James Earl Crowe, Jr., M.D.

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SUMMARY. Dr. Crowe is Director of the Vanderbilt Vaccine Center and the Ann Scott Carell Professor of Pediatrics, Pathology, Microbiology and Immunology. He is a board certified pediatric infectious diseases physician and viral immunology researcher. His laboratory studies the human immune response to infection or vaccination for a wide variety of major human pathogens, including influenza, chikungunya virus, Ebola virus, Zika virus and others. He is the Director of the Human Immunome Project, an ambitious effort to identify the sequence of all transcripts for human adaptive immune receptors on the planet. He is an elected member of the U.S. National Academy of Medicine and has been the recipient of major investigator awards for research, including the Daland Prize of the American Philosophical Society, Korsmeyer Award of the American Society for Clinical Investigation and the Rosenthal Foundation Prize. He has authored over 350 publications to date, is a named inventor on about 50 patents for vaccines and antibodies and is an elected member of the U.S. National Academy of Inventors. Many vaccine candidates and human monoclonal antibodies developed in the course of his research have been tested in humans.

BIRTH: August 14, 1961; Nashville, TN, USA
CITIZENSHIP: United States
PERSONAL: Married to Elizabeth H. Crowe, MD, since May 1987
Son, Stephen Crowe, age 29; daughter, Catherine Crowe, age 26
UNIFORMED SERVICE: Active duty, U.S. Public Health Service, Nov 1990 – Oct 1995;
Inactive Reserves, U.S. Public Health Service, Nov 1995 – Mar 2010
PERSONAL INTERESTS: Endurance sports include ultrarunning – Western States and Arkansas 100-mile races, Grand Canyon Rim2Rim2Rim, Comrades 89k, South Africa, and others, cycling and multisport; three-time Ironman finisher. Art collecting, Haitian, tribal, conceptual and outsider art.

EDUCATION AND RESEARCH TRAINING:

1979 – 1983	B.S., *Magna Cum Laude*, Davidson College, Davidson, NC
1983 – 1987	M.D., U.N.C. School of Medicine, Chapel Hill, NC
1987 – 1990	Pediatric internship and residency, N.C. Memorial Hospitals (University of North Carolina, Chapel Hill, N.C.)
1990 – 1993	Medical Staff Fellow, Respiratory Viruses Section, Laboratory of Infectious Diseases, NIAID, NIH, Bethesda, MD. Mentors: Robert Chanock and Brian Murphy
1993 – 1995	Sr. Research Investigator, Respiratory Viruses Section, Laboratory of Infectious Diseases, NIAID, Bethesda, MD
1995 – 1996	Clinical Fellowship, Infectious Diseases, (as Instructor in Pediatrics), Division of Pediatric Infectious Diseases, Department of Pediatrics, Vanderbilt University Medical Center, Nashville, TN

ACADEMIC APPOINTMENTS:

1996-1996	Instructor, Department of Pediatrics, Division of Pediatric Infectious Diseases, Vanderbilt University Medical Center, Nashville, TN

1996 – 2001 Assistant Professor, Department of Pediatrics, Division of Pediatric Infectious Diseases, Vanderbilt University Medical Center, Nashville, TN
1998 – 2005 Assistant Professor of Microbiology and Immunology, Vanderbilt University Medical Center, Nashville, TN
2001 – 2004 Associate Professor (with tenure), Department of Pediatrics, Division of Pediatric Infectious Diseases, Vanderbilt University Medical Center, Nashville, TN
2005 – 2006 Associate Professor of Microbiology and Immunology, Vanderbilt University Medical Center, Nashville, TN
2004 – present Professor (with tenure), Department of Pediatrics, Division of Pediatric Infectious Diseases, Vanderbilt University Medical Center, Nashville, TN
2006 – present Professor of Pathology, Microbiology and Immunology (department was termed Microbiology and Immunology from 2006-11), Vanderbilt University Medical Center, Nashville, TN

ENDOWED CHAIRS
2005 – 2013 Ingram Professor of Cancer Research, Vanderbilt University
2013 – Ann Scott Carell Chair, Vanderbilt University Medical Center

