Philip J. Kranzusch

Harvard Medical School
Dana-Farber Cancer Institute
Professor of Microbiology
Smith Building, Rm 520B
Boston, MA 02115

Office: (617) 582-9321
Lab: (617) 582-9322
philip_kranzusch[at]dfci.harvard.edu

Education and Employment

- Professor of Microbiology — 2016 – Present
  Professor of Cancer Immunology and Virology
  Harvard Medical School, Dana-Farber Cancer Institute
  - Assistant Professor 2016–2020, Associate Professor 2020–2023
- HHMI / LSRF Postdoctoral Fellow — 2012 – 2016
  University of California–Berkeley, Berkeley, CA
  Advisors: Dr. Jennifer A. Doudna and Dr. James M. Berger
- Doctorate in Virology — 2007 – 2012
  Harvard University, Cambridge, MA
  Advisor: Dr. Sean P.J. Whelan
- Bachelors of Science in Molecular Biology — 2003 – 2006
  University of Wisconsin–Madison, Madison, WI
  Comprehensive Honors Degree

Research Experience

Harvard Medical School, Dana-Farber Cancer Institute
Professor of Microbiology; Cancer Immunology and Virology — 2016 – Present

• My lab studies how cells sense and defend from viral infection. Our research reveals the surprising discovery that human innate immunity evolved from ancient pathways in bacteria. Combining structural biology, cell biology, and novel forward biochemical screening approaches, our work explains the mechanism of how human cells recognize infection and demonstrates that the core components that control these signaling pathways are descended from proteins in bacteria responsible for anti-phage defense. The discovery of the ancient origins of antiviral immunity provides a new framework to explain organization of the human immune system and to define novel components that inhibit pathogen replication in animal cells. Building on this discovery, my lab has used the connection between animal and bacterial antiviral signaling to determine key structures of human immune proteins in activated states, identify new immune receptors in animals, and define common rules that explain how viruses defeat host immunity. Select manuscripts:

Structure of the human cGAS–DNA complex reveals enhanced control of immune surveillance.
Zhou W*, Whiteley AT*, de Oliveira Mann CC., Morehouse BR, Nowak RP, Fischer ES, Gray NS, Mekalanos JJ, **Kranzusch PJ**.
Cell. 2018; 174, 300–311. (*co-first)

Viral and metazoan poxins are cGAMP-specific nucleases that control cGAS-STING signalling.
Eaglesham JB, Pan Y, Kupper TS, **Kranzusch PJ**.
Nature. 2019; 566(7743), 259–263.

Bacterial cGAS-like enzymes synthesize diverse nucleotide signals.
Whiteley AT, Eaglesham JB, de Oliveira Mann CC, Morehouse BR, Lowey B, Nieminen EA, Danilchanka O, King DS, Lee ASY, Mekalanos JJ[#], **Kranzusch PJ**[#].
Nature. 2019; 567(7747), 194–199. ([#]co-corresponding)

STING cyclic dinucleotide sensing originated in bacteria.
Morehouse BR, Govande AA, Millman A, Keszei AFA, Lowey B, Ofir G, Shao S, Sorek R, **Kranzusch PJ**.
Nature. 2020. 586(7829), 429–433.

cGLRs are a diverse family of pattern recognition receptors in innate immunity.
Li Y, Slavik KM, Toyoda HC, Morehouse BR, de Oliveira Mann CC, Elek A, Levy S, Wang Z, Mears KS, Liu J, Kashin D, Guo X, Mass T, Sebé-Pedrós A, Schwede F, **Kranzusch PJ**.
Cell. 2023; 186(15), 3261–3276.

