



Raymond A. Sobel, M.D.

Professor of Pathology

 NIH Biosketch available Online

 Curriculum Vitae available Online

Bio

BIO

Dr. Sobel is a Board Certified neuropathologist who has practiced academic neuropathology service and teaching for 40 years. His research interests are primarily in immune responses in the central nervous system as they relate to the pathogenesis of multiple sclerosis.

ACADEMIC APPOINTMENTS

- Professor, Pathology
- Member, Wu Tsai Neurosciences Institute

HONORS AND AWARDS

- Associate Editor, Journal of Neuropathology and Experimental Neurology (2005-2007)
- Editor-in-Chief, Journal of Neuropathology and Experimental Neurology (2007-2016)
- President, American Association of Neuropathologists (2011-2012)
- Deputy Editor, Journal of Neuropathology and Experimental Neurology (2016-present)
- Award for Meritorious Contributions to Neuropathology, American Association of Neuropathologists (June 8 2019)
- Weil Award for Best Paper on Experimental Neuropathology, American Association of Neuropathologists (June, 2020)

PROFESSIONAL EDUCATION

- M.D., UCSF , Medicine (1976)

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

The lab is concerned with mechanisms of cellular immune reactions and tissue injury in the central nervous system (CNS) as they occur in human multiple sclerosis (MS). CNS tissue samples from animals with experimental autoimmune encephalomyelitis (EAE), a model of MS, and from patients with MS and other CNS diseases are studied using histology and immunohistochemistry at the light microscopic and ultrastructural levels to visualize directly the locations of molecules that are involved in immune-mediated injury and the failure of tissue repair.

We are currently focusing on cross-recognition of neurons and neuronal precursors by anti-myelin proteolipid protein antibodies, which may result in neuronal dysfunction and the failure of neuronal repair in CNS injury and on an oligodendroglipathy induced by the environmental agent azetidine.

Teaching

GRADUATE AND FELLOWSHIP PROGRAM AFFILIATIONS

- Immunology (Phd Program)
- Neurosciences (Phd Program)

Publications

PUBLICATIONS

- **Azetidine-2-carboxylic acid-induced oligodendroglipathy in vitro and the pathogenesis of multiple sclerosis.** *Journal of neuropathology and experimental neurology*
Sobel, R. A., Hinojoza, J. R., Zoabi, M.
2026
- **Induction of Autoimmune Myocarditis in Diversity Outbred Mice.** *Biology*
Sur, M., Mone, K., Singh, S., Rasquinha, M. T., Riethoven, J. M., Mukhopadhyay, I., Sobel, R. A., Reddy, J.
2026; 15 (3)
- **Sjögren Syndrome Candidate Autoantigen AQP5 Triggers AQP4 CNS Autoimmunity Through Self-Antigen Mimicry.** *Neurology(R) neuroimmunology & neuroinflammation*
Moseley, C. E., Sagan, S., Boquett, J. A., Spencer, C. M., Hollenbach, J. A., Sobel, R. A., Rothbard, J. B., Steinman, L., Sabatino, J. J., Zamvil, S. S.
2026; 13 (1): e200517
- **Micron-resolution fiber mapping in histology independent of sample preparation.** *Nature communications*
Georgiadis, M., Auf der Heiden, F., Abbasi, H., Ettema, L., Nirschl, J., Taghavi, H. M., Wakatsuki, M., Liu, A., Ho, W. H., Carlson, M., Doukas, M., Koppes, S. A., Keereweer, et al
2025; 16 (1): 9572
- **Giant calcified lumbar disc herniation in post-operative adjacent segment degeneration: a case report** *JOURNAL OF SPINE SURGERY*
Keyserling, H., Zhang, Y., Skirboll, S., Sobel, R. A., Yoon, B. C.
2025
- **The glycolytic reaction PGAM restrains Th17 pathogenicity and Th17-dependent autoimmunity.** *Cell reports*
Wang, C., Wagner, A., Fessler, J., DeTomaso, D., Zaghouni, S., Zhou, Y., Pierce, K., Sobel, R. A., Clish, C., Yosef, N., Kuchroo, V. K.
2025; 44 (6): 115799
- **Establishing a Murine Model of Muscle Changes in Chronic Nerve Compression.** *The Journal of hand surgery*
Burgess, J., Arora, J., Green, A., Singh, A., Jarman, E., Kang, A., Hayashigatani, K., Liu, Y. K., Sobel, R., Fox, P. M.
2025
- **Differential PERK Signaling Dysregulation in Alzheimer's Disease Neurons and Glia**
Le-Maciukiewicz, M., Park, G., Galdamez, A., Yan, W., Chea, L., Chu, P., Sobel, R., Lin, J.
ELSEVIER SCIENCE INC.2025
- **Transcription factor TCF1 binds to ROR γ t and orchestrates a regulatory network that determines homeostatic Th17 cell state.** *Immunity*
Mangani, D., Subramanian, A., Huang, L., Cheng, H., Krovi, S. H., Wu, Y., Yang, D., Moreira, T. G., Escobar, G., Schnell, A., Dixon, K. O., Krishnan, R. K., Singh, et al
2024
- **Investigations into the Myhc 334-352-specific TCR transgenic mice reveal a role for cytotoxic CD4 T cells in the development of cardiac autoimmunity**
Sur, M., Rasquinha, M., Mone, K., Lasrado, N., Massilamany, C., Sobel, R., Reddy, J.
AMER ASSOC IMMUNOLOGISTS.2024
- **Uncovering microstructural architecture from histology.** *bioRxiv : the preprint server for biology*
Georgiadis, M., Auf der Heiden, F., Abbasi, H., Ettema, L., Nirschl, J., Taghavi, H. M., Wakatsuki, M., Liu, A., Ho, W. H., Carlson, M., Doukas, M., Koppes, S. A., Keereweer, et al

