cartilage, Ligament, muscleheart, blood vessels, bone, neuronal, liver etc. Bio tissue engineering is remarkably multidisciplinary, bringing together cell and molecular biologists, biochemists engineers, pharmacologists, physiciansetc.Tissue engineering aims to create new tissues and organs by introducing cells, biocompatible material and supportive factors. This review paper focus on the using some natural and synthetic bio materials and polymers such aspoly lactic-co-glycolic acid, Poly lactic acid,Poly ε-caprolactone, poly urethane, polyester urethane chitosan and fibrin used for tissue engineering.

Keywords: Tissue engineering, Biological, Synthetic polymers, Composite.

INTRODUCTION

For millennia, humans have been interested in manipulating the vast body of life surrounding them.As social systems and resultant technology have progressed, the motivation and ability to alter life has steadily increased. In actuality much of the biotechnology revolution that so enthralls us today had its roots at the dawn of civilization.For example, humans have been practicing various forms of tissue engineering in its broadest sense for thousands of years. The manipulation of crops and domesticated animals has been a persistent and widespread practice across the planet (Herman, 2002).The simple act of the castration of a farm animal dramatically alters tissue function, yielding desired morphologic, chemical and behavioral changes.Exponential increases in our understanding of the molecular basis of cell interactions have provided the means to more precisely manipulate and perhaps duplicate tissue function.Plant tissue engineering is becoming commonplace and food, fiber, and pharmaceutical production may well be changed irrevocably (Skarja, 20010. Tissue Engineering is the in vitro development (growth) of tissues or organs to replace or support the function of defective or injured body parts or the directed management of the repair of tissues within the body (in vivo).The 20th century will be remembered as a time of revolutionary change in the fields of basic and applied science. New ideas and new tools provided both an increased understanding of the natural world as well as an unparalleled ability to alter the environment and human society (Guan, 2002).

The field of biomedicine reaped the windfall of new achievements in many science, especially improving health care in the world (Langer, 1995).Tissue engineering does open new Position in reconstructive medicine.Tissue engineered substitutes as three dimensional reconstructions can be implanted into the human body leading to rapid host implantation and acceptance (Ladd, 2009). The substitutes must have at least minimal biological and mechanical functions for such reparative role.The term reparative medicine is often used to denote the replacement repair or functional enhancement of tissues and organs.Reparative medicine has traditionally used materials at hand and the technology of the day to restore or improve function of organs and tissues afflicted with birth defects or the ravages of injury, disease, and age (Atala, 2000). The first tissue based therapies for skin grafting were developed in India around 3000BCE, but the synthesis of substitute materials for skin and various grafting techniques(e.g., autologous and allografts) were not developed until the eighteenth century (Atala, 2006). Thefirst engineered skin tissues were generated by Howard Green and colleagues in1975. Tissue engineering employs aspects of molecular biology, cell biology, material technology engineering, and surgical intervention to develop tissue substitutes to restore the function and architecture of damaged or lost tissues and organs (Macchiarini, 2008).

1.TISSUEENGINEERING

Tissue engineering is an important emerging area in biomedical engineering for creatingbiological alternatives for harvested tissues, implants and prostheses.In tissue engineering, a highlyporous artificial extracellular matrix or scaffold is required to accommodate mammaliancells and guide their growth and tissue regeneration in three dimensions (3D). The ideal scaffold for tissue engineering should be biocompatible and biodegradable and providesufficient and adequate interactions with various cell types.The tissue engineered scaffold shouldnot initiate an immunological or ‘foreign body response in the patient.Moreover, it should providetemporary mechanical support that

can withstand in vivo forces and maintain space for tissuedevelopment. The mechanical support should be maintained until the engineered tissue hassufficientmechanical integrity by itself.The engineered scaffold should be a provisional tissue,which facilitates in situ regeneration, thereby helping the body to heal (Langer, 1993).

2. COMMON BIO MATERIALS

There are three categories of scaffold materials in tissue engineering. Natural (biological) materials, synthetic materials and hybrid (semi-synthetic) materialsnaturallyoccurringmaterials have physiological activities, such as cell adhesion, mechanical properties andbiodegradability (Seliktar, 2005). Moreover, cells can adhere and interact with them via integrin, followed byactivation of signal transduction pathways.Natural materials can be degraded and replaced upon the generation of new tissues.Difficulties with natural materials are to obtain them with acontinuous supply and immunological integrity, and to fully understand the cell-scaffoldinteractions. Well-investigated natural scaffolds are chitosan, fibronectin, collagen, fibrin andcombinations hereof. Synthetic polymersarepoly lactic-co-glycolic acid (PLGA), Poly lactic acid (PLA), and Poly ε-caprolactone (PCL) (Lutolf, 20050.

