



Georgios Skiniotis

Professor of Molecular and Cellular Physiology, of Structural Biology and of Photon Science

Molecular & Cellular Physiology

Bio

BIO

The Skiniotis laboratory seeks to resolve structural and mechanistic questions underlying biological processes that are central to cellular physiology. Our investigations employ primarily cryo-electron microscopy (cryoEM) and 3D reconstruction techniques complemented by biochemistry, biophysics and simulation methods to obtain a dynamic view into the macromolecular complexes carrying out these processes. The main theme in the lab is the structural biology of cell surface receptors that mediate intracellular signaling and communication. Our current main focus is the exploration of the mechanisms responsible for transmembrane signal instigation in cytokine receptors and G protein coupled receptor (GPCR) complexes.

ACADEMIC APPOINTMENTS

- Professor, Molecular & Cellular Physiology
- Professor, Structural Biology
- Professor, Photon Science Directorate
- Member, Bio-X
- Member, Wu Tsai Neurosciences Institute

ADMINISTRATIVE APPOINTMENTS

- Co-Director of Stanford-SLAC Cryo-EM Center, Stanford University, (2017- present)
- Professor of Structural Biology and Molecular & Cellular Physiology, Stanford University, (2017- present)
- Jack E. Dixon Collegiate Professor of the Life Sciences, University of Michigan, (2013-2017)
- Assistant Professor, Dept. of Biological Chemistry, University of Michigan, (2008-2013)

HONORS AND AWARDS

- Earl and Thressa Stadtman Scholar Award, ASBMB (2016)
- Presidential Early Career Award for Scientists and Engineers, White House/NIH (2012)
- Pew Scholar in Biomedical Sciences, The Pew Charitable Trusts (2011)
- Damon Runyon Cancer Research Foundation postdoctoral fellow, Damon Runyon Cancer Research Foundation (2004)

BOARDS, ADVISORY COMMITTEES, PROFESSIONAL ORGANIZATIONS

- Scientific Advisory Board member for cryo-EM operations, Harvard Medical School (2018 - present)

Teaching

STANFORD ADVISEES

Postdoctoral Faculty Sponsor

Ximena Barros Alvarez, Gozde Eskici, Yang Gao, Danish Khan, Yamuna Kalyani Mathiharan, Makaia Papisergi-Scott, Michael Robertson, Alpay Seven

Publications

PUBLICATIONS

- **Conformational transitions of a neurotensin receptor1-Gi1complex.** *Nature*
Kato, H. E., Zhang, Y., Hu, H., Suomivuori, C., Kadji, F. M., Aoki, J., Krishna Kumar, K., Fonseca, R., Hilger, D., Huang, W., Latorraca, N. R., Inoue, A., Dror, et al
2019
- **Structures of the Rhodopsin-Transducin Complex: Insights into G-Protein Activation.** *Molecular cell*
Gao, Y., Hu, H., Ramachandran, S., Erickson, J. W., Cerione, R. A., Skiniotis, G.
2019
- **Structures of the M1 and M2 muscarinic acetylcholine receptor/G-protein complexes** *SCIENCE*
Maeda, S., Qu, Q., Robertson, M. J., Skiniotis, G., Kobilka, B. K.
2019; 364 (6440): 552-+
- **Structural insights into the activation of metabotropic glutamate receptors (vol 566, pg 79, 2019)** *NATURE*
Koehl, A., Hu, H., Feng, D., Sun, B., Zhang, Y., Robertson, M. J., Chu, M., Kobilka, T., Laeremans, T., Steyaert, J., Tarrasch, J., Dutta, S., Fonseca, et al
2019; 567 (7747): E10
- **Author Correction: Structural insights into the activation of metabotropic glutamate receptors.** *Nature*
Koehl, A., Hu, H., Feng, D., Sun, B., Zhang, Y., Robertson, M. J., Chu, M., Kobilka, T. S., Laeremans, T., Steyaert, J., Tarrasch, J., Dutta, S., Fonseca, et al
2019
- **Structure of a Signaling Cannabinoid Receptor 1-G Protein Complex** *CELL*
Kumar, K., Shalev-Benami, M., Robertson, M. J., Hu, H., Banister, S. D., Hollingsworth, S. A., Latorraca, N. R., Kato, H. E., Hilger, D., Maeda, S., Weis, W. I., Farrens, D. L., Dror, et al
2019; 176 (3): 448-+
- **Structural insights into the activation of metabotropic glutamate receptors.** *Nature*
Koehl, A., Hu, H., Feng, D., Sun, B., Zhang, Y., Robertson, M. J., Chu, M., Kobilka, T. S., Laermans, T., Steyaert, J., Tarrasch, J., Dutta, S., Fonseca, et al
2019
- **Structures of the M1 and M2 muscarinic acetylcholine receptor/G-protein complexes.** *Science (New York, N.Y.)*
Maeda, S., Qu, Q., Robertson, M. J., Skiniotis, G., Kobilka, B. K.
2019; 364 (6440): 552-57
- **Structure of a Signaling Cannabinoid Receptor 1-G Protein Complex.** *Cell*
Krishna Kumar, K., Shalev-Benami, M., Robertson, M. J., Hu, H., Banister, S. D., Hollingsworth, S. A., Latorraca, N. R., Kato, H. E., Hilger, D., Maeda, S., Weis, W. I., Farrens, D. L., Dror, et al
2018
- **Structure and Conformational Dynamics of a COMPASS Histone H3K4 Methyltransferase Complex.** *Cell*
Qu, Q., Takahashi, Y., Yang, Y., Hu, H., Zhang, Y., Brunzelle, J. S., Couture, J., Shilatfard, A., Skiniotis, G.
2018
- **Structure of the μ -opioid receptor-Gi protein complex.** *Nature*
Koehl, A., Hu, H., Maeda, S., Zhang, Y., Qu, Q., Paggi, J. M., Latorraca, N. R., Hilger, D., Dawson, R., Matile, H., Schertler, G. F., Granier, S., Weis, et al
2018
- **Structural Basis for Teneurin Function in Circuit-Wiring: A Toxin Motif at the Synapse** *CELL*

