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Mini Review

Role of Biotechnology in Human Health Care

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Abstract

Biotechnology covers a broad spectrum of scientific applications that are applied in many sectors including health and agriculture. It involves the usage of living organisms, or its parts in order to deliver innovative methods of production and create new products e.g. new vaccine production (through disease diagnosis) to avoid disease-attack; genetically modified plants (to develop resistance against various pests); bacteria having the ability to cleaning up oil spills etc. All these features are related to biotechnology that is totally applicable to human health care. In other words, biotechnology related to human healthcare has a tremendous impact on the necessity of patients and their families as it not only revolves around medicines and diagnostics that are produced employing a biotechnological process, but also involve gene and cell therapies, recombinant DNA products, tissue engineered products and controlling environment pollution. Today, the majorities of innovative medicines either produced using biotechnology or through diagnostic products, are made readily available to the society by applying modern biotechnology in their development and/or expansion processes.

Keywords biotechnology, diagnostic, disease, human health

Introduction

Biotechnological applications have become increasingly relevant to human health care with respect to vaccine development, tissue engineered products, diagnosis of various infectious diseases, reduction in pesticide level, environmental pollution etc. [1, 2]. The most commonly used biotechnological methods or techniques that are related to reduce or control the burden of various infectious diseases, chemical exposure and pollution are crucially needed for human health care and are sensitive, safe and reproducible including the assessment of tremendous number of samples [3]. Recently, vaccines have been mentioned as weapons of mass protection, while most of the vaccine preventable diseases remain predominant because of economic barriers.

Before the development and wide use of human vaccines, most of the people lived their childhood with encountering a litany of diseases like measles, rubella, chickenpox, whooping cough, and rotavirus diarrhoea. In addition to these universal diseases of childhood, lakhs of children all over the world are suffering from the life threatening episodes of paralytic poliomyelitis, diphtheria, or bacterial meningitis (*Haemophilus influenzae* or *Streptococcus pneumonia*). In this regard, people concerns about their safety against various diseases and thus, need for vaccine-induced protection have been linked to recent epidemic of vaccine-avoidable diseases such as measles, influenza etc [4, 5]. After the H1N1 influenza pandemic response in 2009-2015 (cases reported in India; number of peoples died) has been disclosed, vaccine safety monitoring became a major priority [6]. As per these requirements, biotechnological based companies have developed vaccines to protect humans against dozens of diseases [7].

Vaccines protect against several acute infectious diseases and the long lasting obstacles of these infections, which range from congenital rubella syndrome to Hepatitis B and Human Papilloma virus related cancers [8]. A number of biotechnological approaches, especially in the late 19^{th} and early 20^{th} century were involved in taking the actual pathogen and killing it (before administration). This was actually done with enormous number of disease samples from plague to polio [9, 10]. Another strategy was to cultivate the micro-organism in media where it was poorly suited to the growth and resulting in to mutations

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that were lowering the virulence of the disease and thus, made it safe to use as vaccine e.g. BCG [11]. In addition, modern biotechnological (genetic) techniques allow us to produce wide-range of specific proteins (using bacteria containing plasmids; small loops of DNA i.e. recombinant protein expression). This allowed vaccines to be made of one or more specific proteins from a pathogen such as Hepatitis B surface antigen (HBsAg) [12]. In contrast, recombinant protein vaccines are unconditionally safer than either killed whole pathogens or live attenuated pathogens; however, more doses are required to achieve protection and immunity [13].

Conventional biotechnological approaches for vaccine production against various diseases are extremely expensive, involving the complex production and delivery methods, with high costs of fermentation and purification systems and additional tariff associated with adjuvant (immune enhancing properties), cold storage, transportation and sterile delivery [14, 15]. There is a demand for new biotechnological approaches associated with the adjuvant potential for easy scale-up to create massive quantities of vaccine and directly targeted to the induction of specific cell-mediated responses, in addition to antibodies. In this case, special types of adjuvants or immunopotentiators (natural plant based or structurally modified) are needed to elicit adequate immunity i.e. to enhance both humoral and cell mediated immune response. The exact role of vaccine adjuvants is to enhance the production of T-cell (cell mediated) responses by targeting innate immune cells i.e. Toll-like receptors (TLR), with the additional benefits of less antigen doses and fewer administrations requirement. In addition, adjuvants can be classified (on the basis of physical as well as chemical properties) but most of the compounds continually have dissimilar immune-modulating capacities e.g. Saponin variants may diverge in their efficiency to energizing Th1- or Th2-type immunity [14, 15].