AWARDS AND HONORS, NATIONAL/INTERNATIONAL
1996 Pfizer Faculty Scholar, Pfizer, Inc., New York, NY
1998 Basil O'Connor Scholar Research Award, March of Dimes
1999 Dade MicroScan Young Investigator Award, American Society for Microbiology
2000 Young Investigator Award, Pediatric Infectious Diseases Society
2001 Young Investigator Award, Society for Pediatric Research
2002 Judson Daland Prize for Outstanding Achievement in Patient-Oriented Clinical Research, American Philosophical Society, Philadelphia, PA
2005 Oswald Avery Award for Early Achievement, Infectious Diseases Society of America
2005 Burroughs Wellcome Fund Clinical Scientist Award in Translational Research
2006 E. Mead Johnson Award for Excellence in Pediatric Research, Society for Pediatric Research
2007 Outstanding Investigator Award, American Federation for Medical Research
2010 Norman J. Siegel New Member Outstanding Science Award, American Pediatric Society
2017 Samuel Rosenthal Prize for Excellence in Academic Pediatrics, Samuel Rosenthal Foundation
2017 Stanley J. Korsmeyer Award, American Society for Clinical Investigation
2018 Distinguished Medical Alumnus Award, UNC School of Medicine, Chapel Hill, NC
2018 Best Academic Research Team, 11th Annual Vaccine Industry Excellence Awards

ELECTED FELLOWSHIP/MEMBERSHIP
1994 American Society of Microbiology, Elected Member
1997 American Society for Virology; Elected Full Member
1997 Infectious Diseases Society of America member; 2007 Elected Fellow
1998 Society for Pediatric Research; 2009 – 2012 Elected Council Member
1999 American Association of Immunologists [FASEB], Elected Fellow
2003 American Federation for Medical Research, Elected Fellow
2004 American Society for Clinical Investigation, Elected Fellow
2009 Association of American Physicians, Elected Fellow
2010 American Pediatric Society, Elected Fellow
2010 American Association for the Advancement of Science, Elected Fellow
2010 American Academy of Microbiology, Elected Fellow
2014 National Academy of Medicine, Elected Member
2017 National Academy of Inventors, Elected Fellow

BIOTECH
Founder, **IDBiologics, LLC**, Delaware. Sept 1, 2017 – present.
An antibody discovery biotech company, spun out of my academic laboratory to develop human monoclonal antibody therapeutics.

CLINICAL STAGE DEVELOPMENT OF INVENTIONS
Marburg virus neutralizing human monoclonal antibody MR191

- Given to humans first under emergency IND in 2017.
- Now designated MBP091, as manufactured by our licensee Mapp Biopharmaceutical, Inc.
- Further development is supported by Biomedical Advanced Research and Development Authority (BARDA)

Chikungunya virus neutralizing human monoclonal antibody CHKV-24

- The first monoclonal antibody encoded by mRNA to be dosed in a human
- Given to humans first in Phase I trial in February 2019 evaluating the safety and tolerability of escalating doses of mRNA-1944 via intravenous infusion in healthy adults.
- Now designated mRNA-1944, as manufactured by our licensee Moderna, Inc.
- Further development is supported by DARPA

SELECTED PUBLICATIONS

Williams JV, Harris PA, Tollefson SJ, Halburnt-Rush LL, Pingsterhaus JM, Edwards KM, Wright PF, **Crowe JE Jr.** Human metapneumovirus and lower respiratory tract disease in otherwise healthy infants and children. ***New England Journal of Medicine*** 2004; 350: 443 – 50.

Yu X, Tsibane T, McGraw PA, House F, Keefer CJ, Hicar MD, Tumpey T, Pappas C, Perrone, Martinez O, Stevens J, Wilson I, Aguilar, Altschuler E, Basler C, **Crowe JE Jr.** Neutralizing antibodies derived from the B cells of 1918 influenza pandemic survivors. ***Nature*** 2008; 455: 532 – 536. *Faculty of 1000 Biology Must Read*

Xu R, Ekiert DC, Krause JC, Palese P, **Crowe JE Jr**, Wilson IA. Structural basis of pre-existing immunity to the 2009 H1N1 pandemic influenza virus. ***Science*** 2010; 328: 357 – 60.

de Alwis AR, Smith SA, Olivarez NP, Messer WB, Hynh JP, Wahala WMPB, White LJ, Baric RS, **Crowe JE Jr**, de Silva AM. Molecular basis of dengue virus neutralization by human antibodies. ***Proceedings of the National Academy of Sciences USA***, 2012; 109: 7439 – 44. *Faculty of 1000 Exceptional selection*

Thornburg NJ, Blum DL, Belser JA, Tumpey TM, Desphande S, Fritz GA, Krause JC, Winarski KL, Spiller BW, Nannemann DP, Meiler J, **Crowe JE Jr**. Human antibodies that neutralize respiratory droplet transmissible H5N1 influenza viruses. ***Journal of Clinical Investigation*** 2013; 123: 4405 – 9.