- Li, J., Shalev-Benami, M., Sando, R., Jiang, X., Kibrom, A., Wang, J., Leon, K., Katanski, C., Nazarko, O., Lu, Y. C., Sudhof, T. C., Skiniotis, G., Arac, et al
2018; 173 (3): 735-+
- **Cryo-EM structure of the activated GLP-1 receptor in complex with a G protein.** *Nature*
Zhang, Y., Sun, B., Feng, D., Hu, H., Chu, M., Qu, Q., Tarrasch, J. T., Li, S., Sun Kobilka, T., Kobilka, B. K., Skiniotis, G.
2017; 546 (7657): 248-253
 - **Phase-plate cryo-EM structure of a class B GPCR-G-protein complex.** *Nature*
Liang, Y., Khoshouei, M., Radjainia, M., Zhang, Y., Glukhova, A., Tarrasch, J., Thal, D. M., Furness, S. G., Christopoulos, G., Coudrat, T., Danev, R., Baumeister, W., Miller, et al
2017; 546 (7656): 118-123
 - **Structural and Functional Analysis of a beta(2)-Adrenergic Receptor Complex with GRK5** *Cell*
Komolov, K. E., Du, Y., Duc, N. M., Betz, R. M., Rodrigues, J. P., Leib, R. D., Patra, D., Skiniotis, G., Adams, C. M., Dror, R. O., Chung, K. Y., Kobilka, B. K., Benovic, et al
2017; 169 (3): 407-421 e16
 - **Atomic resolution snapshot of Leishmania ribosome inhibition by the aminoglycoside paromomycin.** *Nature communications*
Shalev-Benami, M., Zhang, Y., Rozenberg, H., Nobe, Y., Taoka, M., Matzov, D., Zimmerman, E., Bashan, A., Isobe, T., Jaffe, C. L., Yonath, A., Skiniotis, G.
2017; 8 (1): 1589
 - **GPCR-G Protein-β-Arrestin Super-Complex Mediates Sustained G Protein Signaling.** *Cell*
Thomsen, A. R., Plouffe, B., Cahill, T. J., Shukla, A. K., Tarrasch, J. T., Dosey, A. M., Kahsai, A. W., Strachan, R. T., Pani, B., Mahoney, J. P., Huang, L., Breton, B., Heydenreich, et al
2016; 166 (4): 907-919
 - **Highly Branched Pentasaccharide-Bearing Amphiphiles for Membrane Protein Studies.** *Journal of the American Chemical Society*
Ehsan, M., Du, Y., Scull, N. J., Tikhonova, E., Tarrasch, J., Mortensen, J. S., Loland, C. J., Skiniotis, G., Guan, L., Byrne, B., Kobilka, B. K., Chae, P. S.
2016; 138 (11): 3789-96
 - **Visualization of arrestin recruitment by a G-protein-coupled receptor** *NATURE*
Shukla, A. K., Westfield, G. H., Xiao, K., Reis, R. I., Huang, L., Tripathi-Shukla, P., Qian, J., Li, S., Blanc, A., Oleskie, A. N., Dosey, A. M., Su, M., Liang, et al
2014; 512 (7513): 218-?
 - **Structure of a modular polyketide synthase** *NATURE*
Dutta, S., Whicher, J. R., Hansen, D. A., Hale, W. A., Chemler, J. A., Congdon, G. R., Narayan, A. R., Hakansson, K., Sherman, D. H., Smith, J. L., Skiniotis, G.
2014; 510 (7506): 512-?
 - **Structural rearrangements of a polyketide synthase module during its catalytic cycle** *NATURE*
Whicher, J. R., Dutta, S., Hansen, D. A., Hale, W. A., Chemler, J. A., Dosey, A. M., Narayan, A. R., Hakansson, K., Sherman, D. H., Smith, J. L., Skiniotis, G.
2014; 510 (7506): 560-?
 - **Ligand-Induced Architecture of the Leptin Receptor Signaling Complex** *MOLECULAR CELL*
Mancour, L. V., Daghestani, H. N., Dutta, S., Westfield, G. H., Schilling, J., Oleskie, A. N., Herbstman, J. F., Chou, S. Z., Skiniotis, G.
2012; 48 (4): 655-661
 - **Crystal structure of the beta(2) adrenergic receptor-Gs protein complex** *NATURE*
Rasmussen, S. G., DeVree, B. T., Zou, Y., Kruse, A. C., Chung, K. Y., Kobilka, T. S., Thian, F. S., Chae, P. S., Pardon, E., Calinski, D., Mathiesen, J. M., Shah, S. T., Lyons, et al
2011; 477 (7366): 549-U311
 - **Structural flexibility of the Gas alpha-helical domain in the beta(2)-adrenoceptor Gs complex** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
Westfield, G. H., Rasmussen, S. G., Su, M., Dutta, S., DeVree, B. T., Chung, K. Y., Calinski, D., Velez-Ruiz, G., Oleskie, A. N., Pardon, E., Chae, P. S., Liu, T., Li, et al
