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DAFTAR PUSTAKA

Akers, M. J. (1985). *Parenteral quality control: Sterility, pyrogen, particulate, and package integrity testing*. M. Dekker.

Akligoh, H., & Molloy, J. (2021). *Chemically Competent Cell Preparation [Calcium Chloride Method] v1*. https://doi.org/10.17504/protocols.io.261ge4k8dv47/v1

Al-Allaf, F. A., Tolmachov, O. E., Zambetti, L. P., Tchetchelnitski, V., & Mehmet, H. (2013). Remarkable stability of an instability-prone lentiviral vector plasmid in *Escherichia coli* Stbl3. *3 Biotech*, *3*(1), 61–70. https://doi.org/10.1007/s13205-012-0070-8

Al-Tubuly, A. A. (2000). SDS-PAGE and Western Blotting. In A. J. T. George & C. E. Urch (Eds.), *Diagnostic and Therapeutic Antibodies* (Vol. 40, pp. 391–405). Humana Press. https://doi.org/10.1385/1-59259-076-4:391

Anand, R. D., Sertil, O., & Lowry, C. V. (2004). Restriction digestion monitors facilitate plasmid construction and PCR cloning. *BioTechniques*, *36*(6), 982–985. https://doi.org/10.2144/04366ST03

Andrew, S. M., Titus, J. A., & Zumstein, L. (2001). Dialysis and Concentration of Protein Solutions. *Current Protocols in Toxicology*, *10*(1). https://doi.org/10.1002/0471140856.txa03hs10

Anton, B. P., & Raleigh, E. A. (2016). Complete Genome Sequence of NEB 5-alpha, a Derivative of *Escherichia coli* K-12 DH5α. *Genome Announcements*, *4*(6), e01245-16. https://doi.org/10.1128/genomeA.01245-16

Aposhian, H. V., & Kornberg, A. (1962). Enzymatic Synthesis of Deoxyribonucleic Acid. *Journal of Biological Chemistry*, *237*(2), 519–525. https://doi.org/10.1016/S0021-9258(18)93954-2

Arslan, M., Tezcan, E., Camci, H., & Avci, M. K. (2021). Effect of DNA Concentration on Band Intensity and Resolution in Agarose Gel Electrophoresis. *Van Sağlık Bilimleri Dergisi*, *14*(3), 326–333. https://doi.org/10.52976/vansaglik.969547

Ashayeri-Panah, M., Eftekhar, F., Kazemi, B., & Joseph, J. (2017). Cloning, optimization of induction conditions and purification of *Mycobacterium tuberculosis* Rv1733c protein expressed in *Escherichia coli*. *Iranian Journal of Microbiology*, *9*(2), 64–73. https://pmc.ncbi.nlm.nih.gov/articles/PMC5715279/

Azpiroz, M. F., & Laviña, M. (2017). Analysis of RecA-independent recombination events between short direct repeats related to a genomic island and to a plasmid in *Escherichia coli* K12. *PeerJ*, *5*, e3293. https://doi.org/10.7717/peerj.3293

Badan Pusat Statistik. (2026). Data ekspor impor nasional: Impor full HS tahun 2026, 2025, 2024, 2023, 2022 (HS 38221900). Retrieved June 26, 2026, from https://www.bps.go.id/id/exim

Bai, X., Hong, J. F., Yu, S., Hu, D. Y., Chen, A. Y., Rich, C. A., Shi, S. J., Xu, S. Y., Croucher, D. M., Müssar, K. J., Meng, D. W., Chen, J. L., & Lahn, B. T. (2025). Prevalence of errors in lab-made plasmids across the globe.

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Ekspresi Gen Penyandi OpenVent DNA Polimerase pada Escherichia coli Galur TOP 10 dan BL21 (DE3) di Dua Macam Media
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Nucleic Acids Research, *53*(14), gkaf697. https://doi.org/10.1093/nar/gkaf697

Baltierra-Trejo, E., Márquez-Benavides, L., & Sánchez-Yáñez, J. M. (2015). Inconsistencies and ambiguities in calculating enzyme activity: The case of laccase. *Journal of Microbiological Methods*, *119*, 126–131. https://doi.org/10.1016/j.mimet.2015.10.007

Banasik, M., Stanisławska-Sachadyn, A., & Sachadyn, P. (2016). A simple modification of PCR thermal profile applied to evade persisting contamination. *Journal of Applied Genetics*, *57*(3), 409–415. https://doi.org/10.1007/s13353-015-0336-z

Baneyx, F., & Mujacic, M. (2004). Recombinant protein folding and misfolding in *Escherichia coli*. *Nature Biotechnology*, *22*(11), 1399–1408. https://doi.org/10.1038/nbt1029

Bansal, S., Kumar, M., Kumar, D., Rai, S., Kumar, V., & Singh, B. (2010). Development of highly reproducible and cost effective PCR teaching kit. *Progressive Agriculture*, *10*(2), 402–404.

Bartoš, O., Chmel, M., & Swierczková, I. (2024). The overlooked evolutionary dynamics of 16S rRNA revises its role as the "gold standard" for bacterial species identification. *Scientific Reports*, *14*(1), 9067. https://doi.org/10.1038/s41598-024-59667-3

Beaufils, C., Man, H.-M., De Poulpiquet, A., Mazurenko, I., & Lojou, E. (2021). From Enzyme Stability to Enzymatic Bioelectrode Stabilization Processes. *Catalysts*, *11*(4), 497. https://doi.org/10.3390/catal11040497

Beck, M. (2018). *Calcium chloride preparation of competent cells v1*. https://doi.org/10.17504/protocols.io.nhbdb2n

Bentley, W. E., Mirjalili, N., Andersen, D. C., Davis, R. H., & Kompala, D. S. (1990). Plasmid-encoded protein: The principal factor in the "metabolic burden" associated with recombinant bacteria. *Biotechnology and Bioengineering*, *35*(7), 668–681. https://doi.org/10.1002/bit.260350704

Bergkessel, M., & Guthrie, C. (2013). Colony PCR. In *Methods in Enzymology* (Vol. 529, pp. 299–309). Elsevier. https://doi.org/10.1016/B978-0-12-418687-3.00025-2

Bertani, G. (1951). Studies on Lysogenesis I: The Mode of Phage Liberation by Lysogenic *Escherichia coli*. *Journal of Bacteriology*, *62*(3), 293–300. https://doi.org/10.1128/jb.62.3.293-300.1951

Betton, J.-M. (2004). Cloning Vectors for Expression-PCR Products. *BioTechniques*, *37*(3), 346–347. https://doi.org/10.2144/04373BM01

Bhadra, S., Nguyen, V., Torres, J.-A., Kar, S., Fadanka, S., Gandini, C., Akligoh, H., Paik, I., Maranhao, A. C., Molloy, J., & Ellington, A. D. (2021). Producing molecular biology reagents without purification. *PLOS ONE*, *16*(6), e0252507. https://doi.org/10.1371/journal.pone.0252507

Bhatwa, A., Wang, W., Hassan, Y. I., Abraham, N., Li, X.-Z., & Zhou, T. (2021). Challenges Associated With the Formation of Recombinant Protein Inclusion Bodies in *Escherichia coli* and Strategies to Address Them for Industrial Applications. *Frontiers in Bioengineering and Biotechnology*, *9*, 630551. https://doi.org/10.3389/fbioe.2021.630551

UNIVERSITAS
GADJAH MADA
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Birnboim, H. C., & Doly, J. (1979). A rapid alkaline extraction procedure for screening recombinant plasmid DNA. *Nucleic Acids Research*, *7*(6), 1513–1523. https://doi.org/10.1093/nar/7.6.1513

Biswas, G. D., Burnstein, K. L., & Sparling, P. F. (1986). Linearization of donor DNA during plasmid transformation in *Neisseria gonorrhoeae*. *Journal of Bacteriology*, *168*(2), 756–761. https://doi.org/10.1128/jb.168.2.756-761.1986

Blaudeck, N., Sprenger, G. A., Freudl, R., & Wiegert, T. (2001). Specificity of Signal Peptide Recognition in Tat-Dependent Bacterial Protein Translocation. *Journal of Bacteriology*, *183*(2), 604–610. https://doi.org/10.1128/JB.183.2.604-610.2001

Bochman, M. L., Paeschke, K., & Zakian, V. A. (2012). DNA secondary structures: Stability and function of G-quadruplex structures. *Nature Reviews Genetics*, *13*(11), 770–780. https://doi.org/10.1038/nrg3296

Bornhorst, J. A., & Falke, J. J. (2000). Purification of proteins using polyhistidine affinity tags. In *Methods in Enzymology* (Vol. 326, pp. 245–254). Elsevier. https://doi.org/10.1016/S0076-6879(00)26058-8

Bradford, M. M. (1976). A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. *Analytical Biochemistry*, *72*(1–2), 248–254. https://doi.org/10.1016/0003-2697(76)90527-3

Bren, A., Hart, Y., Dekel, E., Koster, D., & Alon, U. (2013). The last generation of bacterial growth in limiting nutrient. *BMC Systems Biology*, *7*(1), 27. https://doi.org/10.1186/1752-0509-7-27

Briand, L., Marcion, G., Kriznik, A., Heydel, J. M., Artur, Y., Garrido, C., Seigneuric, R., & Neiers, F. (2016). A self-inducible heterologous protein expression system in *Escherichia coli*. *Scientific Reports*, *6*(1), 33037. https://doi.org/10.1038/srep33037

Brown, T. A. (Ed.). (2002). *Genomes* (2nd ed). Wiley-Liss.

Carroll, A. C., & Wong, A. (2018). Plasmid persistence: Costs, benefits, and the plasmid paradox. *Canadian Journal of Microbiology*, *64*(5), 293–304. https://doi.org/10.1139/cjm-2017-0609

Castro, C., Smidansky, E. D., Arnold, J. J., Maksimchuk, K. R., Moustafa, I., Uchida, A., Götte, M., Konigsberg, W., & Cameron, C. E. (2009). Nucleic acid polymerases use a general acid for nucleotidyl transfer. *Nature Structural & Molecular Biology*, *16*(2), 212–218. https://doi.org/10.1038/nsmb.1540

Chamberlin, M., Mcgrath, J., & Waskell, L. (1970). New RNA Polymerase from *Escherichia coli* infected with Bacteriophage T7. *Nature*, *228*(5268), 227–231. https://doi.org/10.1038/228227a0

Chan, W.-T., Verma, C. S., Lane, D. P., & Gan, S. K.-E. (2013). A comparison and optimization of methods and factors affecting the transformation of *Escherichia coli*. *Bioscience Reports*, *33*(6), e00086. https://doi.org/10.1042/BSR20130098

Chasseur, A. S., Trozzi, G., Istasse, C., Petit, A., Rasschaert, P., Denesvre, C., Kaufer, B. B., Bertzbach, L. D., Muylkens, B., & Coupeau, D. (2022).