2024

- **Investigation into Cardiac Myhc- α 334-352-Specific TCR Transgenic Mice Reveals a Role for Cytotoxic CD4 T Cells in the Development of Cardiac Autoimmunity.** *Cells*
Sur, M., Rasquinha, M. T., Mone, K., Massilamany, C., Lasrado, N., Gurumurthy, C., Sobel, R. A., Reddy, J.
2024; 13 (3)
- **Targeting PGLYRP1 promotes antitumor immunity while inhibiting autoimmune neuroinflammation.** *Nature immunology*
Schnell, A., Huang, L., Regan, B. M., Singh, V., Vonficht, D., Bollhagen, A., Wang, M., Hou, Y., Bod, L., Sobel, R. A., Chihara, N., Madi, A., Anderson, et al
2023
- **T cell deletional tolerance restricts AQP4 but not MOG CNS autoimmunity.** *Proceedings of the National Academy of Sciences of the United States of America*
Sagan, S. A., Moynar, Z., Moseley, C. E., Dandekar, R., Spencer, C. M., Verkman, A. S., Ottersen, O. P., Sobel, R. A., Sidney, J., Sette, A., Anderson, M. S., Steinman, L., Wilson, et al
2023; 120 (30): e2306572120
- **CAR-T Cell-Mediated B-Cell Depletion in Central Nervous System Autoimmunity.** *Neurology(R) neuroimmunology & neuroinflammation*
Gupta, S., Simic, M., Sagan, S. A., Shepherd, C., Duecker, J., Sobel, R. A., Dandekar, R., Wu, G. F., Wu, W., Pak, J. E., Hauser, S. L., Lim, W., Wilson, et al
2023; 10 (2)
- **A Monovalent Mt10-CVB3 Vaccine Prevents CVB4-Accelerated Type 1 Diabetes in NOD Mice.** *Vaccines*
Rasquinha, M. T., Lasrado, N., Sur, M., Mone, K., Qiu, H., Riethoven, J. J., Sobel, R. A., Reddy, J.
2022; 11 (1)
- **Evidence of increased sequestration of pro-resolving lipid mediators within brain esterified lipid pools of multiple sclerosis patients.** *Multiple sclerosis and related disorders*
Shen, Q., Otoki, Y., Sobel, R. A., Nagra, R. M., Taha, A. Y.
2022; 68: 104236
- **Azetidine-2-Carboxylic Acid-Induced Oligodendroglipathy: Relevance to the Pathogenesis of Multiple Sclerosis.** *Journal of neuropathology and experimental neurology*
Sobel, R. A., Albertelli, M., Hinojoza, J. R., Eaton, M. J., Grimes, K. V., Rubenstein, E.
2022
- **Tim-3 adapter protein Bat3 acts as an endogenous regulator of tolerogenic dendritic cell function.** *Science immunology*
Tang, R., Acharya, N., Subramanian, A., Purohit, V., Tabaka, M., Hou, Y., He, D., Dixon, K. O., Lambden, C., Xia, J., Rozenblatt-Rosen, O., Sobel, R. A., Wang, et al
2022; 7 (69): eabm0631
- **Leigh Disease-Like Neuropathology in an Adult Following Covid-19 Infection and Global Anoxia**
Sobel, R., Dulken, B., Reimer, R., Louie, C.
OXFORD UNIV PRESS INC.2021: 582
- **Black and Blue: Eyes and Dyes**
Sobel, R., Nirschl, J., Hammer, P., Sanchez, R., Pershing, S., Louie, C., Lin, J.
OXFORD UNIV PRESS INC.2021: 579
- **Metabolic modeling of single Th17 cells reveals regulators of autoimmunity.** *Cell*
Wagner, A., Wang, C., Fessler, J., DeTomaso, D., Avila-Pacheco, J., Kaminski, J., Zaghoulani, S., Christian, E., Thakore, P., Schellhaass, B., Akama-Garren, E., Pierce, K., Singh, et al
2021
- **T Follicular Regulatory Cell-Derived Fibrinogen-like Protein 2 Regulates Production of Autoantibodies and Induction of Systemic Autoimmunity.** *Journal of immunology (Baltimore, Md. : 1950)*
Sungnak, W., Wagner, A., Kowalczyk, M. S., Bod, L., Kye, Y., Sage, P. T., Sharpe, A. H., Sobel, R. A., Quintana, F. J., Rozenblatt-Rosen, O., Regev, A., Wang, C., Yosef, et al
2020

