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Recombinant DNA Technology: A Short Communication

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Abstract

Recombinant DNA (rDNA) molecules are DNA molecules formed by laboratory methods of genetic recombination (such as molecular cloning) to bring together genetic material from multiple sources, creating sequences that would not otherwise be found in biological organisms. Recombinant DNA is possible because DNA molecules from all organisms share the same chemical structure. They differ only in the nucleotides sequence within that identical overall structure. Through rDNA technology is used to produce an effective and safer production of both live and killed vaccines with increase response and high specificity. Recombinant DNA technology approach is the identification of that protein component of virus or microbial pathogen which itself can elicit the production of antibodies having capacity to neutralize infectivity, potentially protecting the host against the pathogen. Such proteins are useful for identification of the gene coding the protein.

Keywords: Recombinant DNA; Gene therapy; Antibodies; Applications

Introduction

The term biotechnology is a fusion of biology and technology. The area is multidisciplinary, vast and highly divergent, which has made a precise definition of the subject rather difficult.

It is basically the controlled use of biological agents, such as microorganisms or cellular components for human beneficial use. It is the integrated use of biochemistry, microbiology and engineering sciences in order to exploit microorganisms, cultured tissues/cells, to their best [1,2]. Man has continued his quest for improving the natural capabilities of microorganisms and making them capable of novel processes and to create them for highly valuable cause, for human welfare. Years ago, people exploited micro-organisms for making bread, brewing alcohol and cheese production, although the phenomenon of fermentation was not understood thoroughly. Now, the extent of biotechnological application is more sophisticated. Researchers can manipulate living organisms and transfer genetic material between organisms, generating transgenics (plants/animals). The current applications of biotechnology are predominantly practiced in the field of agriculture and medicine. Modern techniques allow production of new and improved foods. Insect resistant crops have been developed using recent advances in biotechnology [3,4,5]. In the field of medicine, it has resulted in development of newer antibiotics, vaccines for various diseases such as cancer, AIDS, hereditary diseases such as Huntington's chorea etc. Biotechnology is also being applied in the area of pollution control, mining and energy production (biofuel production). Genetically engineered micro-organism and plants are used to clean up toxic wastes from industrial effluents and oil spills.

The spectacular progress and enormous understanding over the past two decades in biological processes at both molecular and cellular level is revolutionized by the advent of recombinant DNA technology or Genetic engineering. This field of science is broadly spawned under modern biotechnology, which is precisely the usage of living organisms to produce improved and valuable products for human consumption [6].

The idea of recombinant DNA was first proposed by Peter Lobban, a graduate student of Prof. Dale Kaiser in the Biochemistry Department at Stanford University Medical School [7]. The first publications describing the successful production and intracellular replication of recombinant DNA appeared in 1972 and 1973. Stanford University applied for a US patent on recombinant DNA in 1974, listing the inventors as Stanley N. Cohen and Herbert W. Boyer; this patent was awarded in 1980. The first licensed drug generated using recombinant DNA technology was human insulin, developed by Genentech and Licensed by Eli Lilly and Company Recombinant DNA (rDNA) molecules are DNA molecules formed by laboratory methods of genetic recombination (such as molecular cloning) to bring together genetic material from multiple sources, creating sequences that would not otherwise be found in biological organisms. Recombinant DNA is possible because DNA molecules from all organisms share the same chemical structure [8,9,10].

Application of Recombinant DNA

Vectors in gene therapy

A recombinant virus is a virus produced by recombining pieces of DNA using recombinant DNA technology. This may be used to produce viral vaccines or gene therapy vectors.

Viruses

All viruses bind to their hosts and introduce their genetic

material into the host cell as part of their replication cycle. Therefore this has been recognized as a plausible strategy for gene therapy, by removing the viral DNA and using the virus as a vehicle to deliver the therapeutic DNA. A number of viruses have been used for human gene therapy, including retrovirus, adenovirus, lentivirus, herpes simplex virus, vaccinia, pox virus, and adeno-associated virus [11,12,13].