Correia BE, Bates JT, Loomis RJ, Baneyx G, Jardine JG, Rupert P, Carrico C, Correnti C, Kalyuzhniy O, Vittal V, Connell MJ, Stevens E, Schroeter A, Chen M, MacPherson S, Adachi Y, Holmes MA, Li Y, Klevit RE, Graham BS, Wyatt RT, Baker D, Strong RK, **Crowe JE Jr**, Johnson PR, Schief WR. Proof of principle for epitope-focused vaccine design. ***Nature*** 2014; 507: 201 – 6. *Faculty of 1000 selection.*

Flyak AI, Ilinykh PA, Murin CD, Garron T, Shen X, Fusco ML, Hashiguchi T, Bornholdht ZA, Slaughter JC, Sapparapu G, Ksiazek TG, Ward AB, Ollmann Saphire E, Bukreyev A, **Crowe JE Jr.** Mechanism of human antibody-mediated neutralization of Marburg virus. ***Cell*** 2015; 160: 893 – 903. *Journal cover*

Hashiguchi T, Fusco ML, Bornholdht ZA, Lee JE, Murin CD, Flyak AI, Li S, Matsuoka R, Kohda D, Yanagi Y, Sanner M, Ward AB, **Crowe JE Jr,** Ollmann Saphire E. Structural basis for Marburg and Ebola virus cross-reactivity by a human survivor antibody. ***Cell*** 2015; 160: 904 – 912. *Journal cover*

Willis JR, Sapparapu G, Moola S, Julien J-P, Singh V, King HG, Xia Y, Pickens JA, Labranche CC, Finn JS, Briney BS, Montefiori DC, Wilson IA, Meiler J, **Crowe JE Jr.** Redesigned PG9 variant monoclonal antibodies that exhibit enhanced HIV neutralizing potency and breadth. ***Journal of Clinical Investigation*** 2015; 125: 2523 – 31.

Fibriansah G, Ibarra KD, Ng T-S, Smith SA, Tan JL, Lim X-N, Ooi JSG, Kostyuchenko VA, Wang J, de Silva AM, Harris E, **Crowe JE Jr***, Lok S-M*. CryoEM structure shows antibody neutralizes dengue virus serotype 2 by locking E protein dimers. ***Science*** 2015; 349: 88 – 91. **corresponding*

Fox JM, Long F, Edeling MA, Lin H, Duijl-Richter MKS, Fong RH, Smit JM Doranz BJ, **Crowe JE Jr**, Fremont DH, Rossmann MG, Diamond MS. Protective monoclonal antibodies recognizing multiple arthritogenic alphaviruses bind a single epitope and inhibit both viral entry and egress. ***Cell*** 2015; 163: 1095-1107.

Flyak AI, Shen X, Murin CD, Turner HL, David JA, Fusco ML, Lampley R, Kose N, Ilinykh PA, Kuzmina N, Branchizio A, King H, Brown L, Bryan C, Davidson E, Doranz BJ, Slaughter JC, Sapparapu G, Klages C, Ksiazek TG, Saphire EO, Ward AB, Bukreyev A, **Crowe JE Jr.** Cross-reactive and potent neutralizing antibody responses in human survivors of natural Ebolavirus infection. ***Cell*** 2016; 164: 392-405.

Thornburg NJ, Zhang H, Bangaru S, Sapparapu G, Kose N, Lampley RM, Bombardi RG, Yu Y, Graham S, Branchizio A, Yoder SM, Rock MT, Creech CB, Edwards KM, Lee D, Li S, Wilson IA, García-Sastre A, Albrecht RA, **Crowe JE Jr**. H7N9 influenza virus neutralizing antibodies that possess few somatic mutations. ***Journal of Clinical Investigation*** 2016; 126: 1482-94.

Willis JR, Finn JA, Briney BS, Sapparapu G, Singh V, King HG, LaBranche CC, Montefiori DC, Meiler J, **Crowe JE Jr**. Long antibody HCDR3s from HIV-naïve donors mediate HIV neutralization. ***Proceedings of the National Academy of Sciences USA*** 2016; 113: 4446-51.

