UNIVERSITAS GADJAH MADA
Produksi Protein Rekombinan NoroVLP-SpyTag menggunakan Larva Bombyx mori Lokal Strain PS01 sebagai Dasar Pengembangan Platform Display Antigen Modular
Vidia Ajeng Supriyati, Prof. drh. Widya Asmara, SU., Ph.D; Doddy Irawan Setyo, S.Si., M.Agr., Ph.D
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

DAFTAR PUSTAKA

Achatz, S., & Skerra, A. (2024). Comparative genome analysis of three classical E. coli cloning strains designed for blue/white selection: JM83, JM109 and XL1-Blue. FEBS Open Bio, 14, 888 - 905. https://doi.org/10.1002/2211-5463.13812.

Bai, B., Hu, Q., Hu, H., Zhou, P., Shi, Z., Meng, J., ... & Wang, H. (2008). Virus-like particles of SARS-like coronavirus formed by membrane proteins from different origins demonstrate stimulating activity in human dendritic cells. *PloS one*, *3*(7), e2685.

Bartsch, S. M., Lopman, B. A., Ozawa, S., Hall, A. J., & Lee, B. Y. (2016). Global economic burden of norovirus gastroenteritis. *PLoS ONE, 11*(4), e0151219. https://doi.org/10.1371/journal.pone.0151219

Binbay, F., Rathod, D., George, A., & Imhof, D. (2023). Quality Assessment of Selected Protein Structures Derived from Homology Modeling and AlphaFold. Pharmaceuticals, 16. https://doi.org/10.3390/ph16121662.

Boonyakida, J., Kawasaki, Y., Seki, T., & Kusakabe, T. (2022). Production of norovirus-like particles using the silkworm-baculovirus expression vector system. *Applied Entomology and Zoology, 57*(1), 45–53. https://doi.org/10.1007/s13355-021-00772-4.

Boonyakida, J., Khoris, I., Nasrin, F., & Park, E. (2022). Improvement of Modular Protein Display Efficiency in SpyTag-Implemented Norovirus-like Particles.. Biomacromolecules, 24 1, 308-318 . https://doi.org/10.1021/acs.biomac.2c01150.

Boonyakida, J., Utomo, D. I. S., Soma, F. N., & Park, E. Y. (2022). Two-step purification of tag-free norovirus-like particles from silkworm larvae (Bombyx mori). Protein Expression and Purification, 190, 106010.

Brune, K. D., Leneghan, D. B., Brian, I. J., Ishizuka, A. S., Bachmann, M. F., Draper, S. J., Biswas, S., & Howarth, M. (2016). Plug-and-display: Decoration of virus-like particles via isopeptide bonds for modular immunization. *Scientific Reports, 6, 19234.*

Brune, K. D., & Howarth, M. (2018). New routes and opportunities for modular construction of particulate vaccines: Stick, click, and glue. *ACS Central Science, 4*(9), 1180–1186. https://doi.org/10.1021/acscentsci.8b00703.

Burmester, T. (2013). Evolution and function of the insect hexamerins. *EJE*, *96*(3), 213-225.

Burnette, W. N. (1981). "Western blotting": Electrophoretic transfer of proteins from sodium dodecyl sulfate-polyacrylamide gels to unmodified

UNIVERSITAS GADJAH MADA
Produksi Protein Rekombinan NoroVLP-SpyTag menggunakan Larva Bombyx mori Lokal Strain PS01 sebagai Dasar Pengembangan Platform Display Antigen Modular
Vidia Ajeng Supriyati, Prof. drh. Widya Asmara, SU., Ph.D; Doddy Irawan Setyo, S.Si., M.Agr., Ph.D
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

nitrocellulose and radiographic detection with antibody and radioiodinated protein A. Analytical Biochemistry, 112(2), 195-203. https://doi.org/10.1016/0003-2697(81)90281-5

Campillay-Véliz, C. P., Carvajal, J. J., Avellaneda, A. M., Escobar, D., Covián, C., Kalergis, A. M., & Lay, M. K. (2020). Human norovirus proteins: implications in the replicative cycle, pathogenesis, and the host immune response. Frontiers in Immunology, 11, 961.

Cannon, J. L., Bonifacio, J., Bucardo, F., Buesa, J., Bruggink, L., Chan, M. C. W., ... & Vinjé, J. (2021). Global trends in norovirus genotype distribution among children with acute gastroenteritis. *Emerging infectious diseases*, *27*(5), 1438.

Chen, Q., Lai, H., Hurtado, J., Stahnke, J., Leuzinger, K., & Dent, M. (2021). Agroinfiltration as an effective and scalable strategy of gene delivery for production of pharmaceutical proteins. *Advanced Techniques in Biology & Medicine, 9*(1), 1–8.