- **Parkinson Disease and Amyotrophic Lateral Sclerosis in a Machinist-Welder: Reconsideration of an Archival Case**
Sobel, R.
OXFORD UNIV PRESS INC.2020: 697
- **Mechanisms of Azetidine-2-carboxylic Acid (Aze)-Induced Oligodendroglipathy In Vivo and In Vitro**
Sobel, R., Albertelli, M., Hinojoza, J., Eaton, M., Grimes, K., Rubenstein, E.
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- **In Silico Modeling of Metabolic State in Single Th17 Cells Reveals Novel Regulators of Inflammation and Autoimmunity**
Wagner, A., Wang, C., DeTomaso, D., Pacheco, J., Zaghoulani, S., Fessler, J., Akama-Garren, E., Pierce, K., Ron-Harel, N., Haigis, M., Sobel, R. A., Clish, C., Regev, et al
AMER ASSOC IMMUNOLOGISTS.2020
- **Checkpoint Receptor TIGIT Expressed on Tim-1+ B Cells Regulates Tissue Inflammation.** *Cell reports*
Xiao, S. n., Bod, L. n., Pochet, N. n., Kota, S. B., Hu, D. n., Madi, A. n., Kilpatrick, J. n., Shi, J. n., Ho, A. n., Zhang, H. n., Sobel, R. n., Weiner, H. L., Strom, et al
2020; 32 (2): 107892
- **Potential Genetic and Immunologic Mechanisms of Therapeutic Resistance and Disease Progression in CNS Lymphoma Elucidated Via Whole Brain Autopsy Studies**
Solomon, D. A., Geng, H., Sobel, R. A., Subbaraj, L., Tsang, M., Rubenstein, J. L.
AMER SOC HEMATOLOGY.2019
- **Anti-Myelin Proteolipid Protein Peptide Monoclonal Antibodies Recognize Cell Surface Proteins on Developing Neurons and Inhibit Their Differentiation.** *Journal of neuropathology and experimental neurology*
Sobel, R. A., Eaton, M. J., Jaju, P. D., Lowry, E., Hinojoza, J. R.
2019
- **Glioneuronal Tumor With Features of Ganglioglioma and Neurocytoma Arising in the Fourth Ventricle: A Report of 2 Unusual Cases and a Review of Infratentorial Gangliogliomas.** *Journal of neuropathology and experimental neurology*
Harrison, W., Elsamadicy, A. A., McMahon, J. T., Chagoya, G., Sobel, R. A., McLendon, R. E., Adamson, C.
2019
- **IL-11 Induces Encephalitogenic Th17 Cells in Multiple Sclerosis and Experimental Autoimmune Encephalomyelitis.** *Journal of immunology (Baltimore, Md. : 1950)*
Zhang, X., Kiapour, N., Kapoor, S., Khan, T., Thamilarasan, M., Tao, Y., Cohen, S., Miller, R., Sobel, R. A., Markovic-Plese, S.
2019
- **Liver-specific knockdown of long-chain acyl-CoA synthetase 4 reveals its key role in VLDL-TG metabolism and phospholipid synthesis in mice fed a high-fat diet** *AMERICAN JOURNAL OF PHYSIOLOGY-ENDOCRINOLOGY AND METABOLISM*
Singh, A. B., Kan, C. K., Kraemer, F. B., Sobel, R. A., Liu, J.
2019; 316 (5): E880–E894
- **DGAT1 inhibits retinol-dependent regulatory T cell formation and mediates autoimmune encephalomyelitis** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
Graham, K. L., Werner, B. J., Moyer, K. M., Patton, A. K., Krois, C. R., Yoo, H., Tverskoy, M., LaJevic, M., Napoli, J. L., Sobel, R. A., Zabel, B. A., Butcher, E. C.
2019; 116 (8): 3126-3135
- **Anti-Myelin Proteolipid Protein Antibodies Bind Cell Surface Proteins on Developing Neurons and Inhibit Their Differentiation**
Sobel, R., Eaton, M., Hinojoza, J.
OXFORD UNIV PRESS INC.2018: 481
- **Dendritic Cell PD-L1 Limits Autoimmunity and Follicular T Cell Differentiation and Function** *JOURNAL OF IMMUNOLOGY*
Sage, P. T., Schildberg, F. A., Sobel, R. A., Kuchroo, V. K., Freeman, G. J., Sharpe, A. H.
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- **Functional Anti-TIGIT Antibodies Regulate Development of Autoimmunity and Antitumor Immunity** *JOURNAL OF IMMUNOLOGY*
Dixon, K. O., Schorer, M., Nevin, J., Etmnan, Y., Amoozgar, Z., Kondo, T., Kurtulus, S., Kassam, N., Sobel, R. A., Fukumura, D., Jain, R. K., Anderson, A. C., Kuchroo, et al
2018; 200 (8): 3000–3007