Gene therapy

It has important implications in treatment of acquired and genetic diseases, cancer and possibly AIDS. It is classified into two types:

Germ line gene therapy: Germ cells (sperm or eggs) are modified by the introduction of functional genes. Therefore, the change is heritable and will be passed on to the later generations. This is theoretically highly effective in treating genetic disorders but this option is not considered at present for application in human beings for a variety of ethical reasons.

Somatic gene therapy: The gene is introduced only in somatic cells but it is not herited as germline is not involved. Somatic gene therapy is further divided into two groups: The first one where the functional gene is introduced in addition to the defective gene endogenously that is the modified cell contains both the defective as well as the normal (introduced) copies of the gene. This is called as augmentation therapy. The second is targeted gene transfer, which uses homologous recombination to replace the endogenous gene with the introduced functional gene [14].

Recombinant Antibodies

Developments in the fields of bacterial expression of functional antibodies and methods to select genes from a library by using the phenotype of the encoded polypeptide have been a breakthrough in antibody technology. Today, phage display in combination with antibody gene libraries is widely used to select E. coli host cells that express desired antibody fragments. Such gene libraries are typically produced either from natural sources (e.g., from the spleen of an immunized animal or from plasma cells of human donors) or generated by genetic engineering. The latter has been used to create naïve libraries based on one or more antibody VH and VL gene segments that are diversified by cassette mutagenesis or similar approaches. Such libraries are typically unbiased and can be used for any given antigen [15].

A vast majority of applications of environmental biotechnology use naturally occurring microorganisms (bacteria, fungi, etc.) to identify and filter manufacturing waste before it is introduced into the environment. Bioremediation program involving the use of microorganisms are currently in progress to clean up contaminated air, tracks of land, lakes and waterways. Recombinant technology helps in improving the efficacy of these processes so that their basic biological processes are more efficient and can degrade more complex chemicals and higher volumes of waste materials. Recombinant DNA technology also is being used in development of bioindicators where bacteria have been genetically modified as 'bioluminescors' that give off light in response to several chemical pollutants. These are being used to measure the presence of some hazardous chemicals in the environment. Other genetic sensors that can be used to detect various chemical contaminants are also undergoing trials and include sensors that can be used to track how pollutants are naturally degrading in ground water. For example when gene such as the mercury resistance gene (mer) or the toluene degradation (tol) gene is linked to genes that code for bioluminescence within living bacterial cells, the biosensor cells can signal extremely low levels of inorganic mercury or toluene that are present in contaminated waters and soils by emitting visible light, which can be measured with fiber-optic fluorometers [16].

Future Perspectives

The future of rDNA products as a human therapeutic is looking good. More than 110 companies are involved in discovery, development and marketing of rDNA products. With the use of rDNA technology three major products has been developed. Insulin determir (Latus, Novo Nordisk, Begsvard, Denmark) for diabetes; calcitonin, for treating osteoporosis (Unigene Laboratories, Fairfield, NJ, USA) and palifermin, a keratinocyte growth factor used for treating mucosites (Amgenwoodland Hills, CA, USA) are undergoing FDA review.

Recent advances in biotechnology have created many legal issues, particularly under the patent system. Patent represents one of several types of intellectual properties; their ownership confers the right to exclude others from benefitting from the tangible products of a proprietary subject matter. The discovery and initial characterization of any rDNA product of potential therapeutics application are followed by its patenting. The normal duration of a patent is 20 years, which starts from the date of filing. Thus the timing assumes importance in terms of the duration for marketing of a product. If the patent is filed too early, the window of opportunity to market the product as well as the size of the market will be smaller. The Biotech Industry Guide would be useful for industrial approval, regulatory clearance to rDNA product and bio safety aspects [17,18,19]. It would also provide help to scientists in obtaining patents on their inventions in India.

