**Regenerative Medicine, restoring what was lost**

Chances are, if you are reading this text you might have seen popularized medical dramas on television and streaming services. Doctors young, old, straight-laced and borderline criminals live their lives in a totally engrossing storyline saving lives amongst drama. These certain characteristics might be easily found amongst many real-life physicians, but their lives are far from glamorous. The same could be said about any job.

What we consider Modern-Medicine had its start in the late 1800s into the early 1900s. Techniques continued to evolve with instrumentation and knowledge leading to an increase in life expectancy. Of the techniques that are used they can mostly be summarized as prevention, diagnosis, treatment and surgery. From the 2000s and on is the fruition of many advance types of medicine. There are several STEM fields and areas of study that will bring in a higher standard of care, restore lost functions and regenerate what was degraded or damaged.

**Researching regenerative medicine**

What is regeneration and how is it different from current medicine? Repair is a normal bodily process when recovering from an accident or even surgery. Scarring happens from the body’s attempt to heal after such events. In adults, wound repair can have a distinct lack of regeneration and can be defined as a type of wound contraction or scarring. Damaged tissue repairs itself but does not restore cells to the state they were in before the damage. Essentially from birth and every consecutive year we age, we lose a little of our capacity to spontaneously regenerate from common injuries. Once your body is fully matured, with few genetic exceptions, we progress slowly degrading further into our lives. Specialized fields of Biology and Biomedical research investigates how the body ages and have found several applications that can help regenerate simple tissues to potentially complex organs.

Vast amounts of specialized cells and structures make up organs in animal bodies. If a person finds themselves in need of a replacement heart, a long wait and numerous antigen / antibody checks can happen. If a close match is found, the recipient might have to take years of medication after the surgery to avoid rejection. Researchers have found ways to revert cells into an induced pluripotent stem cells like state. When treated with certain factors, these cells can start to form tissues like what we can find in our bodies but outside living animals. With our current knowledge we are unable to create organ replacements from cells alone. An extracellular matrix (ECM) defines the shape of organs. Scaffolds are what the ECMs are referred to and can structure tissues into full organs. Since there are many animal analogs to human organs, such as pig hearts, there are processes that can remove all foreign animal cells to leave a scaffold. These scaffolds can be reseeded with human cells. This can lead to the eventual ability to grow organs fit for the recipient without rejection and approach closer to a regenerative therapy.

**Engineering in Medicine**

As previously mentioned, animal analogs to human organs have the potential to be used as a scaffold to make new replacement organs. Not all organs or structures in a human body have exact analogs in animals, this is where engineering comes into play. With current imaging technology we can visualize organs down to respectable resolution and size, but they are not entirely accurate depending on the method. Improvements in imaging technology along with advancements with 3D printing, it may be possible to fabricate exact scaffolds bones and other organs for replacements. Technology of that level will need precision down to the finest micrometers in size, but every advancement to manipulate biocompatible compounds at increasingly higher precision will help advancements in replacement therapy.

Genomic modification has the potential of growing replacements organs in vivo and has the potential to overcome many technological challenges. Should we ever get to that level of genomic modification, the ethics around the procedures could delay further advancements. Modeling environments of the human body in computerized bio reactors would be the next best thing. Instrumentation capable of monitoring protein levels and release the correct factors to influence growth would have to be developed. Depending on the complexity of the organs, cells would have to be seeded on tissues during their correct growth state. Designing equipment for such a task will take collaboration, creativity and lifetime of learning to improve such technologies.

**Genetic modification**

Evolution is an accumulation of mutations over the history of our species. If you believe in evolution or not, improvements in sequencing technologies are making it feasible to know your own genome. When you compare your genome to relatives and other people you will see where similarities are shared and where divergence happens. Height, muscle mass and weight gain can all be beneficial or detrimental traits given an appropriate setting. Natural or man-made events can select against these traits. An example would be, skinny people are more likely to die off first if the world froze over and food was scarce. Sometimes certain detrimental traits could be associated with populations of people with somewhat closed reproductive pairings in relationships. Other times mutations might happen by random chance or possibly chemical exposure. Depending on the tissue type and problem to correct, gene therapies can correct health disorders.

The most effective type of gene therapy is prevention and knowledge. Once armed with knowledge, expecting parents could avoid heart ache by screening embryos or simply adopt a child. As techniques improve, debilitating mutations could be corrected at the embryonic stage making inheritable disorders never happen. Foreign protein targeted therapies such as the CRISPR-Cas9 complex works best when stem cells for targeted tissues are modified. In blood there are common myeloid progenitor cells that differentiate into white and red blood cells. Patients with sickle cell anemia would benefit from having the sickle cell mutation corrected for their blood. A patient without the modification in the bone marrow’s stem cells would show some signs of improvement. Faulty stem cells can replace the myeloid progenitor through regular cell replacement making the disorder return. Amongst other genome modifying technologies, viruses have shown the ability to introduce foreign DNA and integrate into genomes. Self-proliferating program viruses in theory could target and potentially correct cells with genetic mistakes or that have turned cancerous.

**Computer Science in Medicine**

The equal availability of quality healthcare is a real problem in the world. An overabundance of incorrectly prescribed antibiotics is a real problem. Antibiotic resistant bacteria are a real threat in hospitals and other public settings. History has also shown that medical professionals are capable of being bought to prescribe a certain brand of pharmaceuticals. While sometimes a lack of experience and knowledge on the subject can lead to numerous unnecessary medical tests, pain and suffering along with continued misdiagnosis. Computer science researchers can play a part in trying to increase the standards of care across the globe.

Learning is a lifelong skill used throughout our lives, different people will devote different amounts of their time in order to keep up with a specific trade or field of knowledge. General purpose learning algorithms such as the IBM’s Watson and Google’s Deep Mind are a type of AI that has the capability to use natural language to learn. With enough access to medical text along with patient data, it becomes possible to have an entity that knows every bit of shared medical knowledge the world as ever known. Limited use of these AI programs has already been used for medical consultation.

Significant amounts of real-world testing and research is still needed before AI programs could reach a similar amount of trust to current practicing physicians. As it may be tempting to use a physician that knows all medical information shared between man, we have never seen a need to have that level of knowledge with human physicians. A potential drawback of that level of knowledge is making incorrect associations with abstract or incorrect data that is no longer relevant to our level of understanding. An absolute trust in this type of technology, or even a person considered an authority on a subject, can be as much of a problem or worse then the issues they try to correct. Computer systems that run such services can be targeted for data manipulation, theft or even be used in terrorist attacks. Such technology should be developed and used with the mindset of being a valuable tool.

**Considerations for breakthroughs**

As with any STEM field, including applications outside of health, never forget who you are and what got you to this point in life. Continue to educate yourself and others about technological advances. Keep an open dialogue to dissenting opinions. Do not turn a blind eye to evil or accept anything morally wrong for monetary gain. Human trafficking, missing people, late term abortion, organized accidents, targeted murders and organ harvesting are things that happen. Your own rights to your body and the rights of incarcerated individuals may all be brought to question someday. Individual businesses or governmental healthcare programs might include clauses that relinquish healthy organs to people who are in need. Organ donor databases might be targeted for people willing to donate their body for another. We are all the same and our positions in life do not allow us to take advantage of another person’s life without expecting the same treatment in return.

Look forward to the future and what we all can do together. Not one of us can figure everything out on our own.

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