University of California–Berkeley

HHMI / LSRF Postdoctoral Fellow 2012 – 2016

Advisors: Dr. Jennifer A. Doudna and Dr. James M. Berger

• Using a structural and biochemical approach, I determined the molecular and evolutionary basis of human 2′3′-cGAMP signaling in the cGAS-STING response to cytosolic DNA

- Determined the first structure of human cGAS (**Kranzusch et al., *Cell Reports* 2013**)
- Discovered bacterial cGAS-like enzymes, and determined how human cGAS catalyzes formation of a unique 2′–5′ phosphodiester bond (**Kranzusch et al., *Cell* 2014**)
- Revealed human 2′3′-cGAMP has evolved to achieve universal signaling by exploiting a conserved STING conformational intermediate (**Kranzusch* and Wilson* et al., *Molecular Cell* 2015**)

Harvard Medical School

Virology Ph.D. Student 2007 – 2012

Advisor: Dr. Sean P.J. Whelan

• Developed a system to reconstitute arenavirus RNA synthesis and template interactions *in vitro*, and used single-molecule EM to determine the first low-resolution structural information for this class of viral polymerases (**Kranzusch et al., *PNAS* 2010**)

• Discovered a new role for the arenavirus matrix protein in regulating RNA synthesis by locking a polymerase–template complex (**Kranzusch et al., *PNAS* 2012**)

Field Research Assistant, Dzanga-Sangha, Central African Republic 2008 – 2009
Collaboration with Dr. Peter D. Walsh and Dr. Beatrice H. Hahn
Noninvasive sampling of pathogen diversity of wild gorilla populations

Research Technician, Washington University–St. Louis 2007
Advisor: Dr. Andrew Pekosz
Investigated role of influenza A virus NS1 cellular localization in effector function

Undergraduate Research Assistant, UW-Madison, Department of Virology and Entomology 2004 – 2006
Advisor: Dr. Thomas L. German

Undergraduate Research Assistant, UW-Madison, Department of Genetics / USDA 2003 – 2006
Advisor: Dr. Shelley H. Jansky

Select Honors and Memberships

Claire W. and Richard P. Morse Research Award – 2023
Cancer Research Institute Lloyd J. Old STAR Award – 2022
NIH Director's New Innovator Award (DP2) – 2021
Burroughs Wellcome Fund Investigators in the Pathogenesis of Infectious Disease (PATH) Award – 2020
The Mark Foundation for Cancer Research Emerging Leader Award – 2020
American Society for Microbiology Award for Early Career Basic Research – 2019
Pew Scholar in the Biomedical Sciences – 2019
Concern Foundation Conquer Cancer Now Award – 2018
Parker Institute for Cancer Immunotherapy – DFCI/PICI Member, 2017
V Foundation V Scholar Award, with Abeloff distinction – 2017
Cancer Research Institute Clinic and Laboratory Integration Program Award – 2017
Hood Foundation Childhood Health Research Awards Program – Fellow, 2017
Smith Family Awards Program for Excellence in Biomedical Research – Fellow, 2016
Life Sciences Research Foundation Fellowship – HHMI Fellow, 2013 – 2016
Postdoctoral fellowship award based on independent research proposal
Bernard N. Fields Prize in Microbiology and Molecular Genetics, 2012
Harvard Medical School research award based on graduate thesis
Member of the American Society of Virology, 2008 – Present
NSF Graduate Research Fellowship Program (Honorable Mention) – 2008 and 2009
Graduate award honorable mention based on research proposal and references
UW-Madison Senior Honors Thesis Summer Research Grant, 2006
UW-Madison Comprehensive Honor's Program (Letters and Science), 2004, 2005 and 2006

Research Publications

Published Manuscripts

56. Johnson AG[#], Mayer ML, Schaefer SL, McNamara-Bordewick NK, Hummer G, **Kranzusch PJ**[#].
Structure and assembly of a bacterial gasdermin pore.
Nature. 2024. Advanced Online Publication. *bioRxiv* DOI 10.1101/2023.04.20.537723. ([#]co-corresponding)

55. Antine SP, Johnson AG, Mooney SE, Leavitt A, Mayer ML, Yirmiya E, Amitai G, Sorek R, **Kranzusch PJ**.
Structural basis of Gabija anti-phage defence and viral immune evasion.
Nature. 2024. 625(7994), 360–365. *bioRxiv* DOI 10.1101/2023.05.01.538945.
    - Preview feature in *Nature*
    - Research Highlight in *Nature Reviews Microbiology*