- **Fas Promotes T Helper 17 Cell Differentiation and Inhibits T Helper 1 Cell Development by Binding and Sequestering Transcription Factor STAT1** *IMMUNITY*
zu Horste, G., Przybylski, D., Schramm, M. A., Wang, C., Schnell, A., Lee, Y., Sobel, R., Regev, A., Kuchroo, V. K.
2018; 48 (3): 556+
- **Epitope Mapping of SERCA2a Identifies an Antigenic Determinant That Induces Mainly Atrial Myocarditis in A/J Mice** *JOURNAL OF IMMUNOLOGY*
Krishnan, B., Massilamany, C., Basavalingappa, R. H., Gangaplara, A., Rajasekaran, R. A., Afzal, M. Z., Khalilzad-Sharghi, V., Zhou, Y., Riethoven, J., Nandi, S. S., Mishra, P. K., Sobel, R. A., Strande, et al
2018; 200 (2): 523–37
- **Microhemorrhage-associated tissue iron enhances the risk for *Aspergillus fumigatus* invasion in a mouse model of airway transplantation.** *Science translational medicine*
Hsu, J. L., Manouvakhova, O. V., Clemons, K. V., Inayathullah, M. n., Tu, A. B., Sobel, R. A., Tian, A. n., Nazik, H. n., Pothineni, V. R., Pasupneti, S. n., Jiang, X. n., Dhillon, G. S., Bedi, et al
2018; 10 (429)
- **Induction of Paralysis and Visual System Injury in Mice by T Cells Specific for Neuromyelitis Optica Autoantigen Aquaporin-4.** *Journal of visualized experiments : JoVE*
Sagan, S. A., Cruz-Herranz, A., Spencer, C. M., Ho, P. P., Steinman, L., Green, A. J., Sobel, R. A., Zamvil, S. S.
2017
- **Anti-PD-1-associated inflammatory-demyelinating lesions in patients with brain metastases**
Samghabadi, P., Makar, S., Thomas, R., Pelpola, J., Reddy, S., Tranvinh, E., Spence, A., Vogel, H., Born, D., Sobel, R.
OXFORD UNIV PRESS INC.2017: 500–501
- **T cells targeting neuromyelitis optica autoantigen aquaporin-4 cause paralysis and visual system injury.** *Journal of nature and science*
Cruz-Herranz, A., Sagan, S. A., Sobel, R. A., Green, A. J., Zamvil, S. S.
2017; 3 (5)
- **Lack of Efficacy of Liposomal Amphotericin B Against Acute and Chronic *Trypanosoma cruzi* Infection in Mice** *AMERICAN JOURNAL OF TROPICAL MEDICINE AND HYGIENE*
Clemons, K. V., Sobel, R. A., Martinez, M., Correa-Oliveira, R., Stevens, D. A.
2017; 97 (4): 1141–46
- **Tolerance checkpoint bypass permits emergence of pathogenic T cells to neuromyelitis optica autoantigen aquaporin-4** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
Sagan, S. A., Winger, R. C., Cruz-Herranz, A., Nelson, P. A., Hagberg, S., Miller, C. N., Spencer, C. M., Ho, P. P., Bennett, J. L., Levy, M., Levin, M. H., Verkman, A. S., Steinman, et al
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- **The central vein sign and its clinical evaluation for the diagnosis of multiple sclerosis: a consensus statement from the North American Imaging in Multiple Sclerosis Cooperative** *NATURE REVIEWS NEUROLOGY*
Sati, P., Oh, J., Constable, R. T., Evangelou, N., Guttmann, C. R., Henry, R. G., Klawiter, E. C., Mainero, C., Massacesi, L., McFarland, H., Nelson, F., Ontaneda, D., Rauscher, et al
2016; 12 (12): 714-722
- **Identification of an Epitope from Adenine Nucleotide Translocator 1 That Induces Inflammation in Heart in A/J Mice.** *American journal of pathology*
Basavalingappa, R. H., Massilamany, C., Krishnan, B., Gangaplara, A., Kang, G., Khalilzad-Sharghi, V., Han, Z., Othman, S., Li, Q., Riethoven, J., Sobel, R. A., Steffen, D., Reddy, et al
