Review Article

DNA probe

N. C. Indhu Rekka[1], R. Sarah Sathiyawathie[1]*, Deepa Gurunathan[2]

ABSTRACT

Due to the essentials of modern science in various fields, especially in medicine, DNA technology, there is an increased scope for the identification of various tools. DNA probes are stretches of single-stranded DNA used to detect the presence of complementary nucleic acid sequences (target sequences) by hybridization. DNA probes are usually labeled, for example, with radioisotopes, epitopes, biotin, or fluorophores to enable their detection. DNA probe is prepared for commercial purposes and is believed to be the most sophisticated and sensitive means to identify genes or specific DNA sequences. It serves various purposes in different fields of which its use is incredibly essential. The need for various tools is indeed in medical science. It helps to identify specific DNA sequences and genes.

KEY WORDS: Diagnosis, DNA probes, Microbiological assays

INTRODUCTION

DNA probes are small segments of DNA which help to detect the presence of a gene of a long DNA sequence, in a biological system. These DNA probes are prepared for commercial purposes and are believed to be the most sophisticated and sensitive means to identify genes or specific DNA sequences. DNA probes provide commercial avenues for diagnosis of infection diseases, identification of food contaminants for isolation of genes, and in other microbiological tests. It is believed that these DNA probe assays for variety of purposes will be cleaner, simpler, faster, and cheaper than the traditional microbiological tests and are also expected to be 100-fold more sensitive.

PRODUCTION OF DNA PROBES

The production of DNA probes can be done by any of the following methods such as (a) using a template DNA with the help of purified biological enzymes, (b) DNA probe of specific sequence can also be obtained using automated DNA synthesizers, and (c) DNA probe can also be included in viral DNA and may even multiply in bacteria, thus by this way, many copies of DNA probe can be obtained.[1]

Access this article online	
Website: jprsolutions.info	ISSN: 0975-7619

USES OF DNA PROBES

DNA probe is a distinct piece of DNA that differentiates one individual from another. It is designed using DNA from the subject whose DNA is being tested. DNA probes are usually used when scientists need to identify suspects or victims of a crime.[2] A DNA probe is when one strand or a piece of DNA molecule is used in laboratory experiments. This is to search for the availability of a complementary sequence in a combination of different other single-stranded DNA molecules. DNA probe is a chemical, which is applied to pinpoint tested DNA.[3]

APPLICATIONS IN NUCLEIC ACID HYBRIDIZATION

Nucleic acid hybridization with a labeled probe is the only practical way to detect a complementary target sequence in a complex nucleic acid mixture. The probes considered are oligonucleotides or polynucleotides, DNA or RNA, single- or double-stranded, and natural or modified, either in the nucleotide bases or in the backbone. The hybridization products are duplexes or triplexes formed with targets in solution or on solid supports.[4-6] Direct labeling is illustrated with radioactive probes.[7] The indirect labels begin with biotinylated probes as prototypes. Reporter groups considered include radioactive, fluorescent, and chemiluminescent nucleotides, as

[1]Department of Research, Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India, [2]Department of Pathology, Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India

***Corresponding author:** Dr. R. Sarah Sathiyawathie, Department of Research, Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences, Saveetha University, 162, Poonamallee High Road, Chennai - 600 077, Tamil Nadu, India. Phone: +91-9884156513. E-mail: dr.sarahrobin@gmail.com

Received on: 12-09-2018; Revised on: 22-11-2018; Accepted on: 17-01-2019

well as enzymes with colorimetric, fluorescent, and luminescent substrates.[8,9]

USES IN MICROECOLOGY

Within the field of microbial ecology, oligonucleotide probes are used to determine the presence of microbial species, genera, or microorganisms classified on a more broad level such as bacteria, archaea, and eukaryotes through fluorescence *in situ* hybridization. rRNA probes have enabled scientists to visualize microorganisms, yet to be cultured in laboratory settings, by retrieval of rRNA sequences directly from the environment.[10] Examples of these types of microorganisms include (i) Nevskia ramosa[11] and (ii) Achromatium oxaliferum.[12]