Chhabra, P., de Graaf, M., Parra, G. I., Chan, M. C. W., Green, K., Martella, V., Wang, Q., White, P. A., Katayama, K., Vennema, H., Koopmans, M. P. G., & Vinjé, J. (2019). Updated classification of norovirus genogroups and genotypes. *Journal of General Virology, 100*(10), 1393–1406. https://doi.org/10.1099/jgv.0.001318

Chu, P., Huang, H., Boonchan, M., Tyan, Y., Louis, K., Lee, K., Motomura, K., & Ke, L. (2021). Mass Spectrometry-Based System for Identifying and Typing Norovirus Major Capsid Protein VP1. Viruses, 13. https://doi.org/10.3390/v13112332.

Contreras-Martos, S., Nguyen, H. H., Nguyen, P. N., Hristozova, N., Macossay-Castillo, M., Kovacs, D., ... & Lebrun, P. (2018). Quantification of intrinsically disordered proteins: a problem not fully appreciated. Frontiers in molecular biosciences, 5, 83.

De Sá Magalhães, S., De Santis, E., Hussein-Gore, S., Colomb-Delsuc, M., & Keshavarz-Moore, E. (2022). Quality assessment of virus-like particle: A new transmission electron microscopy approach. *Frontiers in Molecular Biosciences*, *9*, 975054.

Desantis, F., Miotto, M., Di Rienzo, L., Milanetti, E., & Ruocco, G. (2021). Spatial organization of hydrophobic and charged residues affects protein thermal stability and binding affinity. Scientific Reports, 12. https://doi.org/10.1038/s41598-022-16338-5.

UNIVERSITAS GADJAH MADA
Produksi Protein Rekombinan NoroVLP-SpyTag menggunakan Larva Bombyx mori Lokal Strain PS01 sebagai Dasar Pengembangan Platform Display Antigen Modular
Vidia Ajeng Supriyati, Prof. drh. Widya Asmara, SU., Ph.D; Doddy Irawan Setyo, S.Si., M.Agr., Ph.D
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Devant, J., Hofhaus, G., Bhella, D., & Hansman, G. (2019). Heterologous Expression of Human Norovirus GII.4 VP1 Leads to Assembly of T=4 Virus-Like Particles. bioRxiv. https://doi.org/10.1101/583385.

Dominguez, C., Boelens, R., & Bonvin, A. (2003). HADDOCK: a protein-protein docking approach based on biochemical or biophysical information.. Journal of the American Chemical Society, 125 7, 1731-7 . https://doi.org/10.1021/ja026939x.

Dower, W. J., Miller, J. F., & Ragsdale, C. W. (1988). High efficiency transformation of E. coli by high voltage electroporation. Nucleic Acids Research, 16(13), 6127–6145. https://doi.org/10.1093/nar/16.13.6127

Doytchinova, I. A., & Flower, D. R. (2007). VaxiJen: a server for prediction of protective antigens, tumour antigens and subunit vaccines. BMC bioinformatics, 8(1), 4.

Duong-Ly, K. C., & Gabelli, S. B. (2014). Salting out of proteins using ammonium sulfate precipitation. In *Methods in enzymology* (Vol. 541, pp. 85-94). Academic Press.

Edmunds, N., Genc, A., & McGuffin, L. (2024). Benchmarking of AlphaFold2 accuracy self-estimates as indicators of empirical model quality and ranking: a comparison with independent model quality assessment programmes. Bioinformatics, 40. https://doi.org/10.1093/bioinformatics/btae491.

Emini, E. A., Hughes, J. V., Perlow, D., & Boger, J. (1985). Induction of hepatitis A virus-neutralizing antibody by a virus-specific synthetic peptide. Journal of virology, 55(3), 836-839.

Excler, J. L., Saville, M., Berkley, S., & Kim, J. H. (2021). Vaccine development for emerging infectious diseases. *Nature medicine*, *27*(4), 591-600.

Gamage, D., Gunaratne, A., Periyannan, G., & Russell, T. (2019). Applicability of Instability Index for In vitro Protein Stability Prediction.. Protein and peptide letters, 26 5, 339-347 . https://doi.org/10.2174/0929866526666190228144219.

Goldsmith, M. R., Shimada, T., & Abe, H. (2005). The genetics and genomics of the silkworm, *Bombyx mori*. *Annual Review of Entomology, 50*, 71–100. https://doi.org/10.1146/annurev.ento.50.071803.130456.

Green, M. R., & Sambrook, J. (2021). Alkaline agarose gel electrophoresis. *Cold Spring Harbor Protocols*, *2021*(11), pdb-prot100438.

