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Medical Microbiology: Diseases

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Abstract

Antonie van Leeuwenhoek, in 1674, first saw what he called “ammalcules”-bacteria and protozoa in biological samples, including those taken from his own body. Many important developments related to clinical microbiology took place during the latter part of the 19th century. In 1875, F.J. Cohn published an early classification of bacteria, using the genus name Bacillus for the first time. Robert Koch described anthrax in 1876, the culture plate technique in 1881 and the aetiology of tuberculosis in 1884. He was awarded the Nobel Prize for his contributions to medicine in 1905. Joseph Lister demonstrated the isolation of bacteria in pure culture, Louis Pasteur introduced the concept of vaccination with attenuated microorganisms and Paul Ehrlich demonstrated the formation of antibodies, all during the 19th century [1]. Since then, medical microbiology has evolved at an explosive rate (ASM, 1999). A wide variety of emerging pathogens continue to be described as various advances are made in medicine (CDC, webpage). During the last two decades, molecular diagnostic techniques have led to a revolution in our abilities to identify, classify and understand microorganisms. Increasing numbers of diagnostic tests, including those commercially available, are based on molecular techniques. Some enthusiasts predict that they may replace culture as the routine laboratory method of investigation [2].

Microbiology is the science concerned with studying all microorganisms. Medical microbiology restricts this to the microbes that live on the human surface, and those there or elsewhere that may invade human tissues or otherwise cause infectious disease. In a nutshell, medical microbiology involves the diagnosis, treatment and control of human infection [3].

Clinical microbiology has matured into a wide-ranging science, not just a service to process specimens and provide results but also to advise on the collection of specimens, the interpretation of results and management of patients, the selection of antimicrobial agents and in the control of hospital-acquired infections. Conventional pathogens are capable of causing infections in previously healthy people. The organisms isolated from clinical specimens may derive from bacteria and fungi that are permanently living on body surfaces (commensals) or from the environment. Opportunistic pathogens are those that usually do not cause disease in normal people, but may cause serious infections in immune compromised patients. Hence, the significance of laboratory findings will depend on how the specimen was collected and needs to be assessed in the context of the clinical situation. Serious nosocomial infections are often caused by commensals and environmental organisms [4]. A clear distinction between a primary pathogen, a commensal and a contaminant is not always clear-cut. This situation is frequently encountered in immunologically compromised patients. As a result, the liaison between the medical microbiologist and the clinician is of paramount importance to ensure a sensible interpretation of laboratory findings.

Medical microbiology, the large subset of microbiology that is applied to medicine, is a branch of medical science concerned with the prevention, diagnosis and treatment of infectious diseases. In addition, this field of science studies various clinical applications of microbes for the improvement of health. There are four kinds of microorganisms that cause infectious disease: bacteria, fungi, parasites and viruses, and one type of infectious protein called prion [5].

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Introduction

In 1676, Anton van Leeuwenhoek observed bacteria and other microorganisms, using a single-lens microscope of his own design. In 1796, Edward Jenner developed a method using cowpox to successfully immunize a child against smallpox. The same principles are used for developing vaccines today. Following on from this, in 1857 Louis Pasteur also designed vaccines against several diseases such as anthrax, fowl cholera and rabies as well as pasteurization for food preservation [6].

In 1867 Joseph Lister is considered to be the father of antiseptic surgery. By sterilizing the instruments with diluted carbolic acid and using it to clean wounds, post-operative infections were reduced, making surgery safer for patients. In the years between 1876 and 1884 Robert Koch provided much insight into infectious diseases. He was one of the first scientists to focus on the isolation of bacteria in pure culture. This gave rise to the germ theory, a certain microorganism being responsible for a certain disease. He developed a series of criteria around this that have become known as the Koch's postulates.

A major milestone in medical microbiology is the Gram stain. In 1884 Hans Christian Gram developed the method of staining bacteria to make them more visible and differentiated under a microscope [7]. This technique is widely used today. In 1910 Paul Ehrlich tested multiple combinations of arsenic based chemicals on infected rabbits with syphilis. Ehrlich then found that arsphenamine was found effective against syphilis spirochetes. The arsphenamine was then made available in 1910, known as Salvarsan.