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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Marek's Disease Virus Virulence Genes Encode Circular RNAs. *Journal of Virology*, *96*(9), e00321-22. https://doi.org/10.1128/jvi.00321-22

Chen, S., Zheng, X., Cao, H., Jiang, L., Liu, F., & Sun, X. (2015). A simple and efficient method for extraction of Taq DNA polymerase. *Electronic Journal of Biotechnology*, *18*(5), 355–358. https://doi.org/10.1016/j.ejbt.2015.08.001

Cheng, B., Zhu, C.-X., Ji, C., Ahumada, A., & Tse-Dinh, Y.-C. (2003). Direct Interaction between *Escherichia coli* RNA Polymerase and the Zinc Ribbon Domains of DNA Topoisomerase I. *Journal of Biological Chemistry*, *278*(33), 30705–30710. https://doi.org/10.1074/jbc.M303403200

Choi, J. H., Keum, K. C., & Lee, S. Y. (2006). Production of recombinant proteins by high cell density culture of *Escherichia coli*. *Chemical Engineering Science*, *61*(3), 876–885. https://doi.org/10.1016/j.ces.2005.03.031

Choi, Y. J., Morel, L., Le François, T., Bourque, D., Bourget, L., Groleau, D., Massie, B., & Míguez, C. B. (2010). Novel, Versatile, and Tightly Regulated Expression System for *Escherichia coli* Strains. *Applied and Environmental Microbiology*, *76*(15), 5058–5066. https://doi.org/10.1128/AEM.00413-10

Cline, J. (1996). PCR fidelity of pfu DNA polymerase and other thermostable DNA polymerases. *Nucleic Acids Research*, *24*(18), 3546–3551. https://doi.org/10.1093/nar/24.18.3546

Coelho-Rocha, N. D., De Castro, C. P., De Jesus, L. C. L., Leclercq, S. Y., De Cicco Sandes, S. H., Nunes, A. C., Azevedo, V., Drumond, M. M., & Mancha-Agresti, P. (2018). Microencapsulation of Lactic Acid Bacteria Improves the Gastrointestinal Delivery and in situ Expression of Recombinant Fluorescent Protein. *Frontiers in Microbiology*, *9*, 2398. https://doi.org/10.3389/fmicb.2018.02398

Coniey, E. C., Saunders, V. A., & Saunders, J. R. (1986). Deletion and rearrangement of plasmld DNA during transformation of *Escherichia coli* with linear plasmid molecules. *Nucleic Acids Research*, *14*(22), 8905–8917. https://doi.org/10.1093/nar/14.22.8905

Craggs, T. D., Sustarsic, M., Plochowietz, A., Mosayebi, M., Kaju, H., Cuthbert, A., Hohlbein, J., Domicevica, L., Biggin, P. C., Doye, J. P. K., & Kapanidis, A. N. (2019). Substrate conformational dynamics facilitate structure-specific recognition of gapped DNA by DNA polymerase. *Nucleic Acids Research*, *47*(20), 10788–10800. https://doi.org/10.1093/nar/gkz797

Dagert, M., & Ehrlich, S. D. (1979). Prolonged incubation in calcium chloride improves the competence of *Escherichia coli* cells. *Gene*, *6*(1), 23–28. https://doi.org/10.1016/0378-1119(79)90082-9

Dao, T. T., Truong, D. D., Duong, L. N., Nguyen, N. N., & Nguyen, H. D. (2023). Preparation of *Bacillus Subtilis* Cell Samples and Generation of an SDS-PAGE. *BioTechniques*, *74*(3), 123–129. https://doi.org/10.2144/btn-2022-0083

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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Dauga, C., Zabrovskaia, A., & Grimont, P. A. D. (1998). Restriction Fragment Length Polymorphism Analysis of Some Flagellin Genes of *Salmonella enterica*. *Journal of Clinical Microbiology*, *36*(10), 2835–2843. https://doi.org/10.1128/JCM.36.10.2835-2843.1998

De Marco, A. (2025). Recent advances in recombinant production of soluble proteins in *E. coli*. *Microbial Cell Factories*, *24*(1), 21. https://doi.org/10.1186/s12934-025-02646-8

De Ungria, M. C. A., Tillett, D., Neilan, B. A., Cox, P. T., & Lee, A. (1998). A Novel Method of Extracting Plasmid DNA from *Helicobacter* Species. *Helicobacter*, *3*(4), 269–277. https://doi.org/10.1111/j.1523-5378.1997.06085.pp.x-i1

de Winter, J. C. F. (n.d.). *Using the Student's t-test with extremely small sample sizes*. https://doi.org/10.7275/E4R6-DJ05

Dean, G. H., Asmarayani, R., Ardiyani, M., Santika, Y., Triono, T., Mathews, S., & Webb, C. O. (2018). Generating DNA sequence data with limited resources for molecular biology: Lessons from a barcoding project in Indonesia. *Applications in Plant Sciences*, *6*(7), e01167. https://doi.org/10.1002/aps3.1167

Demerec, M., & Fano, U. (1945). Bacteriophage-resistant mutants in *Escherichia coli*. *Genetics*, *30*(2), 119–136. https://doi.org/10.1093/genetics/30.2.119

Dewi, K. S. (2016). Construction and Periplasmic Expression of the Anti-EGFRvIII ScFv Antibody Gene in *Escherichia coli*. *Scientia Pharmaceutica*, *84*(1), 141–152. https://doi.org/10.3797/scipharm.ISP.2015.06

Dixon, M., & Webb, E. C. (1964). *Enzymes* (2. ed., compl. rev). Longmans.

Dong, H., Nilsson, L., & Kurland, C. G. (1995). Gratuitous overexpression of genes in *Escherichia coli* leads to growth inhibition and ribosome destruction. *Journal of Bacteriology*, *177*(6), 1497–1504. https://doi.org/10.1128/jb.177.6.1497-1504.1995

Dong, T., & Schellhorn, H. E. (2009). Global effect of RpoS on gene expression in pathogenic *Escherichia coli* O157:H7 strain EDL933. *BMC Genomics*, *10*(1), 349. https://doi.org/10.1186/1471-2164-10-349

Dos Santos, H. R. M., Argolo, C. S., Argôlo-Filho, R. C., & Loguercio, L. L. (2019). A 16S rDNA PCR-based theoretical to actual delta approach on culturable mock communities revealed severe losses of diversity information. *BMC Microbiology*, *19*(1), 74. https://doi.org/10.1186/s12866-019-1446-2

Driscoll, M. D., Rentergent, J., & Hay, S. (2014). A quantitative fluorescence-based steady-state assay of DNA polymerase. *The FEBS Journal*, *281*(8), 2042–2050. https://doi.org/10.1111/febs.12760

Du, F., Liu, Y.-Q., Xu, Y.-S., Li, Z.-J., Wang, Y.-Z., Zhang, Z.-X., & Sun, X.-M. (2021). Regulating the T7 RNA polymerase expression in *E. coli* BL21 (DE3) to provide more host options for recombinant protein production. *Microbial Cell Factories*, *20*(1), 189. https://doi.org/10.1186/s12934-021-01680-6

Eli, P., & Husimi, Y. (1998). Imidazole Improves Specificity of PCR by Suppressing the Product-Priming Outgrowth. *Chemistry Letters*, *27*(7), 683–684. https://doi.org/10.1246/cl.1998.683

UNIVERSITAS
GADJAH MADA
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Fernández, L. A., & De Lorenzo, V. (2001). Formation of disulphide bonds during secretion of proteins through the periplasmic-independent type I pathway. *Molecular Microbiology*, *40*(2), 332–346. https://doi.org/10.1046/j.1365-2958.2001.02410.x

Fernández-Castané, A., Caminal, G., & López-Santín, J. (2012). Direct measurements of IPTG enable analysis of the induction behavior of *E. coli* in high cell density cultures. *Microbial Cell Factories*, *11*(1), 58. https://doi.org/10.1186/1475-2859-11-58

Fiege, K., & Frankenberg-Dinkel, N. (2020). Construction of a new T7 promoter compatible *Escherichia coli* Nissle 1917 strain for recombinant production of heme-dependent proteins. *Microbial Cell Factories*, *19*(1), 190. https://doi.org/10.1186/s12934-020-01447-5

Florkin, M. (Ed.). (1973). *Comprehensive biochemistry. 13: Sect. 3, Biochemical reactions mechanisms: Enzyme nomenclature: recommendations (1972) of the Commission of Biochemical Nomenclature on the nomenclature and classification of enzymes together with their units and the symbols of enzyme kinetics* (3. ed). Elsevier.

