Medically Important Bacterial Infections Molecular Diagnostics

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Abstract

Infectious diseases are widespread over the globe. According to a recent World Health Organization report, infectious diseases are now the leading cause of death among children and young adults worldwide. In non-industrialized countries, infectious illnesses caused 45 percent of all deaths and 63% of deaths in early childhood. The development of novel, rare, or long-forgotten infectious diseases in affluent countries, such as HIV/AIDS, Lyme disease, and tuberculosis, has piqued public attention and sparked commitments to surveillance and control. According to recent reports, infectious diseases cause more than 17 million fatalities worldwide each year, the most of which are caused by bacterial infections. As a result, controlling infectious diseases remains a critical duty around the world. Diagnostic medical bacteriology is divided into two categories. There are two types of diagnostic medical bacteriology. Identification and type are two components. Medical bacteriology diagnostics is divided into two categories. Identification and type are the two components. Molecular biology has the capacity to transform the way we live. Diagnostic tests are performed in order to improve patient care. They occur in a hospital or in the neighbourhood. Since the invention of PCR in the 1970s, in the late 1980s, there was a huge amount of research was done that allowed for the introduction application of molecular assays to a variety of clinical scenarios microbiology. Molecular biology is still being used. Many people have found it difficult to keep up with the quick changes. Before deciding which test to use, technology will become obsolete.

Keywords: Diagnostic medical bacteriology • Molecular biology • Diagnostic assays • Diagnostic laboratory

Introduction

Following the cellular and protein period of the 1970s and 1980s, the last ten years of the twentieth century saw an exponential development in knowledge of molecular biology techniques. This technological explosion in molecular biology has had far-reaching repercussions, allowing significant advancements in a wide range of life sciences fields, including bacteriology. General molecular biology approaches are now being used by molecular bacteriologists to support their specific area of interest. This chapter examines the present state of molecular biology techniques in medical bacteriology, with a focus on the molecular identification of bacterial infection causative agents [1]. The chapter also seeks to provide a broad overview of current technology's applications so that the reader has a better understanding of the wide range of techniques accessible, both as research tools and in everyday situations. The managerial, financial, labour and space requirements of adopting molecular diagnostics will be examined. This chapter discusses the evolution of laboratory diagnosis of infectious diseases, as well as current understanding, literature, and recommendations. This review focuses on medically significant bacterial infections [2].

Historical considerations

In 1676, Anton van Leeuwenhoek, a Dutch cloth merchant and amateur lens grinder, used a rudimentary microscope to study living microorganisms, which he dubbed "animalcules." He looked for "animalcules" in many places, including pond water, sick individuals, and even his own mouth, and discovered that they were everywhere. In spherical, rod, and spiral forms, he described and recorded all of the primary types of microorganisms: protozoa, algae, yeast, fungi, and bacteria. His discoveries opened up a new realm, the microbial world, and this was the first milestone in diagnostic microbiology's history. Although the Roman physician Girolamo Fracastoro proposed in 1546 that disease was caused by invisible living creatures, people did not clearly recognise the role of microorganisms in diseases until 1876, 200 years after Leeuwenhoek discovered his little "animalcules," when German physician Robert Koch established his famous "Koch's postulates" based on the relationship between Bacillus anthracis and anthrax [3].

Koch's postulates include the following:

- To prove that a certain bacterium is the cause of a specific disease, the microbe must be discovered in all cases of the condition.
- This microorganism must then be entirely removed from the afflicted body and cultured in a pure culture outside of it.
- This pure culture must be capable of infecting healthy animals with the illness via inoculation.
- The identical microorganism should be extracted from the infected animals and cultured in a pure culture outside of the body.

Koch was a pioneer in medical microbiology, and his theories are still regarded foundational in bacteriology. Infectious diseases can spread through populations, causing epidemics or even pandemics. Some epidemic or pandemic diseases are so dangerous that they can kill hundreds of thousands, if not millions, of people. For example, bubonic plague, caused by Yersinia pestis, moved from Asia to Europe via the Black Sea ports, killing 42 million people, 25 million of them were in Europe, in just over four years between 1347 and 1352, decreasing Europe's population to 50 million people.

