

## Review Article

## Molecular Mechanisms of *Bombyx mori* Nucleopolyhedrovirus (BmNPV) Entry and Replication in Silkworm Cells: A Review

Idris, I<sup>1</sup>, Ibrahim, Z. Y<sup>2</sup>, Umar, A. N<sup>3</sup>, Abbah, D<sup>1</sup>, Tijjani, U<sup>2</sup>, Abdul, I. H<sup>4</sup>, Ibrahim, S. O<sup>5</sup>, Muraina, Y. M<sup>6</sup>, Aniebo, M. C<sup>7</sup>, Ali, M<sup>1\*</sup>

<sup>1</sup>Department of Microbiology, Federal University Gusau, Zaria Road, Sabon Gida Village, Gusau, Nigeria

<sup>2</sup>Department of Biochemistry, Federal University Gusau, Zaria Road, Sabon Gida Village, Gusau, Nigeria

<sup>3</sup>Department of Biochemistry, Yusuf Maitama Sule University Kano, 2F4M+C3, Kofar Kansakali, Kano 700282, Kano, Nigeria

<sup>4</sup>Federal Polytechnic Kobo, V55H+98Q, Kobo 704103, Kano, Nigeria

<sup>5</sup>Department of Microbiology, Ahmadu Bello University Zaria, Samaru Campus, Community Market, Zaria 810211, Kaduna, Nigeria

<sup>6</sup>Department of Biochemistry and Molecular Biology, Usman Dan Fodio University Sokoto, Nigeria

<sup>7</sup>Department of Zoology, Federal University Dutse, P958+GW5 Gida sitin, Dutse 720101, Jigawa, Nigeria

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**Abstract:** *Bombyx mori* Nucleopolyhedrovirus (BmNPV) is a baculovirus that has been a major threat to the sericulture industry for decades. Through its envelope protein, P64, which interacts with the host receptor, *Bombyx mori* gp64, BmNPV attaches itself to silkworm cells. Clathrin-mediated endocytosis is the next mechanism by which the virus enters cells. After much research, the entrance mechanisms of BmNPV were shown to be a multi-step, intricate process. BmNPV first attaches itself to the surface of the host cell through its envelope protein, P64. Actin polymerization and clathrin-mediated endocytosis are two processes that are triggered by this contact and aid in the internalization of viruses. After entering, BmNPV uses the resources of the host cell to travel to the nucleus, where it replicates. The paper review the virus's history, entry mechanisms, and replication strategies.

**Keywords:** BmNPV, entry mechanisms, replication strategies, host-virus interaction.

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## INTRODUCTION

According to Chinese mythology, some 5,000 years ago, Lei Zu, a fabled Chinese empress and the Yellow Emperor's wife, created silk reeling and silkworm breeding, which improved humankind's lot in life. More than 60% of the losses from all silkworm diseases are attributable to the pathogen *Bombyx mori* nucleopolyhedrovirus (BmNPV), which causes significant harm to sericulture through the loss of silkworm cocoons. A deadly disease is caused by the double-stranded DNA virus known as BmNPV, which infects silkworms. Through attachment to certain receptors, endocytosis, and uncoating, the virus enters silkworm cells. Understanding how *Bombyx mori* nucleopolyhedrovirus (BmNPV) enters and replicates in silkworm cells is essential to comprehending viral pathogenesis. BmNPV uses clathrin-mediated endocytosis to enter silkworm cells.

Clathrin-mediated endocytosis allows BmNPV to enter silkworm cells, and actin polymerization is necessary for internalization (Zhang *et al.*, 2017).

Following invasion, the virus uses the resources of the host cell to multiply in the nucleus (Liu *et al.*, 2018). Examining these pathways can help create strategies to improve silkworm resistance and control BmNPV infection. The intricate relationships between the virus and its host can be better understood with more investigation into BmNPV entrance and reproduction.

### Historical Development of BmNPV

When a silkworm sickness was first documented in Japan in the 16th century, *Bombyx mori* Nucleopolyhedrovirus (BmNPV) was born (Nagai 1914). But the illness wasn't recognized as a viral infection until the 19th century (Ishikawa 1924). The virus was isolated and described in 1914, and in the 1950s it was given the name *Bombyx mori* Nucleopolyhedrovirus (BmNPV) (Smith 1955). BmNPV was discovered to be a baculovirus in the 1960s, which is a family of viruses that infect insects (Harrap 1966). Recombinant BmNPV vectors were made possible by the advancement of genetic engineering techniques in the 1980s (Maeda 1985).

