INTRODUCTION

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Every year the number of patients diagnosed with ESRD (End Stage Renal Disease) increases exponentially creating urgency for clinicians and scientists to search out new approaches that will someday improve the treatment of patients with renal disease. Acute kidney failure (AKF) is represented by a rapid decrease in renal function usually accompanied by an increase in creatinine and other physiologic parameters over several days. Some of the major causes of AKF include the following: inadequate renal perfusion, hemorrhage and loss of intravascular fluid, low cardiac output, low systemic vascular resistance, acute tubular injury, glomerulonephritis, as well as, urinary obstruction. Chronic kidney disease (CKD), on the other hand, is characterized by a long-standing, progressive deterioration of renal function. These symptoms develop slowly leading to ESRD **(Rastogi and Nissenson, 2009).**

One of the major challenges in Regenerative Medicine, in particular the field of kidney regeneration, is improvement of current therapies coupled with discoveries of new approaches to treat patients suffering from acute and chronic kidney disease. Tissue Engineering and Stem Cell Therapies are the major new fields of investigation in renal regeneration. The idea of recreating a de novo ex vivo kidney using scaffolds as a skeleton in which to seed renal cells or stem cells would be an ideal solution for organ shortages. Alternatively, the application of stem cells, endogenous as well as exogenous, may be a feasible approach to slowing the progression of chronic kidney disease **(Nissenson et al., 2008).**

Tremendous advancements to the efficiency of hemodialysis have been reached in the last decade. However, none of these improvements has had a huge and tangible impact on patient compliance, nor capable of

decreasing, to acceptable levels, mortality rates. In addition, dialysis is still considered unphysiologic and a principal cause of many side effects. Ideally, artificial kidneys that are wearable, continuously operating, efficient and capable of mimicking the regulatory and endocrine function would be desirable and many scientists are looking at applications of nanotechnology and bio-material techniques **(Fissell et al., 2009).**

The role of the kidney is much more than mere blood filtration and purification. In fact, the renal compartment is involved in secretion of critical hormones, blood cell production and bone metabolism. In order to overcome the problems currently encountered with current modes of therapy, Regenerative Medicine and Tissue Engineering scientists are looking at novel approaches for Renal Replacement Therapy and organ transplantation. Partial or complete de novo reconstruction of the whole organ is being investigated for their potential in clinical applications **(Zhang et al., 2009).**

In the last decade investigations on using stem cells to treat kidney disease have increased exponentially and various approaches are being attempted to determine if in the future this particular cell therapy may be suitable to clinically treat patients with ESRD. An effective treatment of renal disease would promote renal cell regeneration, or eventually replace the damaged cells, or eventually prevent fibrosis, a consequence of end stage disease. It is clear from reviews of the literature that different stem cell types exist that possess different degrees of self-renewal as well as pluripotential capability **(Morizane et al., 2009).**

The in vivo use of DNA or RNA in order to restore, recover or modulate gene function and cure a wide range of genetic and acquired diseases is the ultimate goal of Gene Therapy. Recently the possibility to modulate/silence/enhance gene expression for the treatment of various

renal and renal-related diseases has been investigated. A great deal of this research has focused on the possible treatments for renal cell carcinomas. The kidney is a challenging organ for Gene Therapy due to the complexity of its structures, the presence of a filtration barrier, and the high rate of blood flow with consequent low dwell time **(Chen et al., 2008).**