54. Yirmiya E*, Leavitt A*, Lu A, Ragucci AE, Avraham C, Osterman I, Garb J, Antine SP, Mooney SE, Hobbs SJ, **Kranzusch PJ**, Amitai G[#], Sorek R[#].
Phages overcome bacterial immunity via diverse anti-defence proteins.
Nature. 2024. 625(7994), 352–359. *bioRxiv* DOI 10.1101/2023.05.01.538930. (*co-first, [#]co-corresponding)
    - Preview feature in *Nature*
    - Research Highlight in *Nature Reviews Microbiology*

53. Brogan AP, Habib C, Hobbs SJ, **Kranzusch PJ**, Rudner DZ.
Bacterial SEAL domains undergo autoproteolysis and function in regulated intramembrane proteolysis.
PNAS. 2023. 120(40), e2310862120. *bioRxiv* DOI 10.1101/2023.06.27.546760.

52. Govande AA*, Babnis A*, Urban C, Habjan M, Hartmann R, **Kranzusch PJ**[#], Pichlmair A[#].
RNase L activating 2′–5′ oligoadenylates bind ABCF1, -3 and Decr-1.
Journal of General Virology. 2023. 104(9), 001890. *bioRxiv* DOI 10.1101/2023.03.21.532770. (*co-first, [#]co-corresponding)

51. Cai H*[#], Li L*, Slavik KM*, Huang J, Yin T, Ai X, Hédelin L, Haas G, Xiang Z, Yang Y, Li X, Chen Y, Wei Z, Deng H, Chen D, Jiao R, Martins N, Meignin C, **Kranzusch PJ**[#], Imler JL.
The virus-induced cyclic dinucleotide 2′3′-c-di-GMP mediates STING-dependent antiviral immunity in *Drosophila*.
Immunity. 2023. 56, 1991–2005. *bioRxiv* DOI 10.1101/2023.05.08.539652. (*co-first, [#]co-corresponding)
    - Preview feature in *Immunity*

50. Boys IN, Johnson AG, Quinlan M, **Kranzusch PJ**, Elde NC.
Structural homology screens reveal host-derived poxvirus protein families impacting inflammasome activity.
Cell Reports. 2023. 42(8), 112878. *bioRxiv* DOI 10.1101/2023.02.26.529821.

49. Li Y, Slavik KM, Toyoda HC, Morehouse BR, de Oliveira Mann CC, Elek A, Levy S, Wang Z, Mears KS, Liu J, Kashin D, Guo X, Mass T, Sebé-Pedrós A, Schwede F, **Kranzusch PJ**.
cGLRs are a diverse family of pattern recognition receptors in innate immunity.
Cell. 2023; 186(15), 3261–3276. *bioRxiv* DOI 10.1101/2023.02.22.529553.
    - Preview feature in *Cell*
    - Commentaries (2) in *Trends in Immunology*
    - Research Highlight in *Nature Reviews Immunology*

48. Duncan-Lowey B*, Tal N*, Johnson AG, Rawson A, Mayer ML, Doron S, Millman A, Melamed S, Fedorenko T, Kacen A, Amitai G, Sorek R[#], **Kranzusch PJ**[#].
Cryo-EM structure of the RADAR supramolecular anti-phage defense complex.
Cell. 2023; 186(5), 987–998. *bioRxiv* DOI 10.1101/2022.08.17.504323. (*co-first, [#]co-corresponding)
    - Preview feature in *Cell*

47. Mosallanejad K, Zhou W, Govande AA, Hancks DC, **Kranzusch PJ**, Kagan JC.
Species-specific self-DNA detection mechanisms by mammalian cyclic GMP-AMP synthases.
Science Immunology. 2023; 8(79), eabp9765. *bioRxiv* DOI 10.1101/2022.03.09.483681.