Friehs, K. (2004). Plasmid Copy Number and Plasmid Stability. In T. Scheper (Ed.), *New Trends and Developments in Biochemical Engineering* (Vol. 86, pp. 47–82). Springer Berlin Heidelberg. https://doi.org/10.1007/b12440

Gallagher, S. R. (2007). One-Dimensional SDS Gel Electrophoresis of Proteins. *Current Protocols in Cell Biology*, *37*(1). https://doi.org/10.1002/0471143030.cb0601s37

Gallagher, S. R. (2008). SDS-Polyacrylamide Gel Electrophoresis (SDS-PAGE). *Current Protocols Essential Laboratory Techniques*, *00*(1). https://doi.org/10.1002/9780470089941.et0703s00

Garza-Cervantes, J. A., Meza-Bustillos, J. F., Resendiz-Hernández, H., Suárez-Cantú, I. A., Ortega-Rivera, O. A., Salinas, E., Escárcega-González, C. E., & Morones-Ramírez, J. R. (2020). Re-sensitizing Ampicillin and Kanamycin-Resistant *E. coli* and *S. aureus* Using Synergistic Metal Micronutrients-Antibiotic Combinations. *Frontiers in Bioengineering and Biotechnology*, *8*, 612. https://doi.org/10.3389/fbioe.2020.00612

Gaynutdinov, T. I., Englund, E. A., Appella, D. H., Onyshchenko, M. I., Neumann, R. D., & Panyutin, I. G. (2015). G-Quadruplex Formation Between G-Rich PNA and Homologous Sequences in Oligonucleotides and Supercoiled Plasmid DNA. *Nucleic Acid Therapeutics*, *25*(2), 78–84. https://doi.org/10.1089/nat.2014.0517

Genna, V., Vidossich, P., Ippoliti, E., Carloni, P., & De Vivo, M. (2016). A Self-Activated Mechanism for Nucleic Acid PolymerizationCatalyzed by DNA/RNA Polymerases. *Journal of the American Chemical Society*, *138*(44), 14592–14598. https://doi.org/10.1021/jacs.6b05475

Gibb, A. P., & Wong, S. (1998). Inhibition of PCR by Agar from Bacteriological Transport Media. *Journal of Clinical Microbiology*, *36*(1), 275–276. https://doi.org/10.1128/JCM.36.1.275-276.1998

Godbey, W. T. (2022). Cell growth. In *Biotechnology and its Applications* (pp. 117–150). Elsevier. https://doi.org/10.1016/B978-0-12-817726-6.00005-8

UNIVERSITAS GADJAH MADA
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Goetz, H., Kuschel, M., Wulff, T., Sauber, C., Miller, C., Fisher, S., & Woodward, C. (2004). Comparison of selected analytical techniques for protein sizing, quantitation and molecular weight determination. *Journal of Biochemical and Biophysical Methods*, *60*(3), 281–293. https://doi.org/10.1016/j.jbbm.2004.01.007

Gomes, L., Monteiro, G., & Mergulhão, F. (2020). The Impact of IPTG Induction on Plasmid Stability and Heterologous Protein Expression by *Escherichia coli* Biofilms. *International Journal of Molecular Sciences*, *21*(2), 576. https://doi.org/10.3390/ijms21020576

Gonzalez-Colell, M., & Macia, J. (2025). Characterization of recombinase activity across cellular growth phases. *Scientific Reports*, *15*(1), 31311. https://doi.org/10.1038/s41598-025-17024-y

Goranson-Siekierke, J., & Erbe, J. L. (2003). Restriction Analysis of Recombinant Plasmids. In N. Casali & A. Preston, *E. coli Plasmid Vectors* (Vol. 235, pp. 175–182). Humana Press. https://doi.org/10.1385/1-59259-409-3:175

Görke, B., & Stülke, J. (2008). Carbon catabolite repression in bacteria: Many ways to make the most out of nutrients. *Nature Reviews Microbiology*, *6*(8), 613–624. https://doi.org/10.1038/nrmicro1932

Gu, J., He, Y., He, C., Zhang, Q., Huang, Q., Bai, S., Wang, R., You, Q., & Wang, L. (2025). Advances in the structures, mechanisms and targeting of molecular chaperones. *Signal Transduction and Targeted Therapy*, *10*(1), 84. https://doi.org/10.1038/s41392-025-02166-2

Guan, C. (2005). A single catalytic domain of the junction-resolving enzyme T7 endonuclease I is a non-specific nicking endonuclease. *Nucleic Acids Research*, *33*(19), 6225–6234. https://doi.org/10.1093/nar/gki921

Halder, R., Nissley, D. A., Sitarik, I., Jiang, Y., Rao, Y., Vu, Q. V., Li, M. S., Pritchard, J., & O'Brien, E. P. (2023). How soluble misfolded proteins bypass chaperones at the molecular level. *Nature Communications*, *14*(1), 3689. https://doi.org/10.1038/s41467-023-38962-z

Hall, B. G., Acar, H., Nandipati, A., & Barlow, M. (2014). Growth Rates Made Easy. *Molecular Biology and Evolution*, *31*(1), 232–238. https://doi.org/10.1093/molbev/mst187

Hamdan, M. F., & Tan, B. C. (2025). Genetic modification techniques in plant breeding: A comparative review of CRISPR/Cas and GM technologies. *Horticultural Plant Journal*, *11*(5), 1807–1829. https://doi.org/10.1016/j.hpj.2024.02.012

Hamley, I. W., Kirkham, S., Dehsorkhi, A., Castelletto, V., Adamcik, J., Mezzenga, R., Ruokolainen, J., Mazzuca, C., Gatto, E., Venanzi, M., Placidi, E., Bilalis, P., & Iatrou, H. (2014). Self-Assembly of a Model Peptide Incorporating a Hexa-HistidineSequence Attached to an Oligo-Alanine Sequence, and Binding to GoldNTA/Nickel Nanoparticles. *Biomacromolecules*, *15*(9), 3412–3420. https://doi.org/10.1021/bm500950c

Han, M.-J. (2016). Exploring the proteomic characteristics of the *Escherichia coli* B and K-12 strains in different cellular compartments. *Journal of*

UNIVERSITAS
GADJAH MADA
Ekspresi Gen Penyandi OpenVent DNA Polimerase pada Escherichia coli Galur TOP 10 dan BL21 (DE3) di Dua Macam Media
Ahmad Fathullah Afidaputra, Prof. Ir. Donny Widianto, Ph.D.; Nur Akbar Arofatullah, S.P., M.Biotech., Ph.D
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Bioscience and Bioengineering, *122*(1), 1–9. https://doi.org/10.1016/j.jbiosc.2015.12.005

Handayani, C. V., Laksmi, F. A., Andriani, A., Nuryana, I., Mubarik, N. R., Agustriana, E., Dewi, K. S., & Purnawan, A. (2024). Expression of soluble moloney murine leukemia virus-reverse transcriptase in *Escherichia coli* BL21 star (DE3) using autoinduction system. *Molecular Biology Reports*, *51*(1), 628. https://doi.org/10.1007/s11033-024-09583-6

Hashem, V. I., Klysik, E. A., Rosche, W. A., & Sinden, R. R. (2002). Instability of repeated DNAs during transformation in *Escherichia coli*. *Mutation Research - Fundamental and Molecular Mechanisms of Mutagenesis*, *502*(1–2), 39–46. https://doi.org/10.1016/S0027-5107(02)00027-1

Hashimoto, H., Nishioka, M., Fujiwara, S., Takagi, M., Imanaka, T., Inoue, T., & Kai, Y. (2001). Crystal structure of DNA polymerase from hyperthermophilic archaeon *Pyrococcus kodakaraensis* KOD111Edited by R. Huber. *Journal of Molecular Biology*, *306*(3), 469–477. https://doi.org/10.1006/jmbi.2000.4403

Hassani, M., Hesami, S., Maroofi, N., & Banan, M. (2021). Pitfalls of Restriction Enzyme Mapping Following Generation of CRISPR Constructs. *Avicenna Journal of Medical Biotechnology*, *13*(4), 226–229.

Hayat, S. M. G., Farahani, N., Golichenari, B., & Sahebkar, A. (2018). Recombinant Protein Expression in *Escherichia coli* (*E.coli*): What We Need to Know. *Current Pharmaceutical Design*, *24*(6), 718–725. https://doi.org/10.2174/1381612824666180131121940

Hengge-Aronis, R., Klein, W., Lange, R., Rimmele, M., & Boos, W. (1991). Trehalose synthesis genes are controlled by the putative sigma factor encoded by rpoS and are involved in stationary-phase thermotolerance in *Escherichia coli*. *Journal of Bacteriology*, *173*(24), 7918–7924. https://doi.org/10.1128/jb.173.24.7918-7924.1991

Heyde, S. A. H., & Nørholm, M. H. H. (2021). Tailoring the evolution of BL21 (DE3) uncovers a key role for RNA stability in gene expression toxicity. *Communications Biology*, *4*(1), 963. https://doi.org/10.1038/s42003-021-02493-4

Higuchi, R., Fockler, C., Dollinger, G., & Watson, R. (1993). Kinetic PCR Analysis: Real-time Monitoring of DNA Amplification Reactions. *Nature Biotechnology*, *11*(9), 1026–1030. https://doi.org/10.1038/nbt0993-1026

Hikida, Y., Kimoto, M., Hirao, I., & Yokoyama, S. (2017). Crystal structure of Deep Vent DNA polymerase. *Biochemical and Biophysical Research Communications*, *483*(1), 52–57. https://doi.org/10.1016/j.bbrc.2017.01.007

Hogrefe, H. H., Cline, J., Lovejoy, A. E., & Nielson, K. B. (2001). DNA polymerases from hyperthermophiles. In *Methods in Enzymology* (Vol. 334, pp. 91–116). Elsevier. https://doi.org/10.1016/S0076-6879(01)34461-0

Horhota, A., Zou, K., Ichida, J. K., Yu, B., McLaughlin, L. W., Szostak, J. W., & Chaput, J. C. (2005). Kinetic Analysis of an Efficient DNA-Dependent

UNIVERSITAS GADJAH MADA
Ekspresi Gen Penyandi OpenVent DNA Polimerase pada Escherichia coli Galur TOP 10 dan BL21 (DE3) di Dua Macam Media
Ahmad Fathullah Afidaputra, Prof. Ir. Donny Widianto, Ph.D.; Nur Akbar Arofatullah, S.P., M.Biotech., Ph.D
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

TNAPolymerase. *Journal of the American Chemical Society*, *127*(20), 7427–7434. https://doi.org/10.1021/ja0428255

Hriňová, K., Dlapová, J., Kubala, B., Kormanová, Ľ., Levarski, Z., Struhárňanská, E., Turňa, J., & Stuchlík, S. (2024). Production of Reverse Transcriptase and DNA Polymerase in Bacterial Expression Systems. *Bioengineering*, *11*(7), 727. https://doi.org/10.3390/bioengineering11070727

Hu, J.-H., Wang, F., & Liu, C.-Z. (2015). Development of an efficient process intensification strategy for enhancing Pfu DNA polymerase production in recombinant *Escherichia coli*. *Bioprocess and Biosystems Engineering*, *38*(4), 651–659. https://doi.org/10.1007/s00449-014-1304-4

Huang, F., Spangler, J. R., & Huang, A. Y. (2017). In vivo cloning of up to 16 kb plasmids in *E. coli* is as simple as PCR. *PLOS ONE*, *12*(8), e0183974. https://doi.org/10.1371/journal.pone.0183974