3. SYNTHETIC MATERIALS

3.1. Poly Lactic-Co-Glycolic Acid(PLGA): This copolymer, poly (lactic-co-glycolic acid) (PLGA) was first available as a suturematerial under the trade name Vicryl in 1974. PLGA scaffolds were used in the early1990s toward engineering boneand liver and were famously used in the tissue engineering of cartilage in the shape of a human ear.PLGA in a 50:50 mixture hasa degradation time of about 8 weeks.PLGA can also be blended with other polymersas well as natural materials, such as gelatin,which was used to studytrabecular bone regeneration (Rosso, 2005; Alperin, 2005; Thomson, 1995; Wintermantel, 1991; Cao, 1997, Singhal, 1996).

3.2. Poly Lactic Acid (PLA): PLA is biodegradable aliphatic polyester, more hydrophobic than PGA. There are 2 racemic isoforms, poly-L-lactic acid (PLLA) and poly-D-lactic acid (PDLA). The racemic mixture can be termed poly-D,L-lactic acid (PDLLA) or simplyPLA, without indication of which chiral form is present. PLA in scaffolds is usuallyfound in a copolymer mixture (see above), although a few early studies looked atthe use of PLA scaffolds for cartilage repairand nerve regenerationPLLAfibrousscaffolds maintained integrity for a 42-day period, during which PDLLA fibrous scaffoldsshrunksignificantly after only 3 days (Stegemann, 2007; Chu, 1995; Evans, 1999).

3.3. Poly- ε-Caprolactone(PCL): Poly(ε-caprolactone) (PCL) is a slowly degrading polymer that was first tested asa bulk material for dermal fibroblast growth PCL scaffolds have been used towardtissue engineering efforts in bone, either aloneor combined with hydroxyapatite(HA) PCL scaffolds are attractive for the longer term, as it degrades over2 years (Li, 2006; Doyle, 1996; Corden, 2000; Calvert, 2000; Marra, 1999; Pitt, 1981).

3.4. Poly Urethane (PU): Segmented PU allow for structural variations to achieve elastomeric properties. A major limitation of PU forbiomedical applications is the involvement of toxic precursors (such as toluene diisocyanates) in the synthesis. Progress has been made in the development of biodegradable PU or urethanebased polymers using less toxic diisocyanates. These polymers have been explored for vascular and other tissue engineering applications (Lin, 1994; Green, 1979; Ebrod, 1981; Zhang, 2000).

3.5. Poly Glycolic Acid(PGA): PGA fibers in the forms of tassels and felts were utilized as scaffolds to demonstrate the feasibility oforgan regeneration. Fiber meshes consist of individual fibers either woven or knitted into three-dimensionalpatterns of variable pore size.The advantageous characteristic features of fiber meshes are a largesurface area for cell attachment and a rapid diffusion of nutrients in favor of cell survival and growth. PGA is simple, linear, aliphatic polyester that was first used asa biodegradable suture. The PGA suture was brought to market under the trade nameDexon. PGA in scaffolds was first introduced in the 1980s, alone as a mesh to investigate renal injury (McAninch, 1986). Blended Dacron (polyethylene terephthalate),to study tendon and ligament repair (Cabaud, 1982; Rodkey, 1985; Townley, 1985). Large-scale production of fibrous PGA scaffolds with consistent porosity was achieved in the early 1990s, which was used to regenerate cartilaginous tissue (Freed, 1994). The degradation rate was studied in vitro, whereby only 30% of the polymer remained after 8 weeks (Saad, 1997).

3.6.Degrapol: DegraPol is a polyester-urethane; it consists of two blocks of polymers which impart very different physical and mechanical properties to the final product. It consists of polyhydroxybutyratediol (Hard Segment) and polycaprolactole-dyglicol-diol (Soft Segment). Both are biodegradable polymers and their degradation products are not toxic.Using various ratios of hard and soft segments it's possible to modulate the mechanical properties of the final

product. Unlike traditional materials, DegraPol shows a broad range of elastic modulus, making it a potential new material for the regeneration of many types of biological tissues (Woo, 2007).

3.7. Hydroxyapatite (HAP): The HAP-containing scaffolds improve osteoplastic cell seeding uniformity and show significantly enhanced expression of mature bone marker genes such asosteocalcin and bone sialoprotein over plain polymer scaffolds.Bone tissue formation throughout the scaffold has been demonstrated. Our recent data indicate that HAP in the composite scaffolds. Significantly improves the protein adsorption capacity, suppresses apoptotic cell death and provides a more favorable microenvironment for bone tissue regeneration (Lee, 2000).