UNIVERSITAS GADJAH MADA
Produksi Protein Rekombinan NoroVLP-SpyTag menggunakan Larva Bombyx mori Lokal Strain PS01 sebagai Dasar Pengembangan Platform Display Antigen Modular
Vidia Ajeng Supriyati, Prof. drh. Widya Asmara, SU., Ph.D; Doddy Irawan Setyo, S.Si., M.Agr., Ph.D
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Green, M. R., & Sambrook, J. (2021). Cloning and transformation with plasmid vectors. *Cold Spring Harbor Protocols*, *2021*(11), pdb-top101170.

Gupta, R., Arora, K., Roy, S. S., Joseph, A., Rastogi, R., Arora, N. M., & Kundu, P. K. (2023). Platforms, advances, and technical challenges in virus-like particles-based vaccines. Frontiers in immunology, 14, 1123805.

Hillebrandt, N., Vormittag, P., Bluthardt, N., Dietrich, A., & Hubbuch, J. (2020). Integrated process for capture and purification of virus-like particles: enhancing process performance by cross-flow filtration. *Frontiers in Bioengineering and Biotechnology*, *8*, 489.

Hong, P., Koza, S., & Bouvier, E. S. (2012). A review size-exclusion chromatography for the analysis of protein biotherapeutics and their aggregates. *Journal of liquid chromatography & related technologies*, *35*(20), 2923-2950.

Hu, L., Salmen, W., Chen, R., Zhou, Y., Neill, F., Crowe Jr, J. E., ... & Prasad, B. V. (2022). Atomic structure of the predominant GII. 4 human norovirus capsid reveals novel stability and plasticity. *Nature communications*, *13*(1), 1241.

Jespersen, M. C., Peters, B., Nielsen, M., & Marcatili, P. (2017). BepiPred-2.0: improving sequence-based B-cell epitope prediction using conformational epitopes. Nucleic acids research, 45(W1), W24-W29.

Jumper, J., Evans, R., Pritzel, A., Green, T., Figurnov, M., Ronneberger, O., ... & Hassabis, D. (2021). Highly accurate protein structure prediction with AlphaFold. nature, 596(7873), 583-589.

Jung, J., Grant, T., Thomas, D. R., Diehnelt, C. W., Grigorieff, N., & Joshua-Tor, L. (2019). High-resolution cryo-EM structures of outbreak strain human norovirus shells reveal size variations. *Proceedings of the National Academy of Sciences of the United States of America, 116*(26), 12828–12832.

Kajiura, H., Tatematsu, K. I., Nomura, T., Miyazawa, M., Usami, A., Tamura, T., ... & Fujiyama, K. (2022). Insights into the quality of recombinant proteins produced by two different Bombyx mori expression systems. Scientific Reports, 12(1), 18502.

Kąkol, M., Tagliasacchi, E., Borkowski, A., & Słowakiewicz, M. (2023). Influence of different sample preparation techniques on imaging viruses and virus-like particles by scanning electron and scanning transmission electron microscopes. *Frontiers in Microbiology*, *14*, 1279720.

Kato, T., Kajikawa, M., Maenaka, K., & Park, E. Y. (2010). Silkworm expression system as a platform technology in life science. *Applied Microbiology*

UNIVERSITAS GADJAH MADA
Produksi Protein Rekombinan NoroVLP-SpyTag menggunakan Larva Bombyx mori Lokal Strain PS01 sebagai Dasar Pengembangan Platform Display Antigen Modular
Vidia Ajeng Supriyati, Prof. drh. Widya Asmara, SU., Ph.D; Doddy Irawan Setyo, S.Si., M.Agr., Ph.D
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

and Biotechnology, 85(3), 459–470. https://doi.org/10.1007/s00253-009-2267-2.

Kato, T., Kakuta, T., Yonezuka, A., Sekiguchi, T., Machida, Y., Xu, J., ... & Park, E. Y. (2023). Expression and purification of porcine Rotavirus structural proteins in silkworm larvae as a vaccine candidate. *Molecular Biotechnology*, *65*(3), 401-409.

Khan, M. W. A., Alam, M. J., Sherwani, S., & Alouffi, S. (2022). Molecular docking and interaction analysis of protein complexes using HADDOCK and structural bioinformatics tools. International Journal of Molecular Sciences, 23, 12215. https://doi.org/10.3390/ijms232012215

Koetsier, G., & Cantor, E. (2019). A practical guide to analyzing nucleic acid concentration and purity with microvolume spectrophotometers. *New England Biolabs Inc*, *1*(8).

Koho, T., Mäntylä, T., Laurinmäki, P., Huhti, L., Butcher, S., Vesikari, T., Kulomaa, M., & Hytönen, V. (2012). Purification of norovirus-like particles (VLPs) by ion exchange chromatography.. Journal of virological methods, 181 1, 6-11 . https://doi.org/10.1016/j.jviromet.2012.01.003.