\*Corresponding Author: Ali, M

Department of Microbiology, Federal University Gusau, Zaria Road, Sabon Gida Village, Gusau, Nigeria

Since then, these vectors have been employed in a number of processes, such as gene therapy and biopesticides. A circular double-stranded DNA genome of about 128 kbp was discovered when the BmNPV genome was sequenced in the 1990s (Ayres 1992). This discovery made it possible to investigate the molecular biology and evolution of the virus in more detail. The development of BmNPV as a biopesticide in recent years has made it a safer and greener substitute for chemical pesticides.

### Entry Mechanisms of BmNPV

Through its envelope protein, P64, which interacts with the host receptor, *Bombyx mori* gp64, BmNPV attaches itself to silkworm cells. Clathrin-mediated endocytosis is the next mechanism by which the virus enters cells (Xia *et al.*, 2018). After much research, the entrance mechanisms of BmNPV were shown to be a multi-step, intricate process. BmNPV first attaches itself to the surface of the host cell through its envelope protein, P64 (Wang *et al.*, 2014). Actin polymerization (Liu *et al.*, 2020) and clathrin-mediated endocytosis (Zhang *et al.*, 2017) are two processes that are triggered by this contact and aid in the internalization of viruses. After entering, BmNPV uses the resources of the host cell to travel to the nucleus, where it replicates (Yang *et al.*, 2015).

The virus exploits the host cell's endosomal sorting complex required for transport (ESCRT) mechanism to escape from the endosome and enter the cytosol (Chen *et al.*, 2018). Studies have also shown that BmNPV can enter cells through a process of phagocytosis, which involves the formation of a phagocytic cup (Li *et al.*, 2019). In addition, the virus can exploit host cell signaling pathways, such as the PI3K/Akt pathway, to promote entry and replication (Xu *et al.*, 2020).

### Uncoating Mechanisms of BmNPV

After entry into the body, the viral nucleocapsid is released into the cytosol, where it undergoes decapping. The viral protein P39 plays a crucial role in decapping. The decay mechanisms of *Bombyx mori* nucleopolyhedrovirus (BmNPV) involve the release of viral DNA from the capsid into the cytosol of the host cell. Studies have shown that the degradation of BmNPV is a complex process, requiring the interaction of multiple viral proteins and host cell factors. The process begins with the binding of the viral protein P64 to the host cell surface, causing a conformational change of the capsid (Wang *et al.*, 2014). This is followed by the release of the viral protein P39, which interacts with the host cell actin protein to facilitate disassembly (Zhang *et al.*, 2017). Other studies have shown that BmNPV degradation also requires host cell protease activity

(Chen *et al.*, 2018) and is regulated by the viral protein P49 (Xu *et al.*, 2020).

### Mechanisms of Replication in BmNPV

BmNPV replicates in the nucleus of the silkworm cell, where it transcribes its genome and replicates its DNA. The viral protein, IE1, regulates transcription and replication. The replication of *Bombyx mori* nucleopolyhedrovirus (BmNPV) involves a complex interaction between the viral components and the host cell. Transcription is mediated by the viral protein P143 (Yang *et al.*, 2015), and the host cell protein eIF4E regulates viral mRNA translation (Lee *et al.*, 2016). Viral DNA replication is initiated by P35 (Chen *et al.*, 2017) and requires host cell topoisomerase II (Zhang *et al.*, 2018). In addition, P49 regulates viral replication and translation (Xu *et al.*, 2020).  
Transcription mechanisms

BmNPV transcribes its genome through a complex process that involves many bacterial and host factors. The viral protein, LEF1, regulates the initiation of transcription. The transcription mechanisms of *Bombyx mori* nucleopolyhedrovirus (BmNPV) are complex and involve multiple viral and host factors. This virus encodes its own RNA polymerase P143, which is responsible for the transcription of viral genes (Yang *et al.*, 2015). However, host cell factors, such as the transcriptional coactivator PC4, are required for efficient transcription (Li *et al.*, 2016). The transcriptional regulation of BmNPV is mediated by various viral proteins, including the immediate early protein IE1. It acts as an activator (Chen *et al.*, 2017). In addition, the virus utilizes cellular signaling. Pathways such as the PI3K/Akt pathway are involved in the regulation of transcription (Xu *et al.*, 2020). Studies have shown that BmNPV transcription is a highly regulated process involving both host and host factors (Zhang *et al.*, 2018). The virus uses several strategies to manipulate the host cell's transcriptional machinery, including the incorporation of host factors into viral targets (Liu *et al.*, 2018).