Aluminum salts or alum (especially in the form of hydroxide) have been used as an adjuvant to boost the effectiveness of many vaccine antigens [14, 15]. In view of this, another adjuvant, monophosphoryl lipid A (MPL; GlaxoSmithKline), has been approved for human use in the United States, to boost the antibody response of some of its vaccines [16]. Instead of these vaccines, there are number of biotechnology derived health products for human public health as mentioned in the next section.

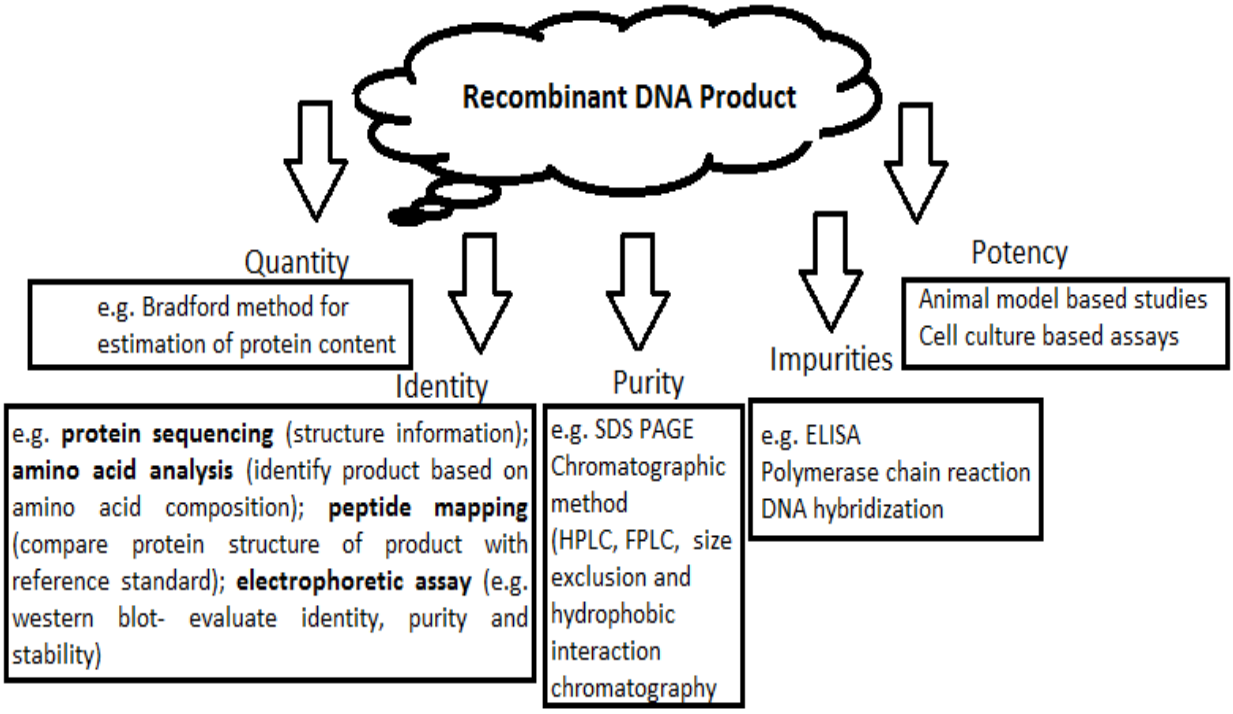

Figure 1: Methods used for the analysis of recombinant DNA products

Recombinant DNA (rDNA) technology has made a wide ranging influence in the area of human healthcare by legalizing the mass production of safe, pure and effective rDNA expression products. Currently, several categories of rDNA products i.e. hormones (for therapeutic use); haemopoietic growth factors; blood coagulation products; thrombolytic agents; anticoagulants and therapeutic enzymes are being produced using rDNA technology for human use [17, 18]. Analytical methods play a vital role in the determination or confirmation of identity, purity and potency of rDNA products with respect to safe and efficacious medicine for human use. A summary of the analytical methods used in analysis of products is illustrated in Fig 1.