Kost, T. A., Condreay, J. P., & Jarvis, D. L. (2005). Baculovirus as versatile vectors for protein expression in insect and mammalian cells. *Nature biotechnology*, *23*(5), 567-575.

Kumar, N., Bajiya, N., Patiyal, S., & Raghava, G. (2023). Multi-perspectives and challenges in identifying B-cell epitopes. Protein Science, 32. https://doi.org/10.1002/pro.4785.

Lampinen, V., Heinimäki, S., Laitinen, O. H., Pesu, M., Hankaniemi, M. M., Blazevic, V., & Hytönen, V. P. (2021). Modular vaccine platform based on the norovirus-like particle. *Journal of Nanobiotechnology, 19*, 25. https://doi.org/10.1186/s12951-021-00772-0.

Lampinen, V., Gröhn, S., Soppela, S., Blazevic, V., Hytönen, V. P., & Hankaniemi, M. M. (2023). SpyTag/SpyCatcher display of influenza M2e peptide on norovirus-like particle provides stronger immunization than direct genetic fusion. Frontiers in Cellular and Infection Microbiology, 13, 1216364.

Laskowski, R. A., Jabłońska, J., Pravda, L., Vařeková, R. S., & Thornton, J. M. (2018). PDBsum: Structural summaries of PDB entries. *Protein science*, *27*(1), 129-134.

Lee, Y., Lee, J., Hong, S., Lee, S., Lee, W., Koh, M., Chang, I., & Lee, S. (2024). Optimization of Electroporation Conditions for Introducing Heterologous DNA into Rhodobacter sphaeroides. Journal of

UNIVERSITAS GADJAH MADA
Produksi Protein Rekombinan NoroVLP-SpyTag menggunakan Larva Bombyx mori Lokal Strain PS01 sebagai Dasar Pengembangan Platform Display Antigen Modular
Vidia Ajeng Supriyati, Prof. drh. Widya Asmara, SU., Ph.D; Doddy Irawan Setyo, S.Si., M.Agr., Ph.D
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Microbiology and Biotechnology, 34, 2347 - 2352. https://doi.org/10.4014/jmb.2408.08044.

Li, S., Ip, D. T. M., Lin, H. Q., Liu, J. M., Miao, Y. G., Ke, L. J., & Wan, D. C. C. (2010). High-level expression of functional recombinant human butyrylcholinesterase in silkworm larvae by Bac-to-Bac system. *Chemico-biological interactions*, *187*(1-3), 101-105.

Liang, S., Zheng, D., Zhang, C., & Zacharias, M. (2009). Prediction of antigenic epitopes on protein surfaces by consensus scoring. BMC Bioinformatics, 10, 302 - 302. https://doi.org/10.1186/1471-2105-10-302.

Lindesmith, L. C., Beltramello, M., Donaldson, E. F., Corti, D., Swanstrom, J., Debbink, K., ... & Baric, R. S. (2012). Immunogenetic mechanisms driving norovirus GII. 4 antigenic variation. *PLoS pathogens*, *8*(5), e1002705.

Lua, L. H. L., Connors, N. K., Sainsbury, F., Chuan, Y. P., Wibowo, N., & Middelberg, A. P. J. (2014). Bioengineering virus-like particles as vaccines. *Biotechnology and Bioengineering, 111*(3), 425–440. https://doi.org/10.1002/bit.25159

Luckow, V. A., Lee, S. C., Barry, G. F., & Olins, P. O. (1993). Efficient generation of infectious recombinant baculoviruses by site-specific transposon-mediated insertion of foreign genes into a baculovirus genome propagated in *Escherichia coli*. *Journal of Virology, 67*(8), 4566–4579. https://doi.org/10.1128/JVI.67.8.4566-4579.1993

Ma, J., Liu, J., & Huo, Y. (2024). Biological and immunological characterization of major capsid protein VP1 from distinct GII. 2 norovirus clusters. Scientific Reports, 14(1), 21035.

Ma, Z., Ma, X., Tao, X., Huang, Y., Jiang, Q., Ding, X., ... & Yao, G. (2025). Immunogenicity of Virus-like Particles Based on VP1 Protein of Bovine Norovirus. Veterinary Sciences, 12(9), 802.

Marx, D., Leblanc, M., Plummer, A., Krueger, S., & Fleming, K. (2020). Domain interactions determine the conformational ensemble of the periplasmic chaperone SurA. Protein Science, 29, 2043 - 2053. https://doi.org/10.1002/pro.3924.

Mateu, M. G. (2013). Assembly, stability and dynamics of virus capsids. *Archives of biochemistry and biophysics*, *531*(1-2), 65-79.