46. Dumitrescu DG, Gordon EM, Kovalyova Y, Seminara AB, Duncan-Lowey B, Forster ER, Zhou W, Booth CJ, Shen A, **Kranzusch PJ**, Hatzios SK.
A microbial transporter of the dietary antioxidant ergothioneine.
Cell. 2022; 185(24), 4526–4540.
    - Preview feature in *Cell*

45. Kimura S[#], Srisuknimit V, McCarty K, Dedon PC, **Kranzusch PJ**, Waldor MK[#].
Sequential action of a tRNA base editor in conversion of cytidine to pseudouridine.
Nature Communications. 2022; 13(1), 5994. *bioRxiv* DOI 10.1101/2022.02.17.480965. ([#]co-corresponding)

44. Leavitt A*, Yirmiya E*, Amitai G*, Lu A*, Garb J, Herbst E, Morehouse BR, Hobbs SJ, Antine SP, Sun Z-YJ, **Kranzusch PJ**[#], Sorek R[#].
Viruses inhibit TIR gcADPR signalling to overcome bacterial defence.
Nature. 2022; 611(7935), 326–331. *bioRxiv* DOI 10.1101/2022.05.03.490397. (*co-first, [#]co-corresponding)
    - Commentary in *Cell Host & Microbe*

43. Zhou W[#], Richmond-Buccola D, Wang Q, **Kranzusch PJ**[#].
Structural basis of human TREX1 DNA degradation and autoimmune disease.
Nature Communications. 2022; 13(1), 4227. ([#]co-corresponding)

42. Morehouse BR, Yip MCJ, Keszei AFA, McNamara-Bordewick NK, Shao S[#], **Kranzusch PJ**[#].
Cryo-EM structure of an active bacterial TIR-STING filament complex.
Nature. 2022; 608(7924), 803–807. ([#]co-corresponding)

41. Hertzog J, Zhou W, Fowler G, Rigby RE, Bridgeman A, Blest HTW, Cursi C, Chauveau L, Davenne T, Warner BE, Kinchington PR, **Kranzusch PJ**, Rehwinkel J.
Varicella-Zoster virus ORF9 is an antagonist of the DNA sensor cGAS.
EMBO Journal. 2022; 41(14), e109217. *bioRxiv* DOI 10.1101/2020.02.11.943415.

40. Hobbs SJ, Wein T, Lu A, Morehouse BR, Schnabel J, Leavitt A, Yirmiya E, Sorek R, **Kranzusch PJ**.
Phage anti-CBASS and anti-Pycsar nucleases subvert bacterial immunity.
Nature. 2022; 605(7910), 522–526.
    - Preview feature in *Nature*
    - Commentary in *Molecular Cell*

39. Johnson AG*, Wein T*, Mayer ML, Duncan-Lowey B, Yirmiya E, Oppenheimer-Shaanan Y, Amitai G, Sorek R[#], **Kranzusch PJ**[#].
Bacterial gasdermins reveal an ancient mechanism of cell death.
Science. 2022; 375(6577), 221–225. *bioRxiv* DOI 10.1101/2021.06.07.447441. (*co-first, [#]co-corresponding)
    - Research Highlight feature in *Nature*
    - Journal Club feature in *PNAS*
    - Commentary in *Signal Transduction and Targeted Therapy*

38. Duncan-Lowey B, McNamara-Bordewick NK, Tal N, Sorek R, **Kranzusch PJ**.
Effector-mediated membrane disruption controls cell death in CBASS antiphage defense.
Molecular Cell. 2021; 81(24), 5039–5051.

37. Tal N*, Morehouse BR*, Millman A, Stokar-Avihail A, Avraham C, Fedorenko T, Yirmiya E, Herbst E, Brandis A, Mehlman T, Oppenheimer-Shaanan Y, Keszei AFA, Shao S, Amitai G, **Kranzusch PJ**[#], Sorek R[#].
Cyclic CMP and cyclic UMP mediate bacterial immunity against phages.
Cell. 2021; 184(23), 5728–5739. (*co-first, [#]co-corresponding)
    - Preview feature in *Cell*
    - Commentary in *Trends in Biochemical Sciences*
    - Featured in *Nature Reviews Microbiology*

36. Slavik KM, Morehouse BR, Ragucci AE, Zhou W, Ai X, Chen Y, Li L, Wei Z, Bähre H, König M, Seifert R, Lee ASY, Cai H, Imler JL, **Kranzusch PJ**.
cGAS-like receptors sense RNA and control 3′2′-cGAMP antiviral signalling in Drosophila.
Nature. 2021; 597(7874), 109–113.
    - Preview feature in *Nature*
    - Commentary in *Trends in Immunology*
    - Commentary in *Signal Transduction and Targeted Therapy*

35. Govande AA, Duncan-Lowey B, Eaglesham JB, Whiteley AT, **Kranzusch PJ**.
Molecular basis of CD-NTase nucleotide selection in anti-phage defense.
Cell Reports. 2021; 35(9), 109206.