Huang, H., & Keohavong, P. (1996). Fidelity and Predominant Mutations Produced by Deep Vent Wild-Type and Exonuclease-Deficient DNA Polymerases During *In Vitro* DNA Amplification. *DNA and Cell Biology*, *15*(7), 589–594. https://doi.org/10.1089/dna.1996.15.589

Huang, H.-J., Chen, W.-Y., & Wu, J.-H. (2014). Total Protein Extraction for Metaproteomics Analysis of Methane Producing Biofilm: The Effects of Detergents. *International Journal of Molecular Sciences*, *15*(6), 10169–10184. https://doi.org/10.3390/ijms150610169

Hussain, S. M., Sharif, A., Bashir, F., Ali, S., Javid, A., Hussain, A. I., Ghafoor, A., Alshehri, M. A., Naeem, A., Naeem, E., & Amjad, M. (2026). Polymerase Chain Reaction: A Toolbox for Molecular Discovery. *Molecular Biotechnology*, *68*(2), 409–421. https://doi.org/10.1007/s12033-025-01390-z

Ihssen, J., & Egli, T. (2004). Specific growth rate and not cell density controls the general stress response in *Escherichia coli*. *Microbiology*, *150*(6), 1637–1648. https://doi.org/10.1099/mic.0.26849-0

İncir, İ., & Kaplan, Ö. (2024). *Escherichia coli* as a versatile cell factory: Advances and challenges in recombinant protein production. *Protein Expression and Purification*, *219*, 106463. https://doi.org/10.1016/j.pep.2024.106463

Inglehart, J., & Nelson, P. C. (1994). On the limitations of automated restriction mapping. *Bioinformatics*, *10*(3), 249–261. https://doi.org/10.1093/bioinformatics/10.3.249

International Union of Biochemistry Commission on Enzymes. (1961). *Report of the Commission on Enzymes of the International Union of Biochemistry 1961*. Pergamon Press.

Ishino, S., & Ishino, Y. (2014). DNA polymerases as useful reagents for biotechnology - the history of developmental research in the field. *Frontiers in Microbiology*, *5*. https://doi.org/10.3389/fmicb.2014.00465

James, J., Yarnall, B., Koranteng, A., Gibson, J., Rahman, T., & Doyle, D. A. (2021). Protein over-expression in *Escherichia coli* triggers adaptation analogous to antimicrobial resistance. *Microbial Cell Factories*, *20*(1), 13. https://doi.org/10.1186/s12934-020-01462-6

UNIVERSITAS GADJAH MADA
Ekspresi Gen Penyandi OpenVent DNA Polimerase pada Escherichia coli Galur TOP 10 dan BL21 (DE3) di Dua Macam Media
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Jiang, R., Yuan, S., Zhou, Y., Wei, Y., Li, F., Wang, M., Chen, B., & Yu, H. (2024). Strategies to overcome the challenges of low or no expression of heterologous proteins in *Escherichia coli*. *Biotechnology Advances*, *75*, 108417. https://doi.org/10.1016/j.biotechadv.2024.108417

Johnson, K. A. (2010). The kinetic and chemical mechanism of high-fidelity DNA polymerases. *Biochimica et Biophysica Acta (BBA) - Proteins and Proteomics*, *1804*(5), 1041–1048. https://doi.org/10.1016/j.bbapap.2010.01.006

Johnson, K. A., & Radhakrishnan, A. (2021). The use of anthrolysin O and ostreolysin A to study cholesterol in cell membranes. In *Methods in Enzymology* (Vol. 649, pp. 543–566). Elsevier. https://doi.org/10.1016/bs.mie.2021.01.011

Juretić, D., & Bonačić Lošić, Ž. (2024). Theoretical Improvements in Enzyme Efficiency Associated with Noisy Rate Constants and Increased Dissipation. *Entropy*, *26*(2), 151. https://doi.org/10.3390/e26020151

Kang, J., Lee, M. S., & Gorenstein, D. G. (2007). Application of RNase in the purification of RNA-binding proteins. *Analytical Biochemistry*, *365*(1), 147–148. https://doi.org/10.1016/j.ab.2007.03.003

Khaerunnisa, Laksmi, F. A., Rahayuningsih, M., Amalia, A. R., Violando, W. A., Nuryana, I., Ertanto, Y., & Nugraha, Y. (2025). One-step rapid production of DNA polymerase from *Pyrococcus furiosus* in *Escherichia coli* system under optimized culture conditions. *Preparative Biochemistry & Biotechnology*, *55*(8), 1066–1074. https://doi.org/10.1080/10826068.2025.2483238

Kintaka, R., Makanae, K., & Moriya, H. (2016). Cellular growth defects triggered by an overload of protein localization processes. *Scientific Reports*, *6*(1), 31774. https://doi.org/10.1038/srep31774

Kleman, G. L., & Strohl, W. R. (1994). Acetate metabolism by *Escherichia coli* in high-cell-density fermentation. *Applied and Environmental Microbiology*, *60*(11), 3952–3958. https://doi.org/10.1128/aem.60.11.3952-3958.1994

Koehl, P., & Levitt, M. (2002). Sequence Variations within Protein Families are Linearly Related to Structural Variations. *Journal of Molecular Biology*, *323*(3), 551–562. https://doi.org/10.1016/s0022-2836(02)00971-3

Komar, A. A., Lesnik, T., & Reiss, C. (1999). Synonymous codon substitutions affect ribosome traffic and protein folding during in vitro translation. *FEBS Letters*, *462*(3), 387–391. https://doi.org/10.1016/S0014-5793(99)01566-5

Koster, M., Bitter, W., & Tommassen, J. (2000). Protein secretion mechanisms in Gram-negative bacteria. *International Journal of Medical Microbiology*, *290*(4–5), 325–331. https://doi.org/10.1016/S1438-4221(00)80033-8

Kovárová-Kovar, K., & Egli, T. (1998). Growth Kinetics of Suspended Microbial Cells: From Single-Substrate-Controlled Growth to Mixed-Substrate Kinetics. *Microbiology and Molecular Biology Reviews*, *62*(3), 646–666. https://doi.org/10.1128/MMBR.62.3.646-666.1998

Kram, K. E., & Finkel, S. E. (2015). Rich Medium Composition Affects *Escherichia coli* Survival, Glycation, and Mutation Frequency during

UNIVERSITAS GADJAH MADA
Ekspresi Gen Penyandi OpenVent DNA Polimerase pada Escherichia coli Galur TOP 10 dan BL21 (DE3) di Dua Macam Media
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Long-Term Batch Culture. *Applied and Environmental Microbiology*, *81*(13), 4442–4450. https://doi.org/10.1128/AEM.00722-15

Kroll, D. J., Abdel-Hafiz, H. A.-M., Marcell, T., Simpson, S., Chen, C.-Y., Gutierrez-Hartmann, A., Lustbader, J. W., & Hoeffler, J. P. (1993). A Multifunctional Prokaryotic Protein Expression System: Overproduction, Affinity Purification, and Selective Detection. *DNA and Cell Biology*, *12*(5), 441–453. https://doi.org/10.1089/dna.1993.12.441

Kumar, J., Bhat, S. U., & Rathore, A. S. (2022). Slow post-induction specific growth rate enhances recombinant protein expression in *Escherichia coli*: Pramlintide multimer and ranibizumab production as case studies. *Process Biochemistry*, *114*, 21–27. https://doi.org/10.1016/j.procbio.2022.01.009

Kuznetsova, A. A., Fedorova, O. S., & Kuznetsov, N. A. (2022). Structural and Molecular Kinetic Features of Activities of DNA Polymerases. *International Journal of Molecular Sciences*, *23*(12), 6373. https://doi.org/10.3390/ijms23126373

Laksmi, F. A., Lischer, K., Nugraha, Y., Violando, W. A., Helbert, Nuryana, I., Khasna, F. N., Nur, N., Ramadhan, K. P., Tobing, D. A. L., Hariyatun, & Hidayat, I. (2025). A robust strategy for overexpression of DNA polymerase from Thermus aquaticus using an IPTG-independent autoinduction system in a benchtop bioreactor. *Scientific Reports*, *15*(1), 5891. https://doi.org/10.1038/s41598-025-89902-4

Lecina, M., Sarró, E., Casablancas, A., Gòdia, F., & Cairó, J. J. (2013). IPTG limitation avoids metabolic burden and acetic acid accumulation in induced fed-batch cultures of *Escherichia coli* M15 under glucose limiting conditions. *Biochemical Engineering Journal*, *70*, 78–83. https://doi.org/10.1016/j.bej.2012.10.006

Lee, P. Y., Costumbrado, J., Hsu, C.-Y., & Kim, Y. H. (2012). Agarose Gel Electrophoresis for the Separation of DNA Fragments. *Journal of Visualized Experiments*, (62), 3923. https://doi.org/10.3791/3923

Lee, S. J., Park, S.-Y., Lee, K.-H., Lee, M.-W., Yu, C.-Y., Maeng, J., Kim, H.-D., & Kim, S. W. (2023). Development of a Simple Direct and Hot-Start PCR Using *Escherichia coli*-Expressing Taq DNA Polymerase. *International Journal of Molecular Sciences*, *24*(14), 11405. https://doi.org/10.3390/ijms241411405

Leelayuwat, C., Srisuk, T., Paechaiyaphum, R., Limpaiboon, T., Romphruk, A., & Romphruk, A. (1997). Production and evaluation of Taq DNA polymerase. *Journal of the Medical Association of Thailand*, S129-137.

