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Commentary
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Emerging Ideas for the Medicine of Tomorrow

Kimi Shetty*

KLE's Academy of Higher Education and Research, Jawaharlal Nehru Medical College, Nehru Nagar, Belgaum 590010, India

***Corresponding author:** Kimi Shetty, KLE's Academy of Higher Education and Research, Jawaharlal Nehru Medical College, Nehru Nagar, Belgaum 590010, India, Tel: 8097345284; E-mail: kimishetty05@gmail.com

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Introduction

"Advances in medicine and agriculture have saved vastly more lives than have been lost in all the wars in history." This quote by the famous Carl Sagan cannot be more apt today, when advancements in the medical field are progressing at such a fast pace that keeping track is difficult. There was a time when medicine consisted of treating the disease only through a variety of drugs derived from plants, animals and the earth. They were potent and efficient but not perfect. However, they managed to complete the job at hand. That is to prevent the disease from causing further harm. Most of our medications today still continue to work on this premise. It was about treating a disease, or reducing its adverse effects on the body. Very few medications actually help in cure or prevention of the disease before it can occur.

Then came the technology boom. Suddenly our understanding of biotechnology, nanotechnology and genetics jumped by leaps and bounds. New laboratories opened up, synthetic drugs were produced due to opening up of vast areas of knowledge. We now have drugs made in laboratories as the main source of new medications. The era of development managed to show us how every small manipulation in the chemical structure of a molecule could either increase efficacy or decrease a potent side effect. Armed with this knowledge, we managed to make newer, more efficacious drugs from the same parent molecule. Multiple generations of drugs with modified mechanisms of action came into being. We now have more efficacious insulin, bisphosphonates, corticosteroids, antipsychotics and even oestrogens due to our acute understanding of structure activity relationships. Science did not stop there. It now looked at arenas seldom explored before. Let us delve into the fascinating new world of advances in medicine that could put the imaginative world of science fiction to shame.

Immunotherapy

The role of the immune system in appropriate functioning of the body has been known for decades. However, it is recently that science has learnt how much small changes in immunity can improve protection against the worst diseases known to mankind. Immunotherapy in the field of cancers, where activation of certain immune cells can enable a 'switching on' of the immune response against tumor cells is currently being looked into. For this purpose, inhibitors of CTLA4, PD-1 etc. have been developed with promising results. Targeting the immune system and forcing it to respond to the threat of tumorigenesis is a diverse mechanism that may remove the tumor cell load or eliminate the tumor completely in future.

Epigenetics

Once the genetic code of humans was completely determined, scientists started researching into the different ways in which the code could be manipulated to resist certain diseases. Epigenetics deals with altering DNA methylation, modifying histones that make the fundamental part of the nucleosome through acetylation, methylation, phosphorylation or ubiquitylation and RNA silencing that helps to either 'turn off' an aberrant gene or 'turn on' a non-functional gene so as to prevent disorders that are hereditary and even cure cancers by turning on tumor suppressor genes.

Monoclonal Antibodies

The most trending form of drug today is a monoclonal antibody. There are abundant new forms of these drugs for various illnesses and everyday their numbers along with their indications are growing. A monoclonal antibody is a molecule that is developed with an affinity only to a specific target. The target is usually a marker present on the specific antigen that it is supposed to destroy. Due to its specificity, it only attacks the prespecified target while eliminating the possibility of adverse effects seen with other drugs that also target other cells. This mode of action is now sought after for most diseases like rheumatoid arthritis, bronchial asthma, hepatitis C and even HIV with varying results.

Gene Therapy

The new miracle in the market is gene therapy. It deals with altering the fundamental basis of all life, the genetic code, and eliminating the parts deemed unfit or dysfunctional while ensuring the healthy genes continue to reproduce. Just the idea of this form of therapy has the potential to eliminate all sorts of genetic and hereditary disorders while creating a new form of worry in the form of 'designer babies'. There are already some forms of gene editing technologies in the market like transcription activator-like effector-based nucleases (TALEN), and the clustered regularly interspaced short palindromic repeats (CRISPR/Cas9) system. On the other hand, newer applications of gene therapy like the chimeric antigen T cell receptors have already secured a cure to refractory forms of acute lymphoblastic leukemia and B cell lymphoma. When the ethical and moral dilemmas are evened out, and newer, more efficient techniques are developed, gene therapy has the potential to change the meaning of disease as we know it.

Reverse Pharmacology

Most drugs we know today enter the market after a lengthy process that involves discovering the efficacy of substances in vivo or in vitro, then isolating the active compounds from it and finally identifying the target for the drug. Reverse pharmacology involves identifying the lead compound and its target first, followed by its screening in vitro or in vivo. This has become a popular technique as identifying the target beforehand makes it more likely to manipulate compounds so as to act on that target. Our ever-growing ensemble of technology also now

makes it possible to synthesize drugs that specifically bind to a target protein to destroy, block or enhance their action. Thus, reverse pharmacology is here to stay.

Nanotechnology

The new kid on the block that showed how large things come in small packages, nanotechnology will soon transform the landscape of medicine. There are nanoshells, nanofibers, magnetic nanoparticles, each designed to deliver a certain load of drug to a specific site in the body. Carbon nanotubes and nanodots can be used for detection of cancers or viruses as they would localize around their targets and provide a better quality image on MRI. Gene therapy also uses nanotechnology to transfer plasmid DNA and replace part of a gene. There are also future applications in microsurgery, nanodentistry and even prevention of cardiac diseases by coming into direct contact with thrombi inside blood vessels and dissolving them.

Biologics and Biosimilars

Already in the market and very commonly used are biologic drugs that are made by laboratory advancements and grown from living things. Insulins, vaccines, hormones, blood components and recombinant proteins are just a few examples of how much we already rely on these products. Their counterparts- biosimilars are 'similar' to their original biologics and have been introduced mainly as a way to prevent rising costs from spiralling out of control and ensure that the masses also gain access to these wonder drugs.

These are just a few examples of some fascinating advances in medicine. It is indeed a great time to be alive to observe the huge strides that science and technology have taken. The best part of it all is that we are just getting started. Soon new innovations in medicine will change the face of disease as we see it today and hopefully bring about a new world where disease will be an obscure rarity and health will be enjoyed by all. In the end, we must remember the words said by Francis Bacon: "Surely every medicine is an innovation, and he that will not apply new remedies, must expect new evils."

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