DIAGNOSTIC APPLICATIONS OF DNA PROBE

The potential advantages of these DNA probe assays in the diagnosis of infectious diseases include rapid detection and identification of infectious agents; the ability to screen selected specimens using batteries of probes; and the detection of non-viable or difficult-to-culture organisms.[13,14] The potential disadvantages of DNA probe assays include the use of isotopic detection methods for optimum sensitivity; limited diagnostic sensitivity of current assays; slow turnaround time for some assay formats; expense of current reagents; limited availability of many probes; lack of technical expertise in most diagnostic laboratories; and the requirement for antimicrobial susceptibility testing (requires culture).[15]

USES OF DNA PROBE TO TYPE ENVIRONMENTAL BACTERIA

Members of the genus *Aspergillus* are among the most widespread fungi in the environment, being found in the soil, on plants, in dust, on food, and in the air.[16,17] Most reported cases of cutaneous aspergillosis have been caused by *Aspergillus fumigatus*, but a number have been associated with *Aspergillus flavus*, the second most common etiologic agent of human aspergillosis.[18] The evidence incriminating different environmental sources of *A. flavus* infection has always been circumstantial Due to the difficulty in tracing the particular subspecific strains, with molecular typing being of recent advancement.[19,20] Among the typing methods that have been applied to *A. flavus* are restriction endonuclease analysis and the detection of restriction fragment length polymorphisms by Southern hybridization and probing with ribosomal or other repetitive sequences. The implications of this study underscore the need to avoid the use of such non-sterile items in hospital units housing patients at high risk for the development of invasive fungal infections. In particular, a policy regarding the use of sterile medical supplies by hospital staff, including ambulance transport teams, to avoid this type of exposure should be considered when managing high-risk neonates.[21-23]

DNA PROBES IN DENTAL PRACTICE

In clinical microbiology, molecular genetic techniques are increasingly being used to detect and/or differentiate uncultivable, anaerobic, or fastidious microorganisms. During the past decade, DNA probe hybridization and *in vitro* amplification by polymerase chain reaction have also been introduced to detect oral pathogens. The present review describes experiences with methods and commercial test systems for the detection of pathogens in periodontitis and caries.[24] Thus, additional targets for DNA probe detection can be found in the dental practice. They are the periodontal pathogens such as *Actinobacillus actinomycetemcomitans*, Bacteroides forsythus, *Porphyromonas gingivalis*, *Prevotella intermedia*, *Treponema denticola*, and caries agents, namely *Streptococcus mutans* group species. In fact, due to the high prevalence of periodontal diseases and caries, oral infections are a main indication for DNA probe application.[25,26]

As was mentioned above, German dentists are confronted with various genetic test systems for periodontal pathogens. With this in mind, we performed a survey among practitioners. Among the ~50,000 dentists practicing in Germany, 3–6% (only) specialized in the diagnosis and treatment of periodontitis and were thus chosen to report their experiences. The 100 most experienced practices (according to data from LCL Biokey) were contacted for a statement, and 32 responses were received.[27]

CONCLUSION

Necessity is the need of invention. Many modern tools are replaced to the conventional ones. These tools are indeed necessary for development in modern science. Despite the availability of various tools, invention of newer tools, devices or instrument are of great demand to study and transform the field of medical science.

REFERENCES

1. Vasavirama K. Molecular probes and their applications. Int J LifeSc Bt Pharm Res 2013;2:32-42.
2. Blackburn GF, Haresh P,CLIN.CHEM.37/9, 1991;1534-9.
3. Amann R, Ludwig W. Ribosomal RNA-targeted nucleic acid probes for studies in microbial ecology. FEMS Microbiol Rev 2000;24:555-65.
4. Wetmur JG. DNA probes: Applications of the principles of nucleic acid hybridization. Crit Rev Biochem Mol Biol 1991;26:227-59.
5. Saiki RK, Celfand DH, Stoffel B, Scharf SJ, Higuchi R, Horn GT, *et al*. Primer-directed enzymatic amplification of DNA with a thermostable DNA polymerase. Science.