34. Zhou W, Mohr L, Maciejowski J, **Kranzusch PJ**.
cGAS phase separation inhibits TREX1-mediated DNA degradation and enhances cytosolic DNA sensing.
Molecular Cell. 2021; 81(4), 739–755.

• Commentary in *Developmental Cell*

33. Eaglesham JB, McCarty KL, **Kranzusch PJ**.
Structures of diverse poxin cGAMP nucleases reveal a widespread role for cGAS-STING evasion in host-pathogen conflict.
eLife. 2020; 9:e59753.

32. Morehouse BR, Govande AA, Millman A, Keszei AFA, Lowey B, Ofir G, Shao S, Sorek R, **Kranzusch PJ**.
STING cyclic dinucleotide sensing originated in bacteria.
Nature. 2020; 586(7829), 429–433.
• Preview feature in *Nature*

31. Lin B, Berard R, Al Rasheed A, Aladba B, **Kranzusch PJ**, Henderlight M, Grom A, Kahle D, Torreggiani S, Aue AG, Mitchell J, de Jesus AA, Schulert G, Goldbach-Mansky R.
A novel STING1 mutation causes a recessive form of STING-associated vasculopathy with onset in infancy (SAVI).
Journal of Allergy and Clinical Immunology. 2020; 146(5), 1204–1208.e6.

30. Lowey B, Whiteley AT, Keszei AFA, Morehouse BR, Antine SP, Cabrera VJ, Kashin D, Schwede F, Mekalanos JJ, Shao S, Lee ASY, **Kranzusch PJ**.
CBASS immunity uses CARF-related effectors to sense 3′–5′- and 2′–5′-linked cyclic oligonucleotide signals and protect bacteria from phage infection.
Cell. 2020; 182(1), 38–49.
• Preview feature in *Cell*

29. Lau RK*, Ye Q*, Birkholz EA, Berg KR, Patel L, Mathews IT, Watrous JD, Ego K, Whiteley AT, Lowey B, Mekalanos JJ, **Kranzusch PJ**, Jain M, Pogliano J, Corbett KD.
Structure and mechanism of a cyclic trinucleotide-activated bacterial endonuclease mediating bacteriophage immunity.
Molecular Cell. 2020; 77(4), 723–733. *bioRxiv* DOI 10.1101/694703. (*co-first)

28. Zhou W, Whiteley AT, **Kranzusch PJ**.
Analysis of human cGAS activity and structure.
Methods in Enzymology. 2019; 625, 13–40.

27. de Oliveira Mann CC, Orzalli MH, King DS, Kagan JC, Lee ASY[#], **Kranzusch PJ**[#].
Modular architecture of the STING C-terminal tail allows interferon and NF-κB signaling adaptation.
Cell Reports. 2019; 27, 1165–1175. ([#]co-corresponding)

26. Hallberg ZF*, Chan CH*, Wright TA, **Kranzusch PJ**, Doxzen KW, Park JJ, Bond DR[#], Hammond MC[#].
Structure and mechanism of a Hypr GGDEF enzyme that activates cGAMP signaling to control extracellular metal respiration.
eLife. 2019; 8:e43959. *bioRxiv* DOI 10.1101/495150. (*co-first, [#]co-corresponding)

25. Barnett KC, Coronas-Serna JM, Zhou W, Ernandes MJ, Cao A, **Kranzusch PJ**, Kagan JC.
Phosphoinositide interactions position cGAS at the plasma membrane to ensure efficient distinction between self- and viral DNA.
Cell. 2019; 176(6), 1432–1446.

