Degeneration– The Pandora's Box of Medicine

The collective history of the medicine man, from Imhotep to Hippocrates to Paul Farmer, has pointed toward several broad classes of disease. Acute and transient disease such as a flu or an infection is rarely life-threatening in the antibiotic era and, these days, hardly noticeable with the cocktail of symptomatic relief drugs that are available. More indolent illnesses such as asthma or even HIV can be managed with regular application of therapeutic tools (having moved past the middle ages you also no longer run the risk of death by dehydration from 'chronic' blood letting!). There exists a third category, however, unconquerable in many ways as it was thousands of years ago – diseases of degeneration.

Alzheimer's.

Multiple sclerosis.

Aging.

That marginal increase in the severity of stiffness you feel in the morning with each passing year.

These are all aberrant physiologies that progress towards a single ultimate end – the eventual succumbing of the body to internal pressures. In this regard, medicine and basic biology stand at an interesting crossroads. Despite increases in our understanding of the molecular basis of disease and our responses to it, we have yet to unleash the wound-healing capacity observed in other species by genetic factors also present in ourselves.

Humans are nothing if not resourceful, however, and we quickly realized that an external stimulus of the healing process was just as effective as one originating from within the body and, perhaps, more amenable to modulation. Regenerative medicine was born thus as an attempt to account for our irrevocable faults. It could not have been timelier. Obesity and America are such frequent bed partners as to border on sociological cliché. The adulteress, osteoarthritis, however, has remained relatively invisible to the public eye. Due to its late onset and increasingly extended life expectancies, rates for osteoarthritis now surpass those of obesity. Of every two readers perusing this piece, the prediction is that at least one of you will curse the authors as you nurse the occasional lancing pain in your hip. Increasing prevalence aside, osteoarthritis is an example of this elusive third class of disease. It is neither immediately curable nor reversible given our understanding of human biology.

Non-prescriptive treatments are certainly available – proper dieting, physical exercise, maintaining normal weight – but in the tradition of human laziness efficiency and pursuit of the "magic bullet" of medicine, this is hardly a desirable alternative. In recent years, tissue engineering has presented one such solution. In a stroke of rare nomenclature-related genius, the name is quite literally what it presents: the artificial creation of different bodily components by biological or biophysical means. A nascent field, tissue engineering is nonetheless expanding rapidly and gradually offering alternatives to more invasive

procedures such as joint replacements, which offer limited improvements and indemnifying long-term complications.

Research is being done to apply tissue engineering to use for almost every mammalian tissue, including cartilage, in a patient-specific manner. This is the truly game-changing aspect of regenerative medicine. It offers the possibility of manipulating a patient's own cells to provide the substance of the therapeutic tools used to alleviate disease symptoms, creating a uniquely targeted system that bypasses many complications related to artificial or donor treatments (graft rejection, autoinflammatory responses at artificial joints, etc.). The following article, "Effect of Varying Concentrations and Application Periods of Chondroitinase ABC on Tissue-Engineered Cartilage," proposes a treatment for sufferers of osteoarthritis by developing tissue-engineered cartilage that can be grown outside the patient but with the patient's own cells. The damaged cartilage is then removed and replaced with tissue-engineered cartilage that biologically and mechanically resembles native cartilage.

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This has important implications with regards to the financing and systemization of joint repair as well as transplants at large. Tissue engineering provides a promising means of addressing issues like the scarcity of donors for needed tissues and organs for transplant operations, the limitations of mechanical substitutes, and the difficulties and complications involved in surgical reconstruction. In 2003, the Centers for Disease Control and Prevention (CDC 2010) also stated that osteoarthritis was draining a frightening $128 billion from the national economy. In addition to alleviating patient suffering, tissue engineering may be a potent mechanism for resecting the growing burden of arthritic problems in an aging population. In the absence of such a measure, we can only expect these issues to snowball further and manifest as negative externalities in other areas beyond healthcare.

As a last consideration, think deeper into the notion of tissue engineering. Bone, tendons, and connective tissue are but few of many subtypes of biological architectures present in the body. Regenerative medicine offers a vehicle for restoring any portion of the body to its healthy (or even younger) state if only we have to courage and drive to probe deeper into the basic biology of these mechanisms and open our minds to the notion of exogenously produced organs. Bioengineered bladders, tracheas, and other bodily organs have already been surgically transplanted into patients in the past year. These efforts have been met with incredible success, and seem likely to continue. We commend the efforts of Tong and his team, and eagerly await the riveting trajectory of this rapidly evolving field of medicine.