Tissue engineered products (e.g. bone grafts; heart valves; xenografts and collagen agents used in gene therapies) have played a major role in the area of biotechnology which includes various biological substitutes that will maintain, restore and improve the tissue functions (animal or human) following the damage through various diseases [19]. Other more complex applications like substitution of heart valves, blood vessels or nerve tissue are under establishment. The principle techniques and source of tissue engineering products are shown in Fig.2.

For the past few years, a lot of progress in the field of animal and human disease diagnosis has been made and this has been brought by the advances in the area of diagnostic biotechnology i.e. diagnosis is now rapid, precise, less expensive and allows a broader range of epidemiological surveillance [20, 21]. In other words, biotechnology has played a key role in the identification of various infectious diseases that requires rapid, sensitive, specific and confirmatory recognition of pathogen.

Formerly, conventional systems of disease diagnosis, observation, treatment and monitoring of control programs were partially successful. The approaches that were commonly adopted included identification (causative agent isolated from pathogen) of samples collected after clinical observations and serological techniques (i.e. agglutination, precipitation, complement fixation and virus neutralization) in combination with the clinical observations [21, 22].

In addition, following are the biotechnological methods that have been used in the detection of proteins, nucleic acids, antigens and antibodies including proteomics (Fig.3). The role of biotechnology in reducing pesticide residues involves the development of plant varieties exhibiting tolerance or resistance to the pests [23]

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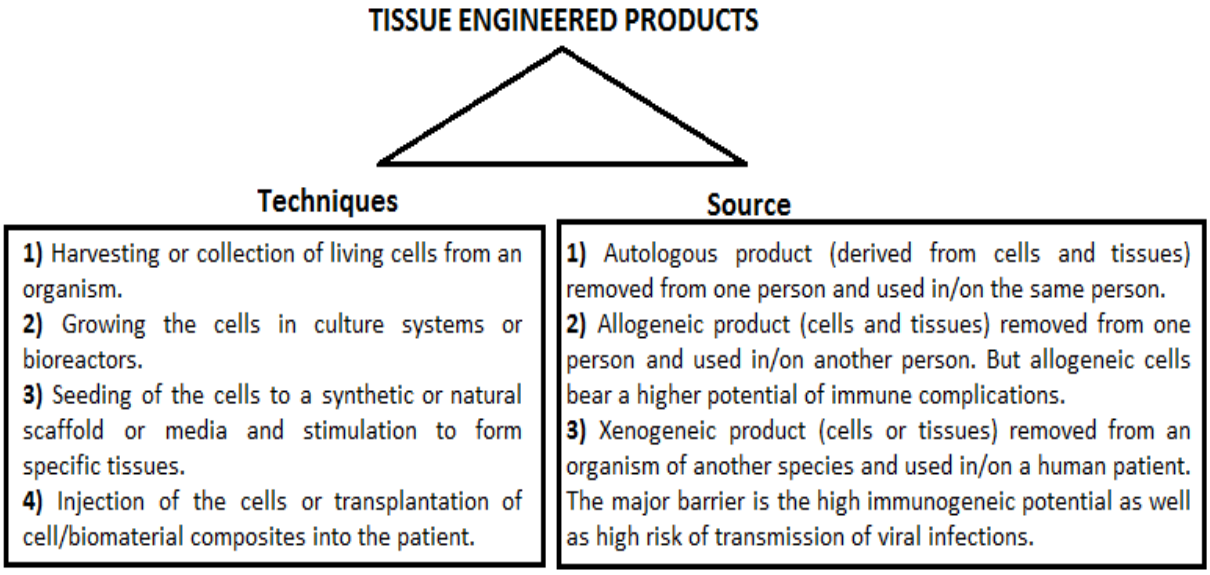