2011; 108 (38): 16086-16091
 - **Ribosome Assembly Factors Prevent Premature Translation Initiation by 40S Assembly Intermediates** *SCIENCE*
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- **Structural organization of a full-length gp130/LIF-R cytokine receptor transmembrane complex** *MOLECULAR CELL*
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- **Structure of a VEGF-VEGF receptor complex determined by electron microscopy** *NATURE STRUCTURAL & MOLECULAR BIOLOGY*
Ruch, C., Skiniotis, G., Steinmetz, M. O., Walz, T., Ballmer-Hofer, K.
2007; 14 (3): 249-250
- **Signaling conformations of the tall cytokine receptor gp130 when in complex with IL-6 and IL-6 receptor** *NATURE STRUCTURAL & MOLECULAR BIOLOGY*
Skiniotis, G., Boulanger, M. J., Garcia, K. C., Walz, T.
2005; 12 (6): 545-551
- **Self-Assembly Behavior and Application of Terphenyl-Cored Trimaltosides for Membrane-Protein Studies: Impact of Detergent Hydrophobic Group Geometry on Protein Stability.** *Chemistry (Weinheim an der Bergstrasse, Germany)*
Ehsan, M., Du, Y., Mortensen, J. S., Hariharan, P., Qu, Q., Ghani, L., Das, M., Grethen, A., Byrne, B., Skiniotis, G., Keller, S., Loland, C. J., Guan, et al
2019
- **De novo computational RNA modeling into cryo-EM maps of large ribonucleoprotein complexes.** *Nature methods*
Kappel, K., Liu, S., Larsen, K. P., Skiniotis, G., Puglisi, E. V., Puglisi, J. D., Zhou, Z. H., Zhao, R., Das, R.
2018
- **Structural Analysis of the Ash2L/Dpy-30 Complex Reveals a Heterogeneity in H3K4 Methylation.** *Structure (London, England : 1993)*
Haddad, J. F., Yang, Y., Takahashi, Y., Joshi, M., Chaudhary, N., Woodfin, A. R., Benyoucef, A., Yeung, S., Brunzelle, J. S., Skiniotis, G., Brand, M., Shilatifard, A., Couture, et al
2018
- **Development of an antibody fragment that stabilizes GPCR/G-protein complexes.** *Nature communications*
Maeda, S., Koehl, A., Matile, H., Hu, H., Hilger, D., Schertler, G. F., Manglik, A., Skiniotis, G., Dawson, R. J., Kobilka, B. K.
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- **Vitamin E-based glycoside amphiphiles for membrane protein structural studies.** *Organic & biomolecular chemistry*
Ehsan, M., Du, Y., Molist, I., Seven, A. B., Hariharan, P., Mortensen, J. S., Ghani, L., Loland, C. J., Skiniotis, G., Guan, L., Byrne, B., Kobilka, B. K., Chae, et al
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- **Architecture of an HIV-1 reverse transcriptase initiation complex.** *Nature*
Larsen, K. P., Mathiharan, Y. K., Kappel, K., Coey, A. T., Chen, D. H., Barrero, D., Madigan, L., Puglisi, J. D., Skiniotis, G., Puglisi, E. V.
2018
- **Alternative Mode of E-Site tRNA Binding in the Presence of a Downstream mRNA Stem Loop at the Entrance Channel.** *Structure (London, England : 1993)*
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2018; 26 (3): 437-45.e3
- **Dendronic trimaltoside amphiphiles (DTMs) for membrane protein study** *CHEMICAL SCIENCE*
Sadaf, A., Du, Y., Santillan, C., Mortensen, J. S., Molist, I., Seven, A. B., Hariharan, P., Skiniotis, G., Loland, C. J., Kobilka, B. K., Guan, L., Byrne, B., Chae, et al
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2017; 114 (10): 2562-2567
- **Conformationally Preorganized Diastereomeric Norbornane-Based Maltosides for Membrane Protein Study: Implications of Detergent Kink for Micellar Properties.** *Journal of the American Chemical Society*
Das, M., Du, Y., Ribeiro, O., Hariharan, P., Mortensen, J. S., Patra, D., Skiniotis, G., Loland, C. J., Guan, L., Kobilka, B. K., Byrne, B., Chae, P. S.