1988;239:487.
6. Wong DM, Weinstock PH, Wetmur JG. Branch capture reactions: Displacers derived from asymmetric PCR. Nucleic Acids Res 1991;19:2251.
7. Cullen BR, Bick MD. Thermal denatur-of DNA from bromodeoxyuridine substituted cells. Nucleic Acids Res 1976;3:49.
8. KaUenbach NR. Theory of thermal transitions in low molecular weight RNA chains. J Mol Biol 1968;37:445.
9. Braunlin WH, Bloomfield VA. HNMR study of base-pairing reactions of d(GGAATTCC): Salt effects on the equilibria and kinetics of strand association. Biochemistry 1991;30:754.
10. Amann R, Ludwig W, Schleifer KH. Phylogenetic identification and *in situ* detection of individual microbial cells without cultivation. Microbiol Rev 1995;59:143-69.
11. Glöckner FO, Babenzien HD, Amann R. Phylogeny and identification *in situ* of *Nevskia ramosa*. Appl Environ Microbiol 1998;64:1895-901.
12. Glöckner FO, Babenzien HD, Amann R. Phylogeny and diversity of *Achromatium oxaliferum*. Syst Appl Microbiol 1999;22:28-38.
13. Pfaller MA. Candida species: Emerging hospital bloodstream pathogens. Infect Control Hosp Epidemiol 1991;12:103-10.
14. Cancrini G, Iori A. Traditional and innovative diagnostic tools: When and why they should be applied. Parassitologia 2004;46:173-6.
15. Bryce EA, Walker M, Scharf S, Lim AT, Walsh A, Sharp N, *et al*. An outbreak of cutaneous aspergillosis in a tertiary-care hospital. Infect. Control Hosp Epidemiol 1996;17:70-2.
16. Priya S, Don KR. Diagnostic advantages of DNA probe. Drug Invent Today 2019;12:189-92
17. Chazalet V, Debeaupuis JP, Sarfati J, Lortholary J, Ribaud P, Shah P, *et al*. Molecular typing of environmental and patient isolates of *Aspergillus fumigatus* from various hospital settings. J Clin Microbiol 1998;36:1494-500.
18. Girardin H, Sarfati J, Kobayashi H, Bouchara JP, Latgé JP. Use of DNA moderately repetitive sequence to type *Aspergillus fumigatus* isolates from aspergilloma patients. J Infect Dis 1994;169:683-5.
19. Mitchell SJ, Gray J, Morgan ME, Hocking MD, Durbin GM. Nosocomial infection with *Rhizopus microsporus* in preterm infants: Association with wooden tongue depressors. Lancet 1996;348:441-3.
20. Tyler KD, Wang G, Tyler SD, Johnson WM. Factors affecting reliability and reproducibility of amplification based DNA fingerprinting of representative bacterial pathogens. J Cli. Microbiol 1997;35:339-46.
21. Moody SF, Tyler BM. Use of nuclear DNA restriction fragment length polymorphisms to analyze the diversity of the *Aspergillus flavus* group: *A. flavus*, *A. parasiticus*, and *A. nomius*. Appl Environ Microbiol 1990;56:2453-61.
22. Singer S, Singer D, Ruchel R, Mergeryan H, Schmidt U, Harms K. Outbreak of systemic aspergillosis in a neonatal intensive care unit. Mycoses 1998;41:223-7.
23. Papouli M, Roilides E, Bibashi E, Andreou A. Primary cutaneous aspergillosis in neonates: Case report and review. Clin Infect Dis 1996;22:1102-4.
24. Slots J, Rams TE. New views on periodontal microbiota in special patient categories. J Clin Periodontol 1991;18:411-20.
25. Rupf S, Merte K, Eschrich K. Quantification of bacteria in oral samples by competitive polymerase chain reaction. J Dent Res 1999;78:850-6.
26. Herzberg MC, Weyer MW. Dental plaque, platelets, and cardiovascular diseases. Ann Periodontol 1998;3:151-60.
27. Conrads G. Testing for marker bacteria in progressive periodontitis: The European experience. Infect Dis Clin Pract 2002;10:481-7.

Source of support: Nil; Conflict of interest: None Declared