Matsuura, K. (2018). Synthetic approaches to construct viral capsid-like spherical nanomaterials.. Chemical communications, 54 65, 8944-8959 . https://doi.org/10.1039/c8cc03844a.

UNIVERSITAS GADJAH MADA
Produksi Protein Rekombinan NoroVLP-SpyTag menggunakan Larva Bombyx mori Lokal Strain PS01 sebagai Dasar Pengembangan Platform Display Antigen Modular
Vidia Ajeng Supriyati, Prof. drh. Widya Asmara, SU., Ph.D; Doddy Irawan Setyo, S.Si., M.Agr., Ph.D
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Mehalko, J. L., & Esposito, D. (2016). Engineering the transposition-based baculovirus expression vector system for higher efficiency protein production from insect cells. *Journal of biotechnology*, *238*, 1-8.

Metz, S. W., Gardner, J., Geertsema, C., Le, T. T., Goh, L., Vlak, J. M., ... & Pijlman, G. P. (2013). Effective chikungunya virus-like particle vaccine produced in insect cells. PLoS neglected tropical diseases, 7(3), e2124.

Metz, S. W., Pijlman, G. P., & Funk, A. (2013). Advances in virus-like particle vaccine development against emerging infectious disease viruses. *Virology Journal, 10*, 366. https://doi.org/10.1186/1743-422X-10-366

Minkner, R., Xu, J., Takemura, K., Boonyakida, J., Wätzig, H., & Park, E. Y. (2020). Ni-modified magnetic nanoparticles for affinity purification of His-tagged proteins from the complex matrix of the silkworm fat body. Journal of Nanobiotechnology, 18(1), 159.

Miyazaki, N., Taylor, D., Hansman, G., & Murata, K. (2015). Antigenic and Cryo-Electron Microscopy Structure Analysis of a Chimeric Sapovirus Capsid. Journal of Virology, 90, 2664 - 2675. https://doi.org/10.1128/jvi.02916-15.

Moeini, H., Afridi, S., Donakonda, S., Knolle, P., Protzer, U., & Hoffmann, D. (2021). Linear B-Cell Epitopes in Human Norovirus GII.4 Capsid Protein Elicit Blockade Antibodies. Vaccines, 9. https://doi.org/10.3390/vaccines9010052.

Mohsen, M. O., Zha, L., Cabral-Miranda, G., & Bachmann, M. F. (2022). Major findings and recent advances in virus-like particle (VLP)-based vaccines. *Seminars in Immunology, 53*, 101479. https://doi.org/10.1016/j.smim.2021.101479

Motohashi, T., Shimojima, T., Fukagawa, T., Maenaka, K., & Park, E. (2005). Efficient large-scale protein production of larvae and pupae of silkworm by Bombyx mori nuclear polyhedrosis virus bacmid system.. Biochemical and biophysical research communications, 326 3, 564-9 . https://doi.org/10.1016/j.bbrc.2004.11.060.

Nakane, T., Kotecha, A., Sente, A., McMullan, G., Masiulis, S., Brown, P. M., ... & Scheres, S. H. (2020). Single-particle cryo-EM at atomic resolution. *Nature*, *587*(7832), 152-156.

Napotnik, T. B., Polajžer, T., & Miklavčič, D. (2021). Cell death due to electroporation–a review. *Bioelectrochemistry*, *141*, 107871.

Nierengarten, M. B. (2025). Men face substantial lifelong risk of oral HPV infection: A study provides information on rates of newly acquired oral

UNIVERSITAS GADJAH MADA
Produksi Protein Rekombinan NoroVLP-SpyTag menggunakan Larva Bombyx mori Lokal Strain PS01 sebagai Dasar Pengembangan Platform Display Antigen Modular
Vidia Ajeng Supriyati, Prof. drh. Widya Asmara, SU., Ph.D; Doddy Irawan Setyo, S.Si., M.Agr., Ph.D
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

HPV infections and associated risk factors for acquiring HPV infections in a multinational cohort of more than 3000 men. Cancer (0008543X), 131(3).

Nooraei, S., Bahrulolum, H., Hoseini, Z. S., Katalani, C., Hajizade, A., Easton, A. J., & Ahmadian, G. (2021). Virus-like particles: Preparation, immunogenicity and their roles as nanovaccines and drug nanocarriers. *Journal of Nanobiotechnology, 19*(1), 59. https://doi.org/10.1186/s12951-021-00806-7

Park, E. Y. (2026). Expression of Recombinant Proteins. In *Silkworm Biofactory: A Breakthrough Platform for High-Yield Protein Production* (pp. 121-158). Singapore: Springer Nature Singapore.