Levinthal, M., & Pownder, T. (1996). Hns, rpoS and lrp mutations affect stationary-phase survival at high osmolarity. *Research in Microbiology*, *147*(5), 333–342. https://doi.org/10.1016/0923-2508(96)84708-5

Levy, M. S. (2000). Quantitation of supercoiled circular content in plasmid DNA solutions using a fluorescence-based method. *Nucleic Acids Research*, *28*(12), 57e–557. https://doi.org/10.1093/nar/28.12.e57

Li, F., Xiong, X.-S., Yang, Y.-Y., Wang, J.-J., Wang, M.-M., Tang, J.-W., Liu, Q.-H., Wang, L., & Gu, B. (2021). Effects of NaCl Concentrations on Growth Patterns, Phenotypes Associated With Virulence, and Energy Metabolism

UNIVERSITAS GADJAH MADA
Ekspresi Gen Penyandi OpenVent DNA Polimerase pada Escherichia coli Galur TOP 10 dan BL21 (DE3) di Dua Macam Media
Ahmad Fathullah Afidaputra, Prof. Ir. Donny Widianto, Ph.D.; Nur Akbar Arofatullah, S.P., M.Biotech., Ph.D
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

in *Escherichia coli* BW25113. *Frontiers in Microbiology*, *12*, 705326. https://doi.org/10.3389/fmicb.2021.705326

Li, Z., & Rinas, U. (2020). Recombinant protein production associated growth inhibition results mainly from transcription and not from translation. *Microbial Cell Factories*, *19*(1), 83. https://doi.org/10.1186/s12934-020-01343-y

Liang, Y., Motawaa, M., Bu, X., Wei, J., Shao, Y., & Li, Y. (2025). Construction of primary chassis cells with efficient protein expression in *Thermus thermophilus*. *Microbial Cell Factories*, *24*(1), 163. https://doi.org/10.1186/s12934-025-02785-y

Lischer, K., Tansil, K. P., Ginting, M. J., Sahlan, M., Wijanarko, A., & Yohda, M. (2020). Cloning of DNA Polymerase I *Geobacillus thermoleovorans* SGAir0734 from a Batu Kuwung Hot Spring in *Escherichia coli*. *International Journal of Technology*, *11*(5), 921. https://doi.org/10.14716/ijtech.v11i5.4311

Liu, J., Chang, W., Pan, L., Liu, X., Su, L., Zhang, W., Li, Q., & Zheng, Y. (2018). An Improved Method of Preparing High Efficiency Transformation *Escherichia coli* with Both Plasmids and Larger DNA Fragments. *Indian Journal of Microbiology*, *58*(4), 448–456. https://doi.org/10.1007/s12088-018-0743-z

López-Cano, A., Sicilia, P., Gaja, C., Arís, A., & Garcia-Fruitós, E. (2022). Quality comparison of recombinant soluble proteins and proteins solubilized from bacterial inclusion bodies. *New Biotechnology*, *72*, 58–63. https://doi.org/10.1016/j.nbt.2022.09.003

Lorenz, T. C. (2012). Polymerase Chain Reaction: Basic Protocol Plus Troubleshooting and Optimization Strategies. *Journal of Visualized Experiments*, (63), 3998. https://doi.org/10.3791/3998

Lu, S. (2003). Rapid Screening of Recombinant Plasmids. In N. Casali & A. Preston, *E. coli Plasmid Vectors* (Vol. 235, pp. 169–174). Humana Press. https://doi.org/10.1385/1-59259-409-3:169

Lucena-Aguilar, G., Sánchez-López, A. M., Barberán-Aceituno, C., Carrillo-Ávila, J. A., López-Guerrero, J. A., & Aguilar-Quesada, R. (2016). DNA Source Selection for Downstream Applications Based on DNA Quality Indicators Analysis. *Biopreservation and Biobanking*, *14*(4), 264–270. https://doi.org/10.1089/bio.2015.0064

Ma, C., Tang, Z., Wang, K., Tan, W., Li, J., Li, W., Li, Z., Yang, X., Li, H., & Liu, L. (2006). Real-time monitoring of DNA polymerase activity using molecular beacon. *Analytical Biochemistry*, *353*(1), 141–143. https://doi.org/10.1016/j.ab.2006.02.006

Mahgoub, E. O., & Abdella, G. M. (2023). Cloning and Expression of VP1 Protein for Large-Scale Production in *E. coli* TOP 10. *Applied Microbiology Open Access*, *9*, 268.

Makinoshima, H., Aizawa, S.-I., Hayashi, H., Miki, T., Nishimura, A., & Ishihama, A. (2003). Growth Phase-Coupled Alterations in Cell Structure and Function of *Escherichia coli*. *Journal of Bacteriology*, *185*(4), 1338–1345. https://doi.org/10.1128/JB.185.4.1338-1345.2003

UNIVERSITAS
GADJAH MADA
Ekspresi Gen Penyandi OpenVent DNA Polimerase pada Escherichia coli Galur TOP 10 dan BL21 (DE3) di Dua Macam Media
Ahmad Fathullah Afidaputra, Prof. Ir. Donny Widianto, Ph.D.; Nur Akbar Arofatullah, S.P., M.Biotech., Ph.D
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Malakar, P., & Venkatesh, K. V. (2012). Effect of substrate and IPTG concentrations on the burden to growth of *Escherichia coli* on glycerol due to the expression of Lac proteins. *Applied Microbiology and Biotechnology*, *93*(6), 2543–2549. https://doi.org/10.1007/s00253-011-3642-3

Malvezzi, S., Sturla, S. J., & Tanasova, M. (2015). Quantification of pyrophosphate as a universal approach to determine polymerase activity and assay polymerase inhibitors. *Analytical Biochemistry*, *478*, 1–7. https://doi.org/10.1016/j.ab.2015.03.002

Martínez-Esquivel, B. O., Baltasar-González, M. A., Corona-Montes, V., & Zamora-Domínguez, J. A. (2024). Transfection of the H-RAS gene produces genomic instability in the MOLT-4 cell line. *Revista Médica Del Hospital General de México*, *87*(3), 13130. https://doi.org/10.24875/HGMX.23000051

Matsumoto, H., Haniu, H., & Komori, N. (2019). Determination of Protein Molecular Weights on SDS-PAGE. In B. T. Kurien & R. H. Scofield (Eds.), *Electrophoretic Separation of Proteins* (Vol. 1855, pp. 101–105). Springer New York. https://doi.org/10.1007/978-1-4939-8793-1_10

Mazlan, A. H., Muhamad Najib, M. H. A., Hassan, M. H., Mohd Hatta, F. H., & Yusoff, R. M. (2024). Effect of DNA Template Concentration on Standard Polymerase Chain Reaction. Int*ernational Journal of Pharmaceuticals, Nutraceuticals and Cosmetic Science*, *7*(1), 1–11. https://doi.org/10.24191/ijpnacs.v7i1.01

McDonald, A. G., & Tipton, K. F. (2022). Parameter Reliability and Understanding Enzyme Function. *Molecules*, *27*(1), 263. https://doi.org/10.3390/molecules27010263

Mendoza-Rojas, G., Sarabia-Vega, V., Sanchez-Castro, A., Tello, L., Cabrera-Sosa, L., Nakamoto, J. A., Peñaranda, K., Adaui, V., Alcántara, R., & Milón, P. (2021). A low-cost and open-source protocol to produce key enzymes for molecular detection assays. *STAR Protocols*, *2*(4), 100899. https://doi.org/10.1016/j.xpro.2021.100899

Mergulhão, F. J. M., Summers, D. K., & Monteiro, G. A. (2005). Recombinant protein secretion in *Escherichia coli*. *Biotechnology Advances*, *23*(3), 177–202. https://doi.org/10.1016/j.biotechadv.2004.11.003

Mital, S., Christie, G., & Dikicioglu, D. (2021). Recombinant expression of insoluble enzymes in *Escherichia coli*: A systematic review of experimental design and its manufacturing implications. *Microbial Cell Factories*, *20*(1), 208. https://doi.org/10.1186/s12934-021-01698-w

Mohan, S. B. (1992). Determination of Purity and Yield. In A. Kenney & S. Fowell, *Practical Protein Chromatography* (Vol. 11, pp. 307–324). Humana Press. https://doi.org/10.1385/0-89603-213-2:307

Morrison, D. A. (1977). Transformation in *Escherichia coli*: Cryogenic preservation of competent cells. *Journal of Bacteriology*, *132*(1), 349–351. https://doi.org/10.1128/jb.132.1.349-351.1977

Mullis, K., Faloona, F., Scharf, S., Saiki, R., Horn, G., & Erlich, H. (1986). Specific Enzymatic Amplification of DNA In Vitro: The Polymerase Chain

UNIVERSITAS GADJAH MADA
Ekspresi Gen Penyandi OpenVent DNA Polimerase pada Escherichia coli Galur TOP 10 dan BL21 (DE3) di Dua Macam Media
Ahmad Fathullah Afidaputra, Prof. Ir. Donny Widianto, Ph.D.; Nur Akbar Arofatullah, S.P., M.Biotech., Ph.D
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Reaction. *Cold Spring Harbor Symposia on Quantitative Biology*, *51*(0), 263–273. https://doi.org/10.1101/SQB.1986.051.01.032

Murgatroyd, C. (2018). Epigenetic Changes in the Immune Systems Following Early-Life Stress. In *Inflammation and Immunity in Depression* (pp. 325–338). Elsevier. https://doi.org/10.1016/B978-0-12-811073-7.00018-0

Nakamura, T., Zhao, Y., Yamagata, Y., Hua, Y., & Yang, W. (2013). Mechanism of the nucleotidyl-transfer reaction in DNA polymerase revealed by time-resolved protein crystallography. *BIOPHYSICS*, *9*(0), 31–36. https://doi.org/10.2142/biophysics.9.31

Nasri, M., Berry, F., Sayadi, S., Thomas, D., & Barbotin, J. N. (1988). Stability Fluctuations of Plasmid-bearing Cells: Immobilization Effects. *Microbiology*, *134*(8), 2325–2331. https://doi.org/10.1099/00221287-134-8-2325

Naz, S., & Fatima, A. (2013). Amplification of GC-rich DNA for High-Throughput Family-Based Genetic Studies. *Molecular Biotechnology*, *53*(3), 345–350. https://doi.org/10.1007/s12033-012-9559-y

Ng, W. (2023). Effect of template and primer-probe concentration level on shape of qPCR amplification curve. https://doi.org/10.21203/rs.3.rs-3051803/v1

Ngo, V., Karunatilleke, N. C., Brickenden, A., Choy, W.-Y., & Duennwald, M. L. (2022). Oxidative Stress-Induced Misfolding and Inclusion Formation of Nrf2 and Keap1. *Antioxidants*, *11*(2), 243. https://doi.org/10.3390/antiox11020243