24. Whiteley AT, Eaglesham JB, de Oliveira Mann CC, Morehouse BR, Lowey B, Nieminen EA, Danilchanka O, King DS, Lee ASY, Mekalanos JJ[#], **Kranzusch PJ**[#].
Bacterial cGAS-like enzymes synthesize diverse nucleotide signals.
Nature. 2019; 567(7747), 194–199. ([#]co-corresponding)
• Commentary in *Cell Host & Microbe*
• Featured in *Science Signaling*

23. Eaglesham JB, Pan Y, Kupper TS, **Kranzusch PJ**.
Viral and metazoan poxins are cGAMP-specific nucleases that control cGAS-STING signalling.
Nature. 2019; 566(7743), 259–263.
• Commentary in *Current Biology*
• Commentary in *Biochemistry*
• Featured as Headline Article in *UniProt*

22. Carey CM, Govande A, Cooper JM, Hartley MK, **Kranzusch PJ**, Elde NC.

Recurrent loss-of-function mutations reveal costs to OAS1 antiviral activity in primates.
Cell Host & Microbe. 2019; 25(2), 336–343. *bioRxiv* DOI 10.1101/326454.

21. Zhou W*, Whiteley AT*, de Oliveira Mann CC, Morehouse BR, Nowak RP, Fischer ES, Gray NS, Mekalanos JJ, **Kranzusch PJ**.
Structure of the human cGAS–DNA complex reveals enhanced control of immune surveillance.
Cell. 2018; 174(2), 300–311. (*co-first)
    • Commentary in *Immunity*

20. Brejc K*, Bian Q*, Uzawa S, Wheeler BS, Anderson EC, King DS, **Kranzusch PJ**, Preston CG, Meyer BJ.
Dynamic control of X-chromosome conformation and repression by a histone H4K20 demethylase.
Cell. 2017; 171(1), 85–102. (*co-first)

19. Harrington LB*, Doxzen KW*, Ma E, Liu J, Knott GJ, Edraki A, Garcia B, Amrani N, Chen JS, Cofsky JC, **Kranzusch PJ**, Sontheimer EJ, Davidson AR, Maxwell KL, Doudna JA.
A broad-spectrum inhibitor of CRISPR-Cas9.
Cell. 2017; 170(6), 1224–1233. (*co-first)

18. Lee ASY, **Kranzusch PJ**, Doudna JA, Cate JD.
eIF3d is an mRNA cap-binding protein required for specialized translation initiation.
Nature. 2016; 536(7614), 96–99.

17. Kaya E*, Doxzen KW*, Knoll K, Wilson RC, Strutt SC, **Kranzusch PJ**, Doudna JA.
A bacterial argonaute with noncanonical guide RNA specificity.
PNAS. 2016; 113(15), 4057–4062. (*co-first)

16. Nuñez JK*, Harrington LB*, **Kranzusch PJ**, Engelman AN, Doudna JA.
Foreign DNA capture during CRISPR–Cas adaptive immunity.
Nature. 2015; 527(7579), 535–538. (*co-first)
    • Featured in *Nature Reviews Microbiology*

15. **Kranzusch PJ***, Wilson SC*, Lee ASY, Berger JM, Doudna JA[#], Vance RE[#].
Ancient origin of cGAS-STING reveals mechanism of universal 2′,3′ cGAMP signaling.
Molecular Cell. 2015; 59(6), 891–903. (*co-first, [#]co-corresponding)
    • Cover Article

14. Lee ASY, **Kranzusch PJ**, Cate JD.
eIF3 targets cell proliferation mRNAs for translational activation or repression.
Nature. 2015; 522(7554), 111–114.
    • Featured in *Nature Structural & Molecular Biology*

13. **Kranzusch PJ**, Lee ASY, Wilson SC, Solovykh MS, Vance RE, Berger JM[#], Doudna JA[#].
Structure-guided reprogramming of human cGAS dinucleotide linkage specificity.
Cell. 2014; 158(5), 1011–1021. ([#]co-corresponding)
    • Featured in *Chemistry & Biology*