Pogan, R., Dülfer, J., & Potocnakova, L., Bhide, M., & Pulzova, L. (2016). An Introduction to B-Cell Epitope Mapping and In Silico Epitope Prediction. Journal of Immunology Research, 2016. https://doi.org/10.1155/2016/6760830.

Prasad, B. V. V., Hardy, M. E., Dokland, T., Bella, J., Rossmann, M. G., & Estes, M. K. (1999). X-ray crystallographic structure of the Norwalk virus capsid. *Science, 286*(5438), 287–290.

Ptak-Kaczor, M., Banach, M., Stapor, K., Fabian, P., Konieczny, L., & Roterman, I. (2021). Solubility and Aggregation of Selected Proteins Interpreted on the Basis of Hydrophobicity Distribution. International Journal of Molecular Sciences, 22. https://doi.org/10.3390/ijms22095002.

Puente-Massaguer, E., González-Domínguez, I., Strobl, F., Grabherr, R., Striedner, G., Lecina, M., & Gòdia, F. (2022). Bioprocess characterization of virus-like particle production with the insect cell baculovirus expression system at nanoparticle level. *Journal of Chemical Technology & Biotechnology*, *97*(9), 2456-2465.

Ravichandran, A., Puri, A., Bhate, S., Habibullah, B., Singh, G., & Das, R. (2025). Structure-guided engineering of protein stability through core hydrophobicity. Protein Science, 34. https://doi.org/10.1002/pro.70360.

Redman, E., Wilson, K., & Cory, J. (2016). Trade-offs and mixed infections in an obligate-killing insect pathogen. The Journal of Animal Ecology, 85, 1200 - 1209. https://doi.org/10.1111/1365-2656.12547.

Ren, M., Abdullah, S. W., Pei, C., Guo, H., & Sun, S. (2024). Use of virus-like particles and nanoparticle-based vaccines for combating picornavirus infections. *Veterinary Research*, *55*(1), 128.

UNIVERSITAS GADJAH MADA
Produksi Protein Rekombinan NoroVLP-SpyTag menggunakan Larva Bombyx mori Lokal Strain PS01 sebagai Dasar Pengembangan Platform Display Antigen Modular
Vidia Ajeng Supriyati, Prof. drh. Widya Asmara, SU., Ph.D; Doddy Irawan Setyo, S.Si., M.Agr., Ph.D
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Robilotti, E., Deresinski, S., & Pinsky, B. A. (2015). Norovirus. *Clinical Microbiology Reviews*, 28(1), 134–164. https://doi.org/10.1128/CMR.00075-14

Rohrmann, G. F. (2019). Baculovirus molecular biology (4th edition). NCBI Bookshelf.

Rosano, G. L., & Ceccarelli, E. A. (2014). Recombinant protein expression in Escherichia coli: Advances and challenges. *Frontiers in Microbiology, 5*, 172. https://doi.org/10.3389/fmicb.2014.00172

Rosano, G. L., & Ceccarelli, E. A. (2019). Recombinant protein expression in Escherichia coli: advances and challenges. Frontiers in Microbiology, 10. https://doi.org/10.3389/fmicb.2019.00001

Sambrook, J., & Russell, D. W. (2001). *Molecular cloning: A laboratory manual* (3rd ed.). Cold Spring Harbor Laboratory Press.

Sambrook, J., & Russell, D. (2006). Screening Bacterial Colonies Using X-gal and IPTG: α-Complementation.. CSH protocols, 2006 1. https://doi.org/10.1101/pdb.prot3945.

Saraswat, M., Musante, L., Ravidá, A., Shortt, B., Byrne, B., & Holthofer, H. (2013). Preparative purification of recombinant proteins: current status and future trends. *BioMed research international*, *2013*(1), 312709., C. (2018). Norovirus assembly and stability. *Current opinion in virology*, *31*, 59-65.

Setyo Utomo, D. I., Suhaimi, H., Muhammad Azami, N. A., Azmi, F., Mohd Amin, M. C. I., & Xu, J. (2023). An overview of recent developments in the application of antigen displaying vaccine platforms: Hints for future SARS-CoV-2 VLP vaccines. Vaccines, 11(9), 1506.

Shaw, K., Grimsley, G., Yakovlev, G., Makarov, A., & Pace, C. (2001). The effect of net charge on the solubility, activity, and stability of ribonuclease Sa. Protein Science, 10. https://doi.org/10.1110/ps.440101.

Singh, M., Sori, H., Ahuja, R., Meena, J., Sehgal, D., & Panda, A. (2020). Effect of N-terminal poly histidine-tag on immunogenicity of Streptococcus pneumoniae surface protein SP0845.. International journal of biological macromolecules. https://doi.org/10.1016/j.ijbiomac.2020.07.056.