References

1. Cederbaum SD, Fareed GC, Lovett MA, Shapiro LJ. Recombinant DNA in medicine. West J Med. 1984;141(2):210-22.
2. Griffiths AJF, Gelbart WM, Miller JH, Lewontin RC. Modern Genetic Analysis. 7th edn. New York: W. H. Freeman;1999.
3. Hughes S. Making dollars out of DNA The first major patent in biotechnology and the commercialization of molecular biology. Isis. 2001;92(3):541–575.
4. Hoet RM, Cohen EH, Kent RB, Rookey K, Schoonbroodt S, Hogan S, et al., Ladner RC. Generation of high-affinity human antibodies by combining donor-derived and synthetic complementarity determining- region diversity. Nat.Biotechnol. 2005;23,344–348. doi:10.1038/nbt1067.
5. Hoogenboom HR, deBruine AP, Hufton SE, Hoet RM, Arends JW, and Roovers R C. Antibody phage display technology and its applications. Immuno technology. 1998;4(1):1–20. doi:10.1016/S1380-2933(98)00007-4.

6. D A. Jackson, Symons R H, Berg P. Biochemical method for inserting new genetic information into DNA of Simian Virus 40: Circular SV40 DNA molecules containing lambda phage genes and the galactose operon of Escherichia coli. Proc Natl Acad Sci. 1972;69(10):2904–2909.

7. Kayser O, Müller RH. A Primer on Pharmaceutical Biotechnology and Industrial Applications. Pharmaceutical Biotechnology, Drug Discovery and Clinical Applications. 7th ed. Wiley-VCH-Weinheim. 2005.

8. Knappik A, Ge L, Honegger A, Pack P, Fischer M, Wellnhofer G, et al,. Fully synthetic human combinatorial antibody libraries (HuCAL) based on modular consensus frameworks and CDRs randomized with trinucleotides. J Mol Biol. 2000;296(1):57–86.

9. Lobban P Kaiser A. Enzymatic end-to end joining of DNA molecules. J Mol Biol. 1973;78(3):453–471.

10. Miller JA Jr, Nagarajan V. The impact of biotechnology on the chemical industry in the 21st century. Trends Biotechnol. 2000;18(5):109-191.

11. Lear J. Recombinant DNA: The Untold Story. 1st Ed. New York: Crown Publishers. 1978.

12. Yongjie Huang, Jan Mrazek. Assessing Diversity of DNA Structure-Related Sequence Features in Prokaryotic Genomes. DNA Res. 2014;21(3):285-297. doi:10.1093/dnares/dst057.

13. Amit Vashishth, Nimisha Tehri. 2015. The role of recombinant DNA technology for human welfare. International journal of research in biological Sciences. 2015; 5(4):35-39.

14. Soderlind E, Strandberg L, Jirholt P, Kobayashi N, Alexeiva V, Aberg AM, et al,. Recombining germline-derived CDR sequences for creating diverse single-framework antibody libraries. Nat Biotechnol. 2000;18(8):852–856.

15. Siegel DL. Recombinant monoclonal antibody technology. Transfus clin Biol. 2002;9(1):15–22.

16. Schmitz U, Versmold A, Kaufmann P, Frank HG. Phages display a molecular tool for the generation of antibodies-a review. Placenta. 2000;21:106–112.

17. Thomas PZ. 2006. Use of Genetically Modified Stem Cells in Experimental Gene Therapies. Regenerative Medicine. 2006;(1)1:45-52.

18. Jineetkumar Gawad, Bhakti Chavan, Pradeep Bawane, Amol Mhaske, Savita Tauro. Overview of Cell Signalling and Cell Communication. Journal of Pharmaceutical Biology. 2015;5(2):104-107.

19. Miki Okuno, Rei Kajitani, Rie Ryusui, Hiroya Morimoto, Yukiko Kodama, and Takehiko Itoh. Next-generation sequencing analysis of lager brewing yeast strains reveals the evolutionary history of interspecies hybridization. DNA Research. 2016;23(1):67–80.