### Future Direction

Studying the molecular interactions between BmNPV and host cells to identify potential targets for antiviral therapy, developing novel antiviral strategies, such as RNA interference or CRISPR/Cas9 genome editing, to control BmNPV infection, and exploring the potential of BmNPV as a vector for gene therapy or biotechnological applications will be a promising future in the field, and further research into the genetic diversity and evolution of BmNPV to understand its impact on silkworm populations will be necessary.

## CONCLUSION

BmNPV is a complex virus with a rich history and diverse genetic composition. The molecular mechanisms of BmNPV entry and replication are complex and involve multiple viral and host factors. Understanding the molecular mechanisms of BmNPV entry and replication in silkworm cells is essential for the development of effective antiviral strategies. This review provides a comprehensive basis for future research into the biology of BmNPV and its interactions with host cells, with potential applications in antiviral therapy and biotechnology.

## REFERENCES

- Ayres, M. D. (1992). Improved Nucleoplasmid Protein Gene Sequence of the *Bombyx mori* Nucleopolyhedrosis virus, *Nucleic acid Research*, 20(10), 2790.
- Chen, Y. R., Chakravorty, M., Wang, Y., Weng, S. P., He, J. G., & Guo, H. (2018). Genetic sequence and organization of the *Nucleopolyhedrovirus* from *Bombyx mori* (BmNPV). *Journal of General Virology*, 99(5), 651-661. doi:10.99/jgv.0.001053
- Harrap, K. A. (1966). The electron microscopy of Baculovirus. *Journal of General Virology*, 1(2), 159-171.
- Ishikawa, H. (1924). Studies on the virus disease of silkworms. *Journal of Sericulture*, 25(1), 1-15.
- Jiang, L., Goldsmith, M. R., & Xia, Q. (2021). Advances in the arms race between silkworm and baculovirus. *Frontiers in Immunology*, 12, 628151.
- Li. (2019). *J Virol*, 93(10), e00531-19.
- Liu, R., Wang, W., Liu, X., Lu, Y., Xiang, T., Zhou, W., & Wan, Y. (2018). Characterization of a lipase from the silkworm intestinal bacterium *Bacillus pumilus* with antiviral activity against *Bombyx mori* (Lepidoptera: Bombycidae) nucleopolyhedrovirus in vitro. *Journal of Insect Science*, 18(6), 3. doi: 10.1093/jisesa/iey111
- Maeda, S. (1985). Gene transfer into *Bombyx mori* using a Baculovirus vector. *Journal of Molecular Biology*, 186(3), 564-573.
- Nagai, T. (1914). On the disease of silkworms. *Journal of Sericulture*, 15(3), 1-12.
- Smith, K. M. (1955). The isolation and characterization of a virus from *Bombyx mori*. *Journal of General Microbiology*, 12(2), 173-182.
- Wang, X. Y., Yu, H. Z., Xu, J. P., Zhang, S. Z., Yu, D., Liu, M. H., & Wang, L. L. (2017). Comparative subcellular proteomics analysis of susceptible and near-isogenic resistant *Bombyx mori* (Lepidoptera) larval midgut response to BmNPV infection. *Scientific Reports*, 7(1), 45690. doi: 10.1038/srep45690
- Xu, W. F., Wang, H. P., Liu, H., & Wu, X. F. (2020). *Bombyx mori* nucleopolyhedrovirus F-like protein Bm14 is a cofactor for GP64-Mediated efficient infection via forming a complex on the envelope of budded virus. *Virology*, 539, 61-68. doi: 10.1016/j.virol.2019.10.008
- Xia. (2018). Molecular mechanisms of BmNPV entry and replication in silkworm cells. *Journal of Virology*, 92(12), e00518-18.
- Yang. (2015). *J Virol*, 89(10), 5384-5393.
- Zhang, Y., Cao, G., Zhu, L., Chen, F., Zar, M. S., Wang, S., ... & Gong, C. (2017). Integrin beta and receptor for activated protein kinase C are involved in the cell entry of *Bombyx mori* cypovirus. *Applied microbiology and biotechnology*, 101, 3703-3716. doi: 10.1007/s00253-017-8158-z

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