Smith, H., & Smith, T. (2019). The Dynamic Capsid Structures of the Noroviruses. Viruses, 11. https://doi.org/10.3390/v11030235.

UNIVERSITAS GADJAH MADA
Produksi Protein Rekombinan NoroVLP-SpyTag menggunakan Larva Bombyx mori Lokal Strain PS01 sebagai Dasar Pengembangan Platform Display Antigen Modular
Vidia Ajeng Supriyati, Prof. drh. Widya Asmara, SU., Ph.D; Doddy Irawan Setyo, S.Si., M.Agr., Ph.D
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Stetefeld, J., McKenna, S. A., & Patel, T. R. (2016). Dynamic light scattering: A practical guide and applications in biomedical sciences. Biophysical Reviews, 8(4), 409-427. https://doi.org/10.1007/s12551-016-0218-z

Strobl, F., Ghorbanpour, S. M., Palmberger, D., & Striedner, G. (2020). Evaluation of screening platforms for virus-like particle production with the baculovirus expression vector system in insect cells. *Scientific Reports*, *10*(1), 1065.

Tan, M., & Jiang, X. (2014). Histo-blood group antigens: A common niche for norovirus and rotavirus. *Expert Reviews in Molecular Medicine, 16*, e5. https://doi.org/10.1017/erm.2014.2

Tan, T. K., Rijal, P., Rahikainen, R., Keeble, A. H., Schimanski, L., Hussain, S., Harvey, R., Hayes, J. W. P., Edwards, J. C., McLean, R. K., Martini, V., Pedreño-Lopez, S., Thakur, N., Conceicao, C., Dietrich, I., Shelton, H., Ludi, A., Wilsden, G., Browning, C., ... Townsend, A. R. (2021). A COVID-19 vaccine candidate using SpyCatcher multimerization of the SARS-CoV-2 spike protein receptor-binding domain induces potent neutralising antibody responses. *Nature Communications, 12*(1), 542. https://doi.org/10.1038/s41467-020-20654-7

Thermo Fisher Scientific. (2018). *Bac-to-Bac™ baculovirus expression system: A guide to baculovirus expression vector systems (BEVS) and insect cell culture techniques* (Version MAN0000414). Thermo Fisher Scientific

Tresset, G., Le Coeur, C., Bryche, J. F., Tatou, M., Zeghal, M., Charpilienne, A., ... & Bressanelli, S. (2013). Norovirus capsid proteins self-assemble through biphasic kinetics via long-lived stave-like intermediates. Journal of the American Chemical Society, 135(41), 15373-15381.

Tsurumi, Y., Masuda, A., Xu, J., et al.. Structural and stability differences among GI norovirus virus-like particles produced in silkworm–baculovirus expression vector system. Vaccine. (Tsurumi et al., 2026)

Tu, Q., Yin, J., Fu, J., Herrmann, J., Li, Y., Yin, Y., ... & Zhang, Y. (2016). Room temperature electrocompetent bacterial cells improve DNA transformation and recombineering efficiency. *Scientific reports*, *6*(1), 24648.

Tunyasuvunakool, K., Adler, J., Wu, Z., Green, T., Zielinski, M., Žídek, A., ... & Hassabis, D. (2021). Highly accurate protein structure prediction for the human proteome. Nature, 596(7873), 590-596.

Van Zundert, G. C. P., Rodrigues, J. P. G. L. M., Trellet, M., Schmitz, C., Kastritis, P. L., Karaca, E., ... & Bonvin, A. M. J. J. (2016). The HADDOCK2. 2

UNIVERSITAS GADJAH MADA
Produksi Protein Rekombinan NoroVLP-SpyTag menggunakan Larva Bombyx mori Lokal Strain PS01 sebagai Dasar Pengembangan Platform Display Antigen Modular
Vidia Ajeng Supriyati, Prof. drh. Widya Asmara, SU., Ph.D; Doddy Irawan Setyo, S.Si., M.Agr., Ph.D
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

web server: user-friendly integrative modeling of biomolecular complexes. Journal of molecular biology, 428(4), 720-725.

Vieira, D. D. S., Polveiro, R. C., Butler, T. J., Hackett, T. A., Braga, C. P., Puniya, B. L., ... & Feitosa, F. L. (2021). An in silico, structural, and biological analysis of lactoferrin of different mammals. International journal of biological macromolecules, 187, 119-126.

Vongpunsawad, S., Prasad, B., & Estes, M. (2013). Norwalk Virus Minor Capsid Protein VP2 Associates within the VP1 Shell Domain. Journal of Virology, 87, 4818 - 4825. https://doi.org/10.1128/jvi.03508-12.

Wallace, R. G., & Rochfort, K. D. (2023). Ion-exchange chromatography: basic principles and application. *Protein Chromatography: Methods and Protocols*, 161-177.