Mousa JJ, Sauer MF, Sevy AM, Finn JA, Bates JT, Alvarado G, King HG, Loerinc LB, Fong RH, Doranz BJ, Correia B, Kalyuzhniy O, Wen X, Jardetzky TS, Schief WR, Ohi MD, Meiler J, **Crowe JE Jr.** Structural basis for human antibody neutralization of respiratory syncytial virus at antigenic site II. ***Proceedings of the National Academy of Sciences USA*** 2016; 113: E6849 – E6858.

Gilchuk I, Gilchuk P, Sapparapu G, Lampley R, Singh V, Kose N, Blum DL, Hughes-Baker LJ, Panayampalli SS, Townsend M, Kondas A, Reed Z, Weiner Z OlsonV, Hammarlund E, Raue H-P, Slifka MK, Slaughter JC, Graham BS, Edwards KM, Eisenberg RJ, Cohen GH, Joyce S, **Crowe JE Jr.** Cross-neutralizing and protective human antibody specificities to poxvirus infections. ***Cell*** 2016; 167: 684 – 694.

Sapparapu G, Fernandez E, Kose N, Cao B, Fox JM, Bombardi RG, Zhao H, Nelson CA, Bryan AL, Trevor Barnes, Davidson E, Mysorekar IU, Fremont DH, Doran BJ, Diamond MS, **Crowe JE Jr.** Neutralizing human antibodies prevent Zika virus replication and fetal disease in mice. ***Nature*** 2016; 540: 443 – 447. *F1000Prime Exceptional Article*

Mousa JJ, Kose N, Matta P, **Crowe JE Jr.** A novel pre-fusion conformation-specific neutralizing epitope on the respiratory syncytial virus fusion protein. ***Nature Microbiology*** 2017; 2:16271. doi: 10.1038/nmicrobiol.2016.271.

Gilchuk P, Kuzmina N, Ilinykh PA, Huang K, Gunn BM, Bryan A, Davidson E, Doranz BJ, Turner HL, Fusco ML, Bramble MS, Hoff NA, Binshtein E, Kose N, Flyak AI, Flinko R, Orlandi C, Carnahan R, Parrish EH, Bombardi RG, Sevy A, Singh PK, Mukadi P, Muyembe-Tamfum JJ, Ohi MD, Ollmann Saphire E, Lewis GK, Alter G, Ward AB, Rimoin AW, Bukreyev A, **Crowe JE Jr**. Multifunctional pan-ebolavirus antibodies recognize a site of broad vulnerability on the ebolavirus glycoprotein. ***Immunity*** 2018; 49:363-374.e10.

Goo L, Debbink K, Kose N, Sapparapu G, Doyle MP, Wessel A, Richner JM, Burgomaster KA, Larman BC, Dowd KA, Diamond MS, **Crowe JE Jr**, Pierson TC. A potently neutralizing human monoclonal antibody targeting a novel epitope in the West Nile virus E protein preferentially recognizes mature virions. ***Nature Microbiology*** 2019; 4(1):71-77.

Alvarado G, Ettayebi K, Atmar RL, Bombardi RG, Kose N, Estes MK, **Crowe JE Jr.** Human monoclonal antibodies that neutralize pandemic GII.4 noroviruses. ***Gastroenterology*** 2018; pii: S0016-5085(18)34926-6. doi: 10.1053/j.gastro.2018.08.039. [Epub ahead of print]

Soto C, Bombardi RG, Branchizio A, Kose N, Matta P, Gilchuk P, Finn JA, Sevy AM, Mallal S, Pilkinton M, **Crowe JE Jr**. High frequency of shared clonotypes in human B cell receptor repertoires. ***Nature*** 2019; 566:398-402. PMID: 30760926.

Kose N, Fox JM, Sapparapu G, Robin Bombardi R, Tennekoon RN, de Silva AD, Elbashir SM, Theisen MA, Humphris-Narayanan E, Ciaramella G, Himansu S, Diamond MS, **Crowe JE Jr**. A lipid-encapsulated mRNA encoding a potently neutralizing human monoclonal antibody protects against chikungunya infection. *In press*, ***Science Immunology*** 2019; May 17;4(35). pii: eaaw6647. doi: 10.1126/sciimmunol.aaw6647.

Bangaru S, Lang S, Schotsaert M, Vanderven HA, Zhu X, Kose N, Bombardi R, Finn JA, Kent SJ, Gilchuk P, Gilchuk I, Turner HL, García-Sastre A, Li S, Ward AB, Wilson IA, **Crowe JE Jr.** A site of vulnerability on the influenza virus hemagglutinin head domain trimer interface. ***Cell*** 2019; 177(5):1136-1152.e18.