In 1929 Alexander Fleming developed the most commonly used antibiotic substance both at the time and now: penicillin. In 1939 Gerhard Domagk found Prontosil red protected mice from pathogenic streptococci and staphylococci without toxicity. Domagk received the Nobel Prize in physiology, or medicine, for the discovery of the sulfa drug. DNA sequencing, a method developed by Walter Gilbert and Frederick Sanger in 1977, caused a rapid change the development of vaccines, medical treatments and diagnostic methods. Some of these include synthetic insulin which was produced in 1979 using recombinant DNA and the first genetically engineered vaccine was created in 1986 for hepatitis B [8]. In 1995 a team at The Institute for Genomic Research sequenced the first bacterial genome; Haemophilus influenzae. A few months later, the first eukaryotic genome was completed. This would prove invaluable for diagnostic techniques.

Disease

Disease can arise if the host's protective immune mechanisms are compromised and the organism inflicts damage on the host. Microorganisms can cause tissue damage by releasing a variety of toxins or destructive enzymes. For example, Clostridium tetani releases a toxin that paralyzes muscles, and staphylococcus releases toxins that produce shock and sepsis. Not all infectious agents cause disease in all hosts. For example, less than 5% of individuals infected with polio develop disease [9]. On the other hand, some infectious agents are highly virulent. The prion causing mad cow disease and Creutzfeldt–Jakob disease invariably kills all animals and people that are infected. Persistent infections occur because the body is unable to clear the organism after the initial infection. Persistent infections are characterized by the continual presence of the infectious organism, often as latent infection with occasional recurrent relapses of active infection. There are some viruses that can maintain a persistent infection by infecting different cells of the body. Some viruses once acquired never leave the body. A typical example is the herpes virus, which tends to hide in nerves and become reactivated when specific circumstances arise. Persistent infections cause millions of deaths globally each year. Chronic infections by parasites account for a high morbidity and mortality in many underdeveloped countries [10].

Conclusion

“Medical Microbiology” is a new addition to the Instant Notes series and although the logic, like that of previous books in the series is to present the information in bite-sized chunks, not necessarily expecting students to start at the beginning and read through, it is still a sizeable volume. This is probably inevitable considering the size of the subject, although one has to say that the whole of Biochemistry fits into 438 pages (but not including Molecular Biology which occupies a separate volume). I suppose this indicates that authors have been given a fairly free remit to express what they think their subject encompasses at the present time. The current authors say that students may find that medical microbiology to be an intimidating subject with a language of its own, covering a range from the molecular biology of infectious agents to the clinical consequences, as well as diagnosis and management. Therefore a considerable volume of material needs to be presented: but even at 350 pages the result tends to be a bit of a list.

As with other books in the Instant Notes series the text comes in short “Sections” (they are not called chapters) of a few pages. Each of these commences with a summary section (a half-page or often more) entitled Key Notes, divided into short paragraphs or sentences with bullet points. I found that reading these gave me a great deal of information — often all I wanted to know — and I didn’t get much extra from reading the ‘Section” itself. I suspect that many students might take this route and one has to admit that this subject area is very information rich and practitioners need to have a lot of information at their fingertips. The book is divided up as follows. The first 43 pages form a general introduction to microbial pathogenesis (including prions). This is followed by extensive sections on, first, viruses, and second, bacteria. There is then a short section (in five parts on ‘Human

pathogens: eukaryotic microorganisms' which includes a section on helminths and parasitic arthropods. These of course are hardly microscopic or "microbes", but I suppose are included for the sake of completeness — and also because some of them are vectors for microscopic pathogens. The last two sections deal with diagnosis, treatment and prevention, including extensive details on antibiotic use, and finally on clinical manifestations. One might have thought that the clinical manifestations should come before diagnosis and treatment, but this section seems to fit quite comfortably where it is. It includes sections on skin, bone, eye, respiratory tract, GIT, urinary and genital tract infections, and pregnancy. Here as elsewhere there is detailed consideration of how to deal with immunocompromised patients. Overall I would say that the coverage is pretty complete at the level intended and the writing is straightforward and easy to read. There are not many diagrams or micrographs of actual organisms, although there are quite a lot of chemical structures (e.g. of antibiotics) and simple line diagrams of laboratory procedures and test results. This may be the result of economy in order to keep the size of the book within reasonable bounds. Nevertheless, many of the descriptions of microorganisms, including comments on their identification, said to be important for diagnosis and treatment, could have been aided by pictures.

Acknowledgement

None

Conflict of Interest

None

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