The ESRF Research Journal for Undergraduate Medical Students

Medical History

Volume 2 Issue 1

2024

DOI: 10.5281/zenodo.13892986

Hans Christian Gram:

The Bacteriologist Who Revolutionized Microbiology

Amitava Chatterjee

Associate Professor, Department of Community Medicine, Midnapore Medical College

Corresponding Author

Dr.Amitava Chatterjee
Associate Professor
Department of Community Medicine
Midnapore Medical College
E-mail: amitava.chatt74@gmail.com

Indexed in:

Google Scholar

BASE Bielefeld Academic Search Engine

Hans Christian Gram, a Danish bacteriologist born on September 13, 1853, in Copenhagen, made a profound impact on the field of microbiology with his groundbreaking discovery of the Gram staining technique. Gram's journey began at the University of Copenhagen, where he initially studied natural sciences and later pursued medicine, earning his MD in 1878. His early career involved working as an assistant in botany and later as a resident physician at the Municipal Hospital of Copenhagen. Gram's academic journey included significant contributions to the understanding of human erythrocytes, where he identified macrocytes as characteristic of pernicious anemia.

In 1891, Gram became a professor of pharmacology at the University of Copenhagen and later transitioned to internal medicine, publishing several influential clinical lectures before his retirement in 1923. He passed away on November 14, 1938, leaving behind a legacy that continues to shape modern microbiology.

THE DISCOVERY OF THE GRAM STAIN

The Gram stain's discovery occurred in 1884 while Gram was working in Berlin with Karl Friedländer, a notable microbiologist known for his work on infectious organisms. At that time, bacteriology was gaining momentum as a scientific discipline, with pioneers like Louis Pasteur laying the groundwork for understanding microbial pathogens. Gram sought to develop a staining method that would enhance the visibility of bacteria in tissue samples, particularly focusing on lung tissues from patients who had succumbed to pneumonia.

In his quest for a reliable staining technique, Gram devised a method that involved using crystal violet as the primary stain, followed by iodine as a mordant and alcohol for decolorization. This innovative approach revealed that certain bacterial cells retained the purple color while others did not. The bacteria that retained the purple stain became known as "Gram-positive," while those that lost the stain and appeared red after being counterstained with safranin were classified as "Gram-negative." This distinction was based on differences in cell wall composition and structure.

Gram's initial publication regarding this staining technique reflected both his scientific rigor and humility. He acknowledged its imperfections but expressed hope that it would be beneficial for other researchers: "I have therefore published the method, although I am aware that it is yet very defective and imperfect; but hoped that it can be in the hands of other investigators and it will turn out to be useful." His method quickly gained recognition within the scientific community and became an essential procedure in microbiology laboratories worldwide due to its simplicity and effectiveness in differentiating bacterial species.

THE IMPACT OF THE GRAM STAIN

The impact of the Gram stain extends far beyond mere classification; it has profound implications for medical diagnostics and treatment strategies. By enabling clinicians to distinguish between Gram-positive and Gram-negative bacteria, this technique has facilitated informed decisions regarding antibiotic therapy. Many antibiotics are more effective against Gram-positive bacteria due to their thick peptidoglycan layer, while Gram-negative bacteria often exhibit resistance due to their outer membrane structure. Over time, various modifications to Gram's original technique have emerged to enhance its accuracy and applicability. One notable enhancement was introduced by Dr. Carl Weigert, who added a counterstain step using safranin to further differentiate between bacterial types.

Citation: Chatterjee A. Hans Christian Gram: The Bacteriologist Who Revolutionized Microbiology. RJUMS; 2(1 (Jul-Dec).

Available from: https://esrfrjums.co.in/index.php/main/article/view/45

Published by: Eureka Scientech Research Foundation, Kolkata.

Online access: https://esrfrjums.co.in

This modification allowed for clearer visualization of both Gram-positive and Gram-negative bacteria under a microscope.

Despite its widespread use and importance in clinical microbiology, researchers have noted limitations associated with the Gram stain. Some bacteria exhibit variable staining properties or may not be classified accurately by this method due to inherent differences in cell wall composition or structural characteristics. For example, certain bacteria may be classified as "Gram-variable," meaning they can appear either positive or negative depending on environmental conditions or growth phases.

Modern mechanized methods have also been developed to complement traditional Gram staining techniques. Automated staining systems have been introduced in clinical laboratories to enhance efficiency and standardization of results. Additionally, molecular techniques such as polymerase chain reaction (PCR) allow for rapid identification of bacterial species without relying solely on staining methods.

In recent years, researchers have continued to explore new applications for Gram staining techniques in antibiotic discovery. For instance, teixobactin—a novel antibiotic identified through soil screening—targets Gram-positive bacteria by acting on specific components of their cell walls. This discovery highlights the ongoing relevance of Gram's work in addressing contemporary challenges related to antimicrobial resistance.

CONCLUSION

Hans Christian Gram's contributions to microbiology through the development of the Gram stain have fundamentally shaped our understanding of bacterial classification and diagnosis. His pioneering work laid the foundation for modern microbiological practices that continue to save lives today. While advancements have been made since his time—including modifications to his original technique and the introduction of modern mechanized methods—the essence of Gram's discovery remains integral to clinical microbiology.

BIBLIOGRAPHY

1. [Internet]. [cited 2024 Sept 25]. Available from: https://www.whonamedit.com/doctor.cfm/696.html
2. Hans Christian Gram [Internet]. 2023 [cited 2024 Sept 25]. Available from: https://www.lindahall.org/about/news/scientist-of-the-day/hans-christian-gram/
3. Anekwe L. Hans Christian Gram: The biologist who helped investigate bacteria [Internet]. New Scientist; 2019 [cited 2024 Sept 25]. Available from: https://www.newscientist.com/article/2216418-hans-christian-gram-the-biologist-who-helped-investigate-bacteria/
4. Gram C. Undersøgelser over de røde Blodlegemers Størrelse hos Mennesket (Doctoral dissertation).
5. Gram C. Ueber die isolirte Farbung der Schizomyceten in Schnitt-und Trockenpraparaten. Fortschritte der Medicin. 1884;2:185-9.
6. Gram C. Basedow's Sygdom: bemaerkinger om denne Sygdom og dens Forhold til Angst; vaesentling belyst ved lagttagelser paa det Kong; Universitetet i Rektoratsaaret 1910-1911; Frederiks Hospital 1895-1909. Univ. Bogtr.; 1911.
7. Mackie TJ, Collee JG, McCartney JE. Mackie and McCartney Practical Medical Microbiology. 14th ed. Vol. 1. New Delhi (India), New Delhi (India): Elsevier; 2007. 1 vols.
8. Riedel S, Morse SA, Mietzner TA, Miller S. Jawetz, Melnick & Adelberg's Medical Microbiology. 28th ed. New York, New York: McGraw-Hill Education; 2019. 1 vols.
9. Procop GW, Church DL, Hall GS, Janda WM, Koneman EM, Schreckenberger PC, et al. Koneman's Color Atlas and Textbook of Diagnostic Microbiology. 7th ed. S.l., S.l.: JONES & BARTLETT LEARNING; 2020