Nguyen, H. L., Duviau, M.-P., Laguerre, S., Nouaille, S., Cocaign-Bousquet, M., & Girbal, L. (2022). Synergistic Regulation of Transcription and Translation in *Escherichia coli* Revealed by Codirectional Increases in mRNA Concentration and Translation Efficiency. *Microbiology Spectrum*, *10*(1), e02041-21. https://doi.org/10.1128/spectrum.02041-21

Nguyen, T. K. O., Vu, T. L., Nguyen, M. Q., Ta, H. K. K., Park, K. S., Kim, S. H., Kim, C. J., Jang, Y. J., & Choe, H. (2021). Soluble Prokaryotic Overexpression and Purification of Human GM-CSF Using the Protein Disulfide Isomerase b′a′ Domain. *International Journal of Molecular Sciences*, *22*(10), 5267. https://doi.org/10.3390/ijms22105267

Novick, A., & Weiner, M. (1957). Enzyme Induction as an All-or-None Phenomenon. *Proceedings of the National Academy of Sciences*, *43*(7), 553–566. https://doi.org/10.1073/pnas.43.7.553

Oakley, J. L., & Coleman, J. E. (1977). Structure of a promoter for T7 RNA polymerase. *Proceedings of the National Academy of Sciences*, *74*(10), 4266–4270. https://doi.org/10.1073/pnas.74.10.4266

Oftadeh, O., & Hatzimanikatis, V. (2024). Genome-scale models of metabolism and expression predict the metabolic burden of recombinant protein expression. *Metabolic Engineering*, *84*, 109–116. https://doi.org/10.1016/j.ymben.2024.06.005

Ojima, Y., Saito, H., Miyuki, S., Fukunaga, K., Tsuboi, T., & Azuma, M. (2025). Induction conditions that promote the effect of glycerol on recombinant protein production in *Escherichia coli*. *Biotechnology Reports*, *46*, e00898. https://doi.org/10.1016/j.btre.2025.e00898

UNIVERSITAS
GADJAH MADA
Ekspresi Gen Penyandi OpenVent DNA Polimerase pada Escherichia coli Galur TOP 10 dan BL21 (DE3) di Dua Macam Media
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Old, R. W., & Primrose, S. B. (1985). *Principles of gene manipulation: An introduction to genetic engineering* (3rd. ed). Blackwell Scientific Publications.

Ordóñez, C. D., & Redrejo-Rodríguez, M. (2023). DNA Polymerases for Whole Genome Amplification: Considerations and Future Directions. *International Journal of Molecular Sciences*, *24*(11), 9331. https://doi.org/10.3390/ijms24119331

Osborne, C. A., Galic, M., Sangwan, P., & Janssen, P. H. (2005). PCR-generated artefact from 16S rRNA gene-specific primers. *FEMS Microbiology Letters*, *248*(2), 183–187. https://doi.org/10.1016/j.femsle.2005.05.043

Paalme, V., & Speek, M. (2021). Simple, Inexpensive and RNase-Free Purification of Plasmid DNA by Fractional Precipitation with Isopropanol. *BioTechniques*, *71*(3), 2–5. https://doi.org/10.2144/btn-2021-0018

Pant, T., Kumar, R., Agrawal, C., & Kumar, Y. (2026). Specific detection of Salmonella Typhi by probe-free quantitative polymerase chain reaction. *Archives of Microbiology*, *208*(4), 176. https://doi.org/10.1007/s00203-026-04724-w

Papaneophytou, C. P., & Kontopidis, G. (2014). Statistical approaches to maximize recombinant protein expression in *Escherichia coli*: A general review. *Protein Expression and Purification*, *94*, 22–32. https://doi.org/10.1016/j.pep.2013.10.016

Pastic, A., Kochhar, A., & D'Amours, D. (2025). Protocol for detecting interactions between intrinsically disordered proteins and long DNA substrates by electrophoretic mobility shift assay. *STAR Protocols*, *6*(3), 103968. https://doi.org/10.1016/j.xpro.2025.103968

Patzelt, H., Rüdiger, S., Brehmer, D., Kramer, G., Vorderwülbecke, S., Schaffitzel, E., Waitz, A., Hesterkamp, T., Dong, L., Schneider-Mergener, J., & Bukau, B. (2001). Binding specificity of *Escherichia coli* trigger factor. *Proceedings of the National Academy of Sciences*, *98*(25), 14244–14249. https://doi.org/10.1073/pnas.26143229

Pavlova, A. V., Dolinnaya, N. G., Zvereva, M. I., Kubareva, E. A., & Monakhova, M. V. (2023). New DNA Plasmid Model for Studying DNA Mismatch Repair Response to the G4 Structure. *International Journal of Molecular Sciences*, *24*(2), 1061. https://doi.org/10.3390/ijms24021061

Pouresmaeil, M., & Azizi-Dargahlou, S. (2023). Factors involved in heterologous expression of proteins in *E. coli* host. *Archives of Microbiology*, *205*(5), 212. https://doi.org/10.1007/s00203-023-03541-9

Puigbo, P., Guzman, E., Romeu, A., & Garcia-Vallve, S. (2007). OPTIMIZER: A web server for optimizing the codon usage of DNA sequences. *Nucleic Acids Research*, *35*(Web Server), W126–W131. https://doi.org/10.1093/nar/gkm219

Purzycka, J. K., Olewiecki, I., Soltyszewski, I., Pepinski, W., & Janica, J. (2006). Efficiency comparison of seven different Taq polymerases used in hemogenetics. *International Congress Series*, *1288*, 719–721. https://doi.org/10.1016/j.ics.2005.09.073

UNIVERSITAS
GADJAH MADA
Ekspresi Gen Penyandi OpenVent DNA Polimerase pada Escherichia coli Galur TOP 10 dan BL21 (DE3) di Dua Macam Media
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Querellou, J., & Cambon, M. A. (2004). Heat-stable DNA polymerase of archaeobacteria of genus Pyrococcus (U.S. Patent No. 6,673,585). Appligene-Oncor S.A.

Rajewska, M., Wegrzyn, K., & Konieczny, I. (2012). AT-rich region and repeated sequences – the essential elements of replication origins of bacterial replicons. *FEMS Microbiology Reviews*, *36*(2), 408–434. https://doi.org/10.1111/j.1574-6976.2011.00300.x

Ramírez, O. T., Zamora, R., Espinosa, G., Merino, E., Bolívar, F., & Quintero, R. (1994). Kinetic study of penicillin acylase production by recombinant *E. coli* in batch cultures. *Process Biochemistry*, *29*(3), 197–206. https://doi.org/10.1016/0032-9592(94)85004-6

Ramiro-Martínez, P., De Quinto, I., Lanza, V. F., Gama, J. A., & Rodríguez-Beltrán, J. (2025). Universal rules govern plasmid copy number. *Nature Communications*, *16*(1), 6022. https://doi.org/10.1038/s41467-025-61202-5

Rittié, L., & Perbal, B. (2008). Enzymes used in molecular biology: A useful guide. *Journal of Cell Communication and Signaling*, *2*(1–2), 25–45. https://doi.org/10.1007/s12079-008-0026-2

Robinson, P. K. (2015). Enzymes: Principles and biotechnological applications. *Essays in Biochemistry*, *59*, 1–41. https://doi.org/10.1042/bse0590001

Rodiansyah, A., Tan, M. I., & Nugrahapraja, H. (2022). *Construction, Cloning, and Overexpression of Staphylococcal Enterotoxin B Gene Synthetic (SEBsyn) in pET-28a(+): Pre-development Bacterial-Toxin Therapy for Cancer:* 7th International Conference on Biological Science (ICBS 2021). https://doi.org/10.2991/absr.k.220406.065

Rosa, M. D. (1979). Four T7 RNA polymerase promoters contain an identical 23 bp sequence. *Cell*, *16*(4), 815–825. https://doi.org/10.1016/0092-8674(79)90097-7

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

Rouchka, E. C., and States, D. J. (1998). Sequence assembly validation by multiple restriction digest fragment coverage analysis. In *Proceedings of the International Conference of Intelligent Systems in Molecular Biology*, 6, 140-147.

Roy, U., Mishra, A., Jana, P., & Karmakar, S. (2018). A Comparative Study on Different Plasmid Isolation Procedures. *International Journal of Pure & Applied Bioscience*, *6*(5), 533–541. https://doi.org/10.18782/2320-7051.6988

Sabarudin, S., Alfaqeeh, M., Sida, N., Trinovitasari, N., Ruslin, R., Abushanab, D., Wulandari, W., Khairinisa, M., & Suwantika, A. (2026). Activity-Based Costing of COVID-19 RT-PCR Testing in Public Laboratories in Indonesia: Evidence for Tariff Setting. *ClinicoEconomics and Outcomes Research*, *Volume 18*, 1–10. https://doi.org/10.2147/CEOR.S596722

Saiki, R. K., Gelfand, D. H., Stoffel, S., Scharf, S. J., Higuchi, R., Horn, G. T., Mullis, K. B., & Erlich, H. A. (1988). Primer-Directed Enzymatic

UNIVERSITAS GADJAH MADA
Ekspresi Gen Penyandi OpenVent DNA Polimerase pada Escherichia coli Galur TOP 10 dan BL21 (DE3) di Dua Macam Media
Ahmad Fathullah Afidaputra, Prof. Ir. Donny Widianto, Ph.D.; Nur Akbar Arofatullah, S.P., M.Biotech., Ph.D
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Amplification of DNA with a Thermostable DNA Polymerase. *Science*, *239*(4839), 487–491. https://doi.org/10.1126/science.2448875

Samman, N., Al-Muhalhil, K., & Nehdi, A. (2023). A simple and efficient method for Taq DNA polymerase purification based on heat denaturation and affinity chromatography. *Journal of King Saud University - Science*, *35*(3), 102565. https://doi.org/10.1016/j.jksus.2023.102565

Sankar, S. P., Citartan, M., Ahmed Siti, A., V. Skryabin, B., S. Rozhdestvensky, T., Heah Khor, G., & Hock Tang, T. (2019). A simple method for in-house Pfu DNA polymerase purification for high-fidelity PCR amplification. *Iranian Journal of Microbiology*. https://doi.org/10.18502/ijm.v11i2.1085

Sapriel, G., Wandersman, C., & Delepelaire, P. (2003). The SecB Chaperone Is Bifunctional in *Serratia marcescens*: SecB Is Involved in the Sec Pathway and Required for HasA Secretion by the ABC Transporter. *Journal of Bacteriology*, *185*(1), 80–88. https://doi.org/10.1128/JB.185.1.80-88.2003