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- **The Vps13p-Cdc31p complex is directly required for TGN late endosome transport and TGN homotypic fusion** *JOURNAL OF CELL BIOLOGY*
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2017; 216 (2): 425-439
- **Isolation and structure-function characterization of a signaling-active rhodopsin-G protein complex.** *The Journal of biological chemistry*
Gao, Y., Westfield, G., Erickson, J. W., Cerione, R. A., Skiniotis, G., Ramachandran, S.
2017; 292 (34): 14280-89
- **Phosphoantigen-induced conformational change of butyrophilin 3A1 (BTN3A1) and its implication on V#9V#2 T cell activation.** *Proceedings of the National Academy of Sciences of the United States of America*
Gu, S., Sachleben, J. R., Boughter, C. T., Nawrocka, W. I., Borowska, M. T., Tarrasch, J. T., Skiniotis, G., Roux, B., Adams, E. J.
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- **A snapshot of cryo-EM** *PROTEIN SCIENCE*
Skiniotis, G.
2017; 26 (1): 5-7
- **Structural Basis for Regulated Proteolysis by the #-Secretase ADAM10.** *Cell*
Seegar, T. C., Killingsworth, L. B., Saha, N., Meyer, P. A., Patra, D., Zimmerman, B., Janes, P. W., Rubinstein, E., Nikolov, D. B., Skiniotis, G., Kruse, A. C., Blacklow, S. C.
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- **New penta-saccharide-bearing tripod amphiphiles for membrane protein structure studies.** *The Analyst*
Ehsan, M., Ghani, L., Du, Y., Hariharan, P., Mortensen, J. S., Ribeiro, O., Hu, H., Skiniotis, G., Loland, C. J., Guan, L., Kobilka, B. K., Byrne, B., Chae, et al
2017; 142 (20): 3889-98
- **Extended surface for membrane association in Zika virus NS1 structure** *NATURE STRUCTURAL & MOLECULAR BIOLOGY*
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2016; 23 (9): 865-867
- **Flexible, symmetry-directed approach to assembling protein cages** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
Sciore, A., Su, M., Koldewey, P., Eschweiler, J. D., Diffley, K. A., Linhares, B. M., Ruotolo, B. T., Bardwell, J. C., Skiniotis, G., Marsh, E. N.
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- **2.8-angstrom Cryo-EM Structure of the Large Ribosomal Subunit from the Eukaryotic Parasite Leishmania** *CELL REPORTS*
Shalev-Benami, M., Zhang, Y., Matzov, D., Halfon, Y., Zackay, A., Rozenberg, H., Zimmerman, E., Bashan, A., Jaffe, C. L., Yonath, A., Skiniotis, G.
2016; 16 (2): 288-294
- **Highly Branched Pentasaccharide-Bearing Amphiphiles for Membrane Protein Studies** *JOURNAL OF THE AMERICAN CHEMICAL SOCIETY*
Ehsan, M., Du, Y., Scull, N. J., Tikhonova, E., Tarrasch, J., Mortensen, J. S., Loland, C. J., Skiniotis, G., Guan, L., Byrne, B., Kobilka, B. K., Chae, P. S.
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- **Single-particle cryo-electron microscopy of macromolecular complexes** *MICROSCOPY*
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2016; 65 (1): 9-22
- **Structures of two distinct conformations of holo-non-ribosomal peptide synthetases** *NATURE*
Drake, E. J., Miller, B. R., Shi, C., Tarrasch, J. T., Sundlov, J. A., Allen, C. L., Skiniotis, G., Aldrich, C. C., Gulick, A. M.
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- **Conformational Plasticity in the Transsynaptic Neurexin-Cerebellin-Glutamate Receptor Adhesion Complex.** *Structure (London, England : 1993)*