Tuberculosis was going to make an appearance. Bunyon's moniker, "The Captain of the Men of Death," expresses the enormous fear that the disease was linked with, even up to the present day. It was recognised and feared until the current age as one of life's most common and dangerous perils, from which escape was nearly impossible. During this period, Jean François Fernel, a well-known Renaissance physician, was conducting some groundbreaking research on the circulatory system. In his work Medicini, Fernel recounts a variety of clinical illnesses, including some of the earliest recorded examples of endocarditis [4]. When compared to traditional detection methods, which have been evolving for over a century, molecular detection technologies are very new, having only been around for about 20 years. Despite the fact that deoxyribonucleic acid, or DNA, was discovered in the late 1860s, it was not exploited until the 1970s, when restriction enzymes and recombinant DNA procedures were developed. Many scientists worked hard at this time to solve the profound enigma of DNA. We should remember certain pioneers and their findings to trace the history of molecular detection technologies. In the nuclei of human white blood cells, Johann Friedrich Miescher, a Swiss physician, discovered a mildly acidic substance of unclear purpose in 1869 [5]. This substance was eventually termed deoxyribonucleic acid, or DNA. For nearly a century, the material was generally neglected since it appeared to be too basic to serve any significant purpose. In 1949, a biochemist named Erwin Chargaff found that DNA composition was species specific, meaning that the amount of DNA and its nitrogenous bases differed from one species to the next.

Furthermore, Chargaff discovered that in DNA from all species, the amount of adenine equaled the amount of thymine, and the amount of guanine equaled the amount of cytosine. Scientists learned that chromosomes, which were previously thought to contain genetic information, were made up of DNA and proteins around this time. Franklin Griffth, a British medical officer, discovered how to transfer genetic material from heat-killed bacterium cells to live organisms in 1928 [6]. The first evidence that genetic material is a heat-stable chemical came from this event, known as transformation. Griffth's transforming agent was identified as DNA by Oswald Avery, a Canadian physician and bacteriologist, and his collaborators McCarty and Colin MacLeod in 1944. Experiments carried out in the 1940s revealed that DNA appeared to be the genetic material. However, until 1953, when James Watson and Francis Crick discovered the molecular structure of DNA, no one knew what the structure of DNA was or how such a molecule could hold all the information needed to develop a human being or other living species. The first proof that genetic material is a heat-stable chemical came from this event, known as transformation. Griffth's transforming agent was identified as DNA in 1944 by Oswald Avery, a Canadian bacteriologist, and his collaborators McCarty and Colin MacLeod. DNA appeared to be the genetic substance in experiments undertaken throughout the 1940s [7]. However, until 1953, when James Watson and Francis Crick discovered the chemical structure of DNA, no one knew what the structure of DNA was or how such a molecule could hold all the information required to build a human or other living entity. They deduced that it must take the twisted ladder shape of a double helix after developing various size models of probable DNA configurations. A "backbone" of sugar and phosphate molecules makes up the sides of the ladder. On the interior of the helix, the nitrogen-rich bases A, T, G, and C create the "rungs" of the ladder. Base A would only couple with T, while base G would only pair with C, the pair discovered. They shared the Nobel Prize in Physiology or Medicine in 1962 for their discovery, which they shared with Maurice Wilkins, whose work on Xray crystallography with Rosalind Franklin gave more critical evidence. François Jacob and Jacques Monod developed a hypothesis of genetic regulatory mechanisms in 1961, revealing how specific genes are activated and inhibited at the molecular level, and were given the Nobel Prize in Physiology or Medicine in 1962 for their contribution. Marshall Nirenberg, a young biochemist at the National Institute of Arthritis and Metabolic Diseases, discovered the first "triplet" in 1961, which is a sequence of three DNA bases that codes for one of the twenty amino acids that make up proteins [8]. Within four years, the full genetic code had been deciphered. Almost everything about DNA structures and functions was understood in theory by the end of the 1960s, but individuals couldn't get or edit any gene they wanted until the 1970s, when some essential enzymes were discovered [9]. In 1970, an American microbiologist named Hamilton Smith identified the first restriction enzyme, which breaks DNA at a particularly specific nucleotide sequence. Several other restriction enzymes were discovered over the next few years. In 1978, he and Werner Arber and Daniel Nathans shared the Nobel Prize in Physiology or Medicine for their discovery. Paul Berg created the first DNA molecules that integrated genes from many creatures in 1972. The findings of his investigations were essential in the later development of recombinant genetic engineering. Paul Berg, Walter Gilbert, and Frederick Sanger received the Nobel Prize in Chemistry in 1980 for "his foundational investigations of the biochemistry of nucleic acids, with particular relevance to recombinant DNA." Stanley Cohen and Herbert Boyer collaborated in 1973 to build functioning organisms that integrated and replicated genetic information from other species. Their experiments proved the enormous potential of DNA recombinant engineering in medicine and pharmacology, as well as in industry and agriculture. In 1977, Walter Gilbert and Frederick Sanger developed new techniques for rapid DNA sequencing while working separately in the United States and England. Sanger and Gilbert developed technologies that allowed them to read the nucleotide sequence of whole genes ranging in length from 1,000 to 30,000 bases.

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