2016; 186 (12): 3160-3175
- **Anti-CD48 Monoclonal Antibody Attenuates Experimental Autoimmune Encephalomyelitis by Limiting the Number of Pathogenic CD4+ T Cells.** *Journal of immunology*
McArdel, S. L., Brown, D. R., Sobel, R. A., Sharpe, A. H.
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- **Treatment of spontaneous EAE by laquinimod reduces Tfh, B cell aggregates, and disease progression.** *Neurology(R) neuroimmunology & neuroinflammation*
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- **IL-10-dependent Tr1 cells attenuate astrocyte activation and ameliorate chronic central nervous system inflammation** *BRAIN*
Mayo, L., da Cunha, A. P., Madi, A., Beynon, V., Yang, Z., Alvarez, J. I., Prat, A., Sobel, R. A., Kobzik, L., Lassmann, H., Quintana, F. J., Weiner, H. L.
2016; 139: 1939-1957
- **Dimethyl fumarate treatment induces adaptive and innate immune modulation independent of Nrf2** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
Schulze-Topphoff, U., Varrin-Doyer, M., Pekarek, K., Spencer, C. M., Shetty, A., Sagan, S. A., Cree, B. A., Sobel, R. A., Wipke, B. T., Steinman, L., Scannevin, R. H., Zamvil, S. S.
2016; 113 (17): 4777-4782
- **CNS accumulation of regulatory B cells is VLA-4-dependent.** *Neurology® neuroimmunology & neuroinflammation*
Lehmann-Horn, K., Sagan, S. A., Winger, R. C., Spencer, C. M., Bernard, C. C., Sobel, R. A., Zamvil, S. S.
2016; 3 (2)
- **CD5L/AIM Regulates Lipid Biosynthesis and Restrains Th17 Cell Pathogenicity** *CELL*
Wang, C., Yosef, N., Gaublotme, J., Wu, C., Lee, Y., Clish, C. B., Kaminski, J., Xiao, S., Horste, G. M., Pawlak, M., Kishi, Y., Joller, N., Karwacz, et al
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- **IL-21R signaling is critical for induction of spontaneous experimental autoimmune encephalomyelitis** *JOURNAL OF CLINICAL INVESTIGATION*
Lee, Y., Mitsdoerffer, M., Xiao, S., Gu, G., Sobel, R. A., Kuchroo, V. K.
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- **Deletion of CTLA-4 on regulatory T cells during adulthood leads to resistance to autoimmunity** *JOURNAL OF EXPERIMENTAL MEDICINE*
Paterson, A. M., Lovitch, S. B., Sage, P. T., Juneja, V. R., Lee, Y., Trombley, J. D., Arancibia-Carcamo, C. V., Sobel, R. A., Rudensky, A. Y., Kuchroo, V. K., Freeman, G. J., Sharpe, A. H.
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- **B-Cell Very Late Antigen-4 Deficiency Reduces Leukocyte Recruitment and Susceptibility to Central Nervous System Autoimmunity** *ANNALS OF NEUROLOGY*
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- **Podoplanin negatively regulates CD4(+) effector T cell responses** *JOURNAL OF CLINICAL INVESTIGATION*
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- Shetty, A., Gupta, S. G., Varrin-Doyer, M., Weber, M. S., Prod'homme, T., Molnarfi, N., Ji, N., Nelson, P. A., Patarroyo, J. C., Schulze-Toppoff, U., Fogal, S. E., Forsthuber, T., Sobel, et al
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- **Sphingosine-1-Phosphate Receptor Phosphorylation and its Effects on Autoimmune Neuroinflammation**
Garris, C. S., Wu, L., Sobel, R. A., Snyder, M., Hla, T. T., Dorfman, L. J., Han, M. H.
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