Figure 2: Techniques and source of tissue engineered products

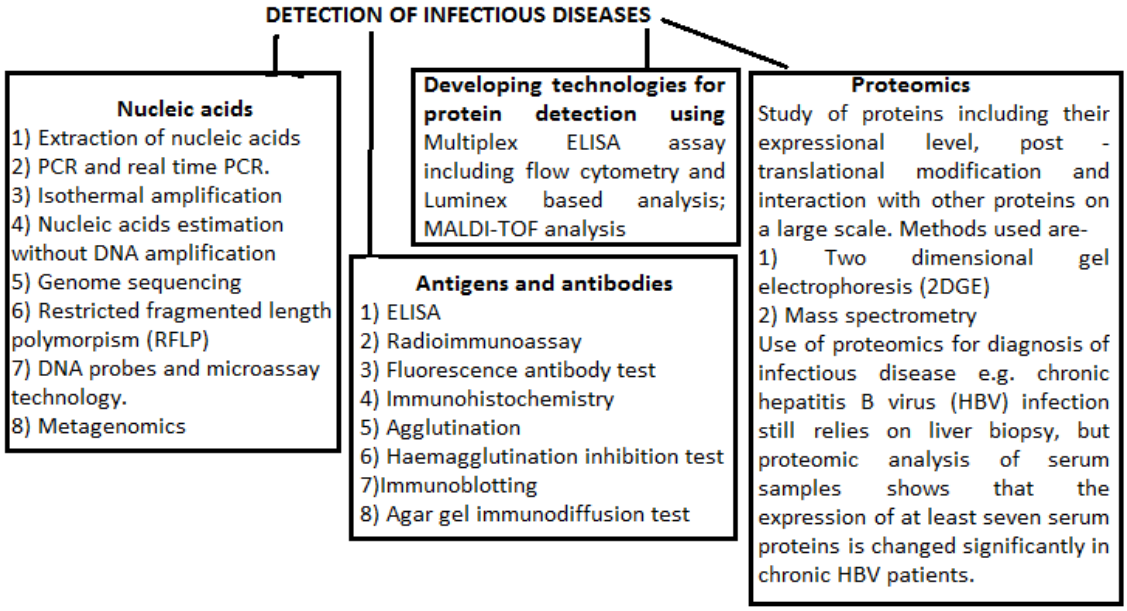

Fig.3. Detection of infectious diseases through recent advances areas of Biotechnology

The result is the elimination or reduction in the need for certain pesticides. These pesticides are slowly damaging our environment including human health. Lot of research work has already been done on pesticides that are responsible for causing diseases like cancer, Alzheimer's disease and even birth defects. In addition, these pesticides also showed some effect on our nervous system, reproductive system and endocrine system [23, 24]. In contrast, the use of biotechnological agents is becoming an important alternative to use various chemicals (biotechnologically derived) for controlling insects and weeds. In addition, in most of the developing countries, farmers face the challenges of high cost of chemical inputs to screen and regulate the fungal diseases [25].

Controlling the environmental pollution and the conservation of environment are some of the major areas that are major concern for all the countries around the world. In this regard, significance and seriousness of biotechnological techniques has to be thoroughly evaluated and utilization of biotechnology derived products that interact with other environmental factors should be properly checked [26]. A number of researchers have expressed dangerous alarm on the release of genetically engineered organisms in the atmosphere and have emphasized thorough investigation and proper risk evaluation of these organisms before transmitting them in to the environment [27]. In contrast, the effect of effluents from various biotechnological companies is also a cause of concern for everyone. So, biotechnology companies should think about the safety after using the biotechnological products. Efforts should be made to use biotechnology to conserve the natural resources. In recent years, biotechnological efforts have been made to create genetically engineered microorganisms to enhance bioremediation [28]. In addition, fermentation technologies showed some serious environmental implications [29]. Several biotechnological procedures have been developed in which all nutrients instigating for fermentation are retained in the final product, which ensures high conversion efficiency and low environmental impact.

Conclusion

Modern biotechnology has been focusing on human health care for decades related to drug development, medical treatment, diagnosis of various diseases, genetically modified foods and crops, gene therapy etc. Apart from this, human genome project was also a part of biotechnology and expecting to decode the whole genome of humans and should be able to replace the defective gene from the genome. Finally, all these techniques or methods related to biotechnology have made a huge progress in recent

years. However, still major efforts are required by scientists to explore new vaccines, drugs, genetically modified crops and resistance against various pests through various biotechnological approaches.

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