Widayanti, T., Azizah, M., Lestari, R., Suryanggono, J., Ningsih, F., & Pambudi, S. (2024). Purification of anti spike SARS-CoV-2 monoclonal antibodies using ion exchange chromatography with different pH conditions. THE 7TH BIOMEDICAL ENGINEERING'S RECENT PROGRESS IN BIOMATERIALS, DRUGS DEVELOPMENT, AND MEDICAL DEVICES: The 15th Asian Congress on Biotechnology in conjunction with the 7th International Symposium on Biomedical Engineering (ACB-ISBE 2022). https://doi.org/10.1063/5.0199130.

Wilson, C., Choy, W., & Karttunen, M. (2022). AlphaFold2: A Role for Disordered Protein/Region Prediction?. International Journal of Molecular Sciences, 23. https://doi.org/10.3390/ijms23094591.

Wu, N., Matand, K., Kebede, B., Acquaah, G., & Williams, S. (2010). Enhancing DNA electrotransformation efficiency in Escherichia coli DH10B electrocompetent cells. Electronic Journal of Biotechnology, 13, 21-22. https://doi.org/10.2225/vol13-issue5-fulltext-11.

Xia, Q., Li, S., & Feng, Q. (2014). Advances in silkworm studies accelerated by the genome sequencing of *Bombyx mori*. *Annual Review of Entomology, 59*, 513–536. https://doi.org/10.1146/annurev-ento-011613-161940.

Xu, J., Kato, T., & Park, E. Y. (2019). Development of SpyTag/SpyCatcher-bacmid expression vector system (SpyBEVS) for protein bioconjugations inside of silkworms. *International journal of molecular sciences*, 20(17), 4228.

Xu, S., Wang, F., Wang, Y. *et al.* (2019). A silkworm based silk gland bioreactor for high-efficiency production of recombinant human lactoferrin with antibacterial and anti-inflammatory activities. *J Biol Eng* 13, 61. https://doi.org/10.1186/s13036-019-0186-z.

UNIVERSITAS GADJAH MADA
Produksi Protein Rekombinan NoroVLP-SpyTag menggunakan Larva Bombyx mori Lokal Strain PS01 sebagai Dasar Pengembangan Platform Display Antigen Modular
Vidia Ajeng Supriyati, Prof. drh. Widya Asmara, SU., Ph.D; Doddy Irawan Setyo, S.Si., M.Agr., Ph.D
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Xu, Y., Liu, N., Yang, F., Wang, X., Huang, J., Shen, X., & Hao, B. (2021). Optimization of infection parameters improves Bombyx mori nucleopolyhedrovirus invasion efficiency. Biologia, 77, 261-267. https://doi.org/10.1007/s11756-021-00931-6.

Yigzaw, Y., Hinckley, P., Hewig, A., & Vedantham, G. (2009). Ion exchange chromatography of proteins and clearance of aggregates. *Current pharmaceutical biotechnology*, *10*(4), 421-426.

Yu, M., Li, Y., Zhang, S., Li, X., Yang, Y., Chen, Y., ... & Su, Z. (2014). Improving stability of virus-like particles by ion-exchange chromatographic supports with large pore size: advantages of gigaporous media beyond enhanced binding capacity. *Journal of Chromatography A*, *1331*, 69-79.

Zakeri, B., Fierer, J. O., Celik, E., Chittock, E. C., Schwarz-Linek, U., Moy, V. T., & Howarth, M. (2012). Peptide tag forming a rapid covalent bond to a protein through engineering a bacterial adhesin. *Proceedings of the National Academy of Sciences, 109*(12), E690–E697. https://doi.org/10.1073/pnas.1115485109.

Zakeri, B., Fierer, J. O., Celik, E., Chittock, E. C., Schwarz-Linek, U., Moy, V. T., & Howarth, M. (2012). Peptide tag forming a rapid covalent bond to a protein, through engineering a bacterial adhesin. Proceedings of the National Academy of Sciences, 109(12), E690-E697.

Zhang, L., Xu, W., , X., Sun, X., Fan, J., & Wang, Y. (2023). Virus-like Particles as Antiviral Vaccine: Mechanism, Design, and Application. Biotechnology and Bioprocess Engineering, 28, 1 - 16. https://doi.org/10.1007/s12257-022-0107-8.

Zhang, Z. T., Wang, H., Dong, H., & Cong, B. (2024). Comparative hemolymph proteomic analyses of the freezing and resistance-freezing Ostrinia furnacalis (Guenée). Scientific Reports, 14(1), 2580.

Zlotnick, A. (2003). Are weak protein–protein interactions the general rule in capsid assembly?. *Virology*, *315*(2), 269-274.