3.8.Phoshate(CAP): Substantial progress has been made in the analysisof progenitor cells with regard to differentiationpathways.This knowledge is being incorporated intothe design of future scaffolds particularly with regard to optimization.Biomaterial development and final design will be essential to the appropriate stimulation and differentiation of bone cells. The environment in which these CaP tissue-scaffold systems are cultivated will greatly affect the long-term tissue viability.However, the diverse nature and independent processing parameters of research in this field makes comparisons especially difficult and the need for consistency fundamental. Assuch,standardization will hopefully expedite thedevelopment of successful tissue-engineering alternatives (Yu, 2010).

4. NATURAL MATERIAL

4.1. Chitosan: The natural biopolymer chitosan is an excellent candidatefor the preparation of wound dressings and hydrogel scaffolds for tissue engineering.There are different ways to form hydrogels from chitosan. Chitosan could be used alone but this is rarely the case because pure chitosan hydrogel is fragile andhas low mechanical strength, which limits its application in tissue engineering. Chitosan has therefore been combined with other compounds or chemicallymodified to improve its properties for tissue engineering applications, in particular to create thermo sensitivehydrogels that will gel in situ (Wood, 2008).

4.2. Collagen: Collagen is the most widely distributed classof proteins in the human body. Collagen can be extracted from various sources considering that it is one of the most abundant proteins on earth. It can be extracted from almost every living animal, even including alligators and kangaroos. The use of collagen-based biomaterials in the field of tissue engineering applications has been intensively growing over the past decades. Collagen possesses a major advantage in being biodegradable, biocompatible, easily available and highly versatile.However, since collagen is a protein, it remains difficult to sterilize without alterations to its structure (Kellner, 2001).

4.3.Fibrin: There are a number of commercially available fibrin products with different amounts and origins of the components (Rotter, 2002; Ma, 2001).The concentration of fibrinogen, varying between 40 and 125 mg/ml,is directly correlated to the tensile strength of the fibrin clot, whereas the degree and speed clotting.The latter proves useful for quick haemostaits to prevent blood loss.(e.g, in suturing of vessels) or in surgical procedures involving careful glue adjustment to fit a tissue or organ (Wang, 2001). Whit in 3 days of application, a preliminary granulation tissue with a large number of wound healing cells is present and is subsequently replaced with collagen fibers one to two weeks later.During normal wound healing the fibrin glue is absorbed within days to weeks depending on the type of sealant and location of application (Webster, 2000).

4.4. Ceramic: Ceramics have been used in bone tissue engineering due to their osteoinductiveand biocompatible properties (Zhou, 2007).Nanophase ceramics - sans immobilized peptides seeded with osteoblasts as osteointegrative devices designed to merge with apposed bone, have come to the fore as well[47]. The absence of peptides on the nanophase ceramics would circumvent the problems which could arise from the interactions of the peptides with the biomaterials. For instance, nanophase alumina, titania, zirconia, and hydroxyapatite (HA), with grain sizes less than 100nm, were compared with their conventional counterparts in regards to cell proliferation, cell adhesion, matrix formation, cellular migration and cell differentiation (Boccaccini, 2003).

4.5. Hydrogels: Hydrogels have many different applications in the field of regenerative medicine. Biodegradable, injectable hydrogels could be utilized as delivery systems, cell carriers, and scaffolds for tissue engineering. Injectable hydrogels are an appealing scaffold because they are structurally similar to the extracellular matrix of many tissues, can often be processed under relatively mild conditions and may be delivered in a minimally invasive manner. Injectable hydrogels are promising substrates for tissue engineering applications due to high tissuelike water content, ability to homogeneously encapsulate cells, efficient mass transfer, easily manipulated physical properties and minimally invasive delivery (Tememoff, 2000; Caldwell, 1997; Breen, 2009).

5. HYBRID (SEMI- SYNTHETIC) MATERIALS

5.1. Polymethyl Methacrylate (PMMA): PMMAis biocompatible in the human eye that the idea of an artificial cornea resurfaced.Unfortunately, biocompatibility was not sufficiently acceptable for a good artificial corona,becausekeratoprosthesesmade from PMMA had a problem of extrusion. Many including Gigard and Cardona, have tested different design and materials, however, long term retention remains a major problems (Kaufman, 1998; Pitt, 1981).

6. CONCLUTION

In the preceding paper, a framework has been sketched to view introduction of bio tissue engineering and categories of scaffold materials in tissue engineering.Tissue engineering aims to develop functional substitutes for damaged or diseased tissues through complex constructs of living cells, bioactive molecules, and 3Dporous scaffolds that support cell attachment, proliferation, and differentiation. Tissue engineering experienced an exponential growth during the last decade from an immerging conceptual stage into a fast developing and multifaceted field.Due to the intrinsic interdisciplinary and multidisciplinary nature of this field, the fast evolution and developmentof the field of tissue engineering have benefited from the convergence of the progresses in eachand every area of the field. Application of bio tissue engineering are improve of renal injury,regeneratecartilaginous,bone, liver, nerve regeneration,dermal fibroblast growth and Endocrinology vascular.

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