Schmidt, T., Friehs, K., & Flaschel, E. (2001). Structures of Plasmid DNA. In M. Schleef (Ed.), *Plasmids for Therapy and Vaccination* (1st ed., pp. 29–43). Wiley. https://doi.org/10.1002/9783527612833.ch02

Schmidt, T., Friehs, K., Schleef, M., Voss, C., & Flaschel, E. (1999). Quantitative Analysis of Plasmid Forms by Agarose and Capillary Gel Electrophoresis. *Analytical Biochemistry*, *274*(2), 235–240. https://doi.org/10.1006/abio.1999.4291

Schumann, A., Cohn, A. R., Gaballa, A., & Wiedmann, M. (2023). *Escherichia coli* B-Strains Are Intrinsically Resistant to Colistin and Not Suitable for Characterization and Identification of *mcr* Genes. *Microbiology Spectrum*, *11*(3), e00894-23. https://doi.org/10.1128/spectrum.00894-23

Seville, M., West, A. B., Cull, M. G., & McHenry, C. S. (1996). Fluorometric Assay for DNA Polymerases and Reverse Transcriptase. *BioTechniques*, *21*(4), 664–672. https://doi.org/10.2144/96214st04

Sheen, H. (2016). Quantitation of yeast total proteins in sodium dodecyl sulfate–polyacrylamide gel electrophoresis sample buffer for uniform loading. *Analytical Biochemistry*, *498*, 95–97. https://doi.org/10.1016/j.ab.2016.01.002

Singha, T. K., Gulati, P., Mohanty, A., Khasa, Y. P., Kapoor, R. K., & Kumar, S. (2017). Efficient genetic approaches for improvement of plasmid based expression of recombinant protein in *Escherichia coli*: A review. *Process Biochemistry*, *55*, 17–31. https://doi.org/10.1016/j.procbio.2017.01.026

Sirajuddin, S. A., & Sundram, S. (2020). Evaluation of two transformation protocols and screening of positive plasmid introduction into *Bacillus cereus* EB2, a gram-positive bacterium using qualitative analyses. *Brazilian Journal of Microbiology*, *51*(3), 919–929. https://doi.org/10.1007/s42770-020-00241-0

Smalla, K., Jechalke, S., & Top, E. M. (2015). Plasmid Detection, Characterization, and Ecology. *Microbiology Spectrum*, *3*(1), 3.1.17. https://doi.org/10.1128/microbiolspec.PLAS-0038-2014

Son, Y. J., Ryu, A. J., Li, L., Han, N. S., & Jeong, K. J. (2016). Development of a high-copy plasmid for enhanced production of recombinant proteins in

UNIVERSITAS
GADJAH MADA
Ekspresi Gen Penyandi OpenVent DNA Polimerase pada Escherichia coli Galur TOP 10 dan BL21 (DE3) di Dua Macam Media
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Leuconostoc citreum. *Microbial Cell Factories*, *15*(1), 12. https://doi.org/10.1186/s12934-015-0400-8

Soupene, E., Van Heeswijk, W. C., Plumbridge, J., Stewart, V., Bertenthal, D., Lee, H., Prasad, G., Paliy, O., Charernnoppakul, P., & Kustu, S. (2003). Physiological Studies of *Escherichia coli* Strain MG1655: Growth Defects and Apparent Cross-Regulation of Gene Expression. *Journal of Bacteriology*, *185*(18), 5611–5626. https://doi.org/10.1128/JB.185.18.5611-5626.2003

Staal, J., Alci, K., Schamphelaire, W. D., Vanhoucke, M., & Beyaert, R. (2019). Engineering a Minimal Cloning Vector from a pUC18 Plasmid Backbone with an Extended Multiple Cloning Site. *BioTechniques*, *66*(6), 254–259. https://doi.org/10.2144/btn-2019-0014

Stanbury, P. F., Whitaker, A., & Hall, S. J. (2017). Microbial growth kinetics. In *Principles of Fermentation Technology* (pp. 21–74). Elsevier. https://doi.org/10.1016/B978-0-08-099953-1.00002-8

Standley, M. S., Million-Weaver, S., Alexander, D. L., Hu, S., & Camps, M. (2019). Genetic control of ColE1 plasmid stability that is independent of plasmid copy number regulation. *Current Genetics*, *65*(1), 179–192. https://doi.org/10.1007/s00294-018-0858-0

Steitz, T. A. (1999). DNA Polymerases: Structural Diversity and Common Mechanisms. *Journal of Biological Chemistry*, *274*(25), 17395–17398. https://doi.org/10.1074/jbc.274.25.17395

Strandberg, L., & Enfors, S. O. (1991). Factors influencing inclusion body formation in the production of a fused protein in *Escherichia coli*. *Applied and Environmental Microbiology*, *57*(6), 1669–1674. https://doi.org/10.1128/aem.57.6.1669-1674.1991

Studier, F. W. (1972). Bacteriophage T7: Genetic and biochemical analysis of this simple phage gives information about basic genetic processes. *Science*, *176*(4033), 367–376. https://doi.org/10.1126/science.176.4033.367

Studier, F. W., & Moffatt, B. A. (1986). Use of bacteriophage T7 RNA polymerase to direct selective high-level expression of cloned genes. *Journal of Molecular Biology*, *189*(1), 113–130. https://doi.org/10.1016/0022-2836(86)90385-2

Summers, D. K., & Sherratt, D. J. (1984). Multimerization of high copy number plasmids causes instability: Cole 1 encodes a determinant essential for plasmid monomerization and stability. *Cell*, *36*(4), 1097–1103. https://doi.org/10.1016/0092-8674(84)90060-6

Sun, S., Xiao, J., Zhang, H., & Zhang, Z. (2016). Pangenome Evidence for Higher Codon Usage Bias and Stronger Translational Selection in Core Genes of *Escherichia coli*. *Frontiers in Microbiology*, *7*. https://doi.org/10.3389/fmicb.2016.01180

Suzuki, T., & Yasui, K. (2011). Plasmid Artificial Modification: A Novel Method for Efficient DNA Transfer into Bacteria. In J. A. Williams (Ed.), *Strain Engineering* (Vol. 765, pp. 309–326). Humana Press. https://doi.org/10.1007/978-1-61779-197-0_18

UNIVERSITAS
GADJAH MADA
Ekspresi Gen Penyandi OpenVent DNA Polimerase pada Escherichia coli Galur TOP 10 dan BL21 (DE3) di Dua Macam Media
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Tabor, S., & Richardson, C. C. (1985). A bacteriophage T7 RNA polymerase/promoter system for controlled exclusive expression of specific genes. *Proceedings of the National Academy of Sciences*, *82*(4), 1074–1078. https://doi.org/10.1073/pnas.82.4.1074

Talaer, J. Y. L., Kermici, M., & Jeanteur, Ph. (1973). Isolation of *Escherichia coli* RNA Polymerase Binding Sites on T5 and T7 DNA: Further Evidence for Sigma-Dependent Recognition of A-T-Rich DNA Sequences. *Proceedings of the National Academy of Sciences, 70*(10), 2911–2915. https://doi.org/10.1073/pnas.70.10.2911

Talukder, A. A., Yanai, S., Nitta, T., Kato, A., & Yamada, M. (1996). RpoS-dependent regulation of genes expressed at late stationary phase in *Escherichia coli*. *FEBS Letters*, *386*(2–3), 177–180. https://doi.org/10.1016/0014-5793(96)00426-7

Tanabe, K., Bohn, E. W., & Wilson, S. H. (1979). Steady-state kinetics of mouse DNA polymerase .beta. *Biochemistry*, *18*(15), 3401–3406. https://doi.org/10.1021/bi00582a029

Tao, Z., Yuan, H., Liu, M., Liu, Q., Zhang, S., Liu, H., Jiang, Y., Huang, D., & Wang, T. (2023). Yeast Extract: Characteristics, Production, Applications and Future Perspectives. *Journal of Microbiology and Biotechnology*, *33*(2), 151–166. https://doi.org/10.4014/jmb.2207.07057

Teng, X. C., Ang, S. Y., Citartan, M., Tang, T. H., & Ahmed, S. A. (2023). Simple approach for expression and rapid purification of Taq DNA polymerase in three *Escherichia coli* strains. *Asia Pacific Journal of Molecular Biology and Biotechnology*, 45–52. https://doi.org/10.35118/apjmbb.2023.031.1.05

Thermo Fisher Scientific. (n.d.). Coomassie Blue Staining [Protocol]. Retrieved 10 November 2026, from https://www.thermofisher.com/id/en/home/references/protocols/proteins-expression-isolation-and-analysis/staining-protein-gels/coomassie-staining.html

Thomas, J. G., & Baneyx, F. (1996). Protein Misfolding and Inclusion Body Formation in Recombinant *Escherichia coli* Cells Overexpressing Heat-shock Proteins. *Journal of Biological Chemistry*, *271*(19), 11141–11147. https://doi.org/10.1074/jbc.271.19.11141

Tomlinson, C., Rajasekaran, A., Brochu-Gaudreau, K., Dubois, C., Farmilo, A. J., Gris, P., Khatiz, A., Matthews, A., Piltonen, M., Amrani, A., & Gris, D. (2024). A convenient analytic method for gel quantification using ImageJ paired with Python or R. *PLOS ONE*, *19*(11), e0308297. https://doi.org/10.1371/journal.pone.0308297

Trajkovic, K., Valdez, C., Ysselstein, D., & Krainc, D. (2019). Fluctuations in cell density alter protein markers of multiple cellular compartments, confounding experimental outcomes. *PLOS ONE*, *14*(2), e0211727. https://doi.org/10.1371/journal.pone.0211727

TransGen Biotech. (n.d.a). FlyCut® BamHI (JB101) [Manual]. Retrieved 5 September 2026, from https://www.transgenbiotech.com/download/pdf/1/JB101_144/JB101.pdf

UNIVERSITAS GADJAH MADA
Ekspresi Gen Penyandi OpenVent DNA Polimerase pada Escherichia coli Galur TOP 10 dan BL21 (DE3) di Dua Macam Media
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

TransGen Biotech. (n.d.b). FlyCut® EcoRI (JE201) [Manual]. Retrieved 5 September 2026, from https://www.transgenbiotech.com/download/pdf/1/JE201_147/JE201.pdf