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- **Crystal Structure of the Pre-fusion Nipah Virus Fusion Glycoprotein Reveals a Novel Hexamer-of-Trimers Assembly** *PLOS PATHOGENS*
Xu, K., Chan, Y., Bradel-Tretheway, B., Akyol-Ataman, Z., Zhu, Y., Dutta, S., Yan, L., Feng, Y., Wang, L., Skiniotis, G., Lee, B., Zhou, Z. H., Broder, et al
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- **Using Protein Dimers to Maximize the Protein Hybridization Efficiency with Multisite DNA Origami Scaffolds** *PLOS ONE*
Verma, V., Mallik, L., Hariadi, R. F., Sivaramakrishnan, S., Skiniotis, G., Joglekar, A. P.
2015; 10 (9)
- **ERdj5 Reductase Cooperates with Protein Disulfide Isomerase To Promote Simian Virus 40 Endoplasmic Reticulum Membrane Translocation** *JOURNAL OF VIROLOGY*
Inoue, T., Dosey, A., Herbstman, J. F., Ravindran, M. S., Skiniotis, G., Tsai, B.
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- **Visualization of an N-terminal fragment of von Willebrand factor in complex with factor VIII** *BLOOD*
Yee, A., Oleskie, A. N., Dosey, A. M., Kretz, C. A., Gildersleeve, R. D., Dutta, S., Su, M., Ginsburg, D., Skiniotis, G.
2015; 126 (8): 939-942
- **Electron Microscopic Visualization of Protein Assemblies on Flattened DNA Origami** *ACS NANO*
Mallik, L., Dhakal, S., Nichols, J., Mahoney, J., Dosey, A. M., Jiang, S., Sunahara, R. K., Skiniotis, G., Walter, N. G.
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- **Architecture of the polyketide synthase module: surprises from electron cryo-microscopy** *CURRENT OPINION IN STRUCTURAL BIOLOGY*
Smith, J. L., Skiniotis, G., Sherman, D. H.
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- **A phosphorylation switch on RbBP5 regulates histone H3 Lys4 methylation** *GENES & DEVELOPMENT*
Zhang, P., Chaturvedi, C., Tremblay, V., Cramet, M., Brunzelle, J. S., Skiniotis, G., Brand, M., Shilatifard, A., Couture, J.
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- **2D Projection Analysis of GPCR Complexes by Negative Stain Electron Microscopy.** *Methods in molecular biology (Clifton, N.J.)*
Peisley, A., Skiniotis, G.
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- **Molecular Basis for DPY-30 Association to COMPASS-like and NURF Complexes** *STRUCTURE*
Tremblay, V., Zhang, P., Chaturvedi, C., Thornton, J., Brunzelle, J. S., Skiniotis, G., Shilatifard, A., Brand, M., Couture, J.
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- **Collective Variable Approaches for Single Molecule Flexible Fitting and Enhanced Sampling** *CHEMICAL REVIEWS*
Vashisth, H., Skiniotis, G., Brooks, C. L.
2014; 114 (6): 3353-3365
- **Flavivirus NS1 Structures Reveal Surfaces for Associations with Membranes and the Immune System** *SCIENCE*
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- Couture, J., Skiniotis, G.
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 - **Phleboviruses encapsidate their genomes by sequestering RNA bases** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
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 - **Using Enhanced Sampling and Structural Restraints to Refine Atomic Structures into Low-Resolution Electron Microscopy Maps** *STRUCTURE*
Vashisth, H., Skiniotis, G., Brooks, C. L.
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 - **Visualization and functional analysis of the oligomeric states of Escherichia coli heat shock protein 70 (Hsp70/DnaK)** *CELL STRESS & CHAPERONES*
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