Trivedi, R. N., Akhtar, P., Meade, J., Bartlow, P., Ataai, M. M., Khan, S. A., & Domach, M. M. (2014). High-Level Production of Plasmid DNA by *Escherichia coli* DH5α Ω *sacB* by Introducing *inc* Mutations. *Applied and Environmental Microbiology*, *80*(23), 7154–7160. https://doi.org/10.1128/AEM.02445-14

Tsai, M. (2019). Catalytic mechanism of DNA polymerases—Two metal ions or three? *Protein Science*, *28*(2), 288–291. https://doi.org/10.1002/pro.3542

Tuttle, A. R., Trahan, N. D., & Son, M. S. (2021). Growth and Maintenance of *Escherichia coli* Laboratory Strains. *Current Protocols*, *1*(1), e20. https://doi.org/10.1002/cpz1.20

Tveit, H., & Kristensen, T. (2001). Fluorescence-Based DNA Polymerase Assay. *Analytical Biochemistry*, *289*(1), 96–98. https://doi.org/10.1006/abio.2000.4903

Tweedie, J. W., & Stowell, K. M. (2005). Quantification of DNA by agarose gel electrophoresis and analysis of the topoisomers of plasmid and M13 DNA following treatment with a restriction endonuclease or DNA topoisomerase I. *Biochemistry and Molecular Biology Education*, *33*(1), 28–33. https://doi.org/10.1002/bmb.2005.494033010410

Ugarov, V. I., Samatov, T. R., Chetverina, H. V., & Chetverin, A. B. (1999). Plasmid Purification Using Hot Mg^{2+} Treatment and No RNase. *BioTechniques*, *26*(2), 194–198. https://doi.org/10.2144/99262bm03

Vashishtha, A. K., Wang, J., & Konigsberg, W. H. (2016). Different Divalent Cations Alter the Kinetics and Fidelity of DNA Polymerases. *Journal of Biological Chemistry*, *291*(40), 20869–20875. https://doi.org/10.1074/jbc.R116.742494

Vincentelli, R., Cimino, A., Geerlof, A., Kubo, A., Satou, Y., & Cambillau, C. (2011). High-throughput protein expression screening and purification in *Escherichia coli*. *Methods*, *55*(1), 65–72. https://doi.org/10.1016/j.ymeth.2011.08.010

Waegeman, H., De Lausnay, S., Beauprez, J., Maertens, J., De Mey, M., & Soetaert, W. (2013). Increasing recombinant protein production in *Escherichia coli* K12 through metabolic engineering. *New Biotechnology*, *30*(2), 255–261. https://doi.org/10.1016/j.nbt.2011.11.008

Wang, H., & Joffré, E. (2025). Plasmid copy number as a modulator in bacterial pathogenesis and antibiotic resistance. *Npj Antimicrobials and Resistance*, *3*(1), 72. https://doi.org/10.1038/s44259-025-00145-9

Wang, L., Miller, A., & Kendall, D. A. (2000). Signal Peptide Determinants of SecA Binding and Stimulation of ATPase Activity. *Journal of Biological Chemistry*, *275*(14), 10154–10159. https://doi.org/10.1074/jbc.275.14.10154

Wang, Y. (2017). Spatial distribution of high copy number plasmids in bacteria. *Plasmid*, *91*, 2–8. https://doi.org/10.1016/j.plasmid.2017.02.005

UNIVERSITAS GADJAH MADA
Ekspresi Gen Penyandi OpenVent DNA Polimerase pada Escherichia coli Galur TOP 10 dan BL21 (DE3) di Dua Macam Media
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Wang, Y., Wang, X., Yu, L., Tian, Y., Li, S., Leng, F., Ma, J., & Chen, J. (2020). Effects of Sr^{2+} on the preparation of *Escherchia coli* DH5α competent cells and plasmid transformation. *PeerJ*, *8*, e9480. https://doi.org/10.7717/peerj.9480

Welfer, G. A., Brady, R. A., Natchiar, S. K., Watson, Z. L., Rundlet, E. J., Alejo, J. L., Singh, A. P., Mishra, N. K., Altman, R. B., & Blanchard, S. C. (2025). Impacts of ribosomal RNA sequence variation on gene expression and phenotype. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *380*(1921), 20230379. https://doi.org/10.1098/rstb.2023.0379

Westphalen, H., Abdelrasoul, A., & Shoker, A. (2021). Protein adsorption phenomena in hemodialysis membranes: Mechanisms, influences of clinical practices, modeling, and challenges. *Colloid and Interface Science Communications*, *40*, 100348. https://doi.org/10.1016/j.colcom.2020.100348

Whitley, E., & Ball, J. (2002). Statistics review 5: Comparison of means. *Critical Care*, *6*(5), 424. https://doi.org/10.1186/cc1548

Wilson, I. G. (1997). Inhibition and facilitation of nucleic acid amplification. *Applied and Environmental Microbiology*, *63*(10), 3741–3751. https://doi.org/10.1128/aem.63.10.3741-3751.1997

Wittmeier, P., & Hummel, S. (2022). Agarose Gel Electrophoresis to Assess PCR Product Yield: Comparison with Spectrophotometry, Fluorometry and qPCR. *BioTechniques*, *72*(4), 155–158. https://doi.org/10.2144/btn-2021-0094

Wood, W. N., Smith, K. D., Ream, J. A., & Lewis, L. K. (2017). Enhancing yields of low and single copy number plasmid DNAs from *Escherichia coli* cells. *Journal of Microbiological Methods*, *133*, 46–51. https://doi.org/10.1016/j.mimet.2016.12.016

Wright, L. W., Lichter, J. B., Reinitz, J., Shifman, M. A., Kidd, K. K., & Miller, P. L. (1994). Computer-assisted restriction mapping: An integrated approach to handling experimental uncertainty. *Bioinformatics*, *10*(4), 435–442. https://doi.org/10.1093/bioinformatics/10.4.435

Yamabhai, M., Buranabanyat, B., Jaruseranee, N., & Songsiriritthigul, C. (2011). Efficient *E. coli* expression systems for the production of recombinant β-mannanases and other bacterial extracellular enzymes. *Bioengineered Bugs*, *2*(1), 45–49. https://doi.org/10.4161/bbug.2.1.13419

Yang, Y., Yu, Q., Wang, M., Zhao, R., Liu, H., Xun, L., & Xia, Y. (2022). *Escherichia coli* BW25113 Competent Cells Prepared Using a Simple Chemical Method Have Unmatched Transformation and Cloning Efficiencies. *Frontiers in Microbiology*, *13*, 838698. https://doi.org/10.3389/fmicb.2022.838698

Yau, S. Y., Keshavarz-Moore, E., & Ward, J. (2008). Host strain influences on supercoiled plasmid DNA production in *Escherichia coli*: Implications for efficient design of large-scale processes. *Biotechnology and Bioengineering*, *101*(3), 529–544. https://doi.org/10.1002/bit.21915

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Yu, L., Hu, G., & Howells, L. (2002). Fluorescence-Based, High-Throughput DNA Polymerase Assay. *BioTechniques*, *33*(4), 938–941. https://doi.org/10.2144/02334pf02

Zenkin, N., & Severinov, K. (2004). The role of RNA polymerase σ subunit in promoter-independent initiation of transcription. *Proceedings of the National Academy of Sciences*, *101*(13), 4396–4400. https://doi.org/10.1073/pnas.0400886101

Zhang, D., Li, S. H.-J., King, C. G., Wingreen, N. S., Gitai, Z., & Li, Z. (2022). Global and gene-specific translational regulation in *Escherichia coli* across different conditions. *PLOS Computational Biology*, *18*(10), e1010641. https://doi.org/10.1371/journal.pcbi.1010641

Zhang, Y., Nunoura, T., Nishiura, D., Hirai, M., Shimamura, S., Kurosawa, K., Ishiwata, C., & Deguchi, S. (2020). A single-molecule counting approach for convenient and ultrasensitive measurement of restriction digest efficiencies. *PLOS ONE*, *15*(12), e0244464. https://doi.org/10.1371/journal.pone.0244464

Zhang, Z., Zheng, S., Zhang, Z., Wu, F., Wu, Q., & Chen, G.-Q. (2025). Lactose induced bioproduction by Halomonas grown under open conditions. *Chemical Engineering Journal*, *507*, 160468. https://doi.org/10.1016/j.cej.2025.160468

Zhang, Z.-X., Nong, F.-T., Wang, Y.-Z., Yan, C.-X., Gu, Y., Song, P., & Sun, X.-M. (2022). Strategies for efficient production of recombinant proteins in *Escherichia coli*: Alleviating the host burden and enhancing protein activity. *Microbial Cell Factories*, *21*(1), 191. https://doi.org/10.1186/s12934-022-01917-y

Zhao, L., Xu, Y., Yang, Z., Liu, W., Zhong, S., Bai, J., & Guo, X. (2025). Unveiling the Mechanism of Deprotonation and Proton Transfer of DNA Polymerase Catalysis via Single-Molecule Conductance. *Advanced Science*, *12*(2), 2408112. https://doi.org/10.1002/advs.202408112

Zhou, J., Li, X., Xia, J., Wen, Y., Zhou, J., Yu, Z., & Tian, B. (2018). The role of temperature and bivalent ions in preparing competent *Escherichia coli*. *3 Biotech*, *8*(5), 222. https://doi.org/10.1007/s13205-018-1243-x

Zhou, Y., Zhu, Y., & Wong, W. K. (2023). Statistical tests for homogeneity of variance for clinical trials and recommendations. *Contemporary Clinical Trials Communications*, *33*, 101119. https://doi.org/10.1016/j.conctc.2023.101119

Zhu, M., & Dai, X. (2019). Growth suppression by altered (p)ppGpp levels results from non-optimal resource allocation in *Escherichia coli*. *Nucleic Acids Research*, *47*(9), 4684–4693. https://doi.org/10.1093/nar/gkz211

Zweitzig, D. R., Riccardello, N. M., Sodowich, B. I., & O'Hara, S. M. (2012). Characterization of a novel DNA polymerase activity assay enabling sensitive, quantitative and universal detection of viable microbes. *Nucleic Acids Research*, *40*(14), e109–e109. https://doi.org/10.1093/nar/gks316