12. Nuñez JK, **Kranzusch PJ**, Noeske J, Wright AV, Davies CW, Doudna JA.
Cas1–Cas2 complex formation mediates spacer acquisition during CRISPR-Cas adaptive immunity.
Nature Structural & Molecular Biology. 2013; 21(6), 528–534.
    • Featured in *Science*

11. Liu W, Li Y, Shaw KS, Learn GH, Plenderleith LJ, Malenke JA, Sundararaman SA, Ramirez MA, Crystal PA, Smith AG, Bibollet-Ruche F, Ayouba A, Locatelli S, Esteban A, Mouacha F, Guichet E, Butel C, Ahuka-Mundeke S, Inogwabini BI, Ndjango JB, Speede S, Sanz CM, Morgan DB, Gonder MK, **Kranzusch PJ**, Walsh PD, Georgiev AV, Muller MN, Piel AK, Stewart FA, Wilson ML, Pusey AE, Cui L, Wang Z, Färnert A, Sutherland CJ, Nolder D, Hart JA, Hart TB, Bertolani P, Gillis A, LeBreton M, Tafon B, Kiyang J, Djoko CF, Schneider BS, Wolfe ND, Mpoudi-Ngole E, Delaporte E, Carter R, Culleton RL, Shaw GM, Rayner JC, Peeters M, Hahn BH, Sharp PM.
African origin of malaria parasite Plasmodium vivax.
Nature Communications. 2013; 5, 3346.

10. **Kranzusch PJ**, Lee ASY, Berger JM[#], Doudna JA[#].
Structure of human cGAS reveals a conserved family of second-messenger enzymes in innate immunity.
Cell Reports. 2013; 3(5), 1362-1368. ([#]co-corresponding)

9. **Kranzusch PJ** and Whelan SP.
Arenavirus Z protein controls viral RNA synthesis by locking a polymerase–promoter complex.
PNAS. 2011; 108(49), 19743–19748.

8. Carette JE*, Raaben MR*, Wong AC*, Herbert AS, Obernosterer G, Mulherkar N, Kuehne AI, **Kranzusch PJ**, Griffin AM, Ruthel G, Cin PD, Dye JM#, Whelan SP#, Chandran K#, Brummelkamp TR#.
Ebola virus entry requires the cholesterol transporter Niemann-Pick C1.
Nature. 2011; 477(7364), 340–3. (*co-first, #co-corresponding)
   • Preview feature in *Nature Reviews Drug Discovery*

7. Radoshitzky SR, Warfield KL, Chi X, Dong L, Kota K, Bradfute SB, Gearhart JD, Retterer C, **Kranzusch PJ**, Misasi JN, Hogenbirk MA, Wahl-Jensen V, Volchkov VE, Cunningham JM, Jahrling PB, Aman MJ, Bavari S, Farzan M, Kuhn JH.
Ebolavirus delta-peptide immunoadhesins inhibit marburgvirus and ebolavirus cell entry.
Journal of Virology. 2011; 85(17), 8502–8513.

6. Rahmeh AA, Schenk AD, Danek EI, **Kranzusch PJ**, Liang B, Walz T, Whelan SP.
Molecular architecture of the vesicular stomatitis virus RNA polymerase.
PNAS. 2010; 107(46), 20075–20080.

5. **Kranzusch PJ**, Schenk AD, Rahmeh AA, Radoshitzky SR, Bavari S, Walz T, Whelan SP.
Assembly of a functional Machupo virus polymerase complex.
PNAS. 2010; 107(46), 20069–20074.

4. Liu W, Li Y, Learn GH, Rudicell RS, Robertson JD, Keele BF, Ndjango JB, Sanz CM, Morgan DB, Locatelli S, Gonder MK, **Kranzusch PJ,** Walsh PD, Delaporte E, Mpoudi-Ngole E, Georgiev AV, Muller MN, Shaw GM, Peeters M, Sharp PM, Rayner JC, Hahn BH.
Origin of the human malaria parasite Plasmodium falciparum in gorillas.
Nature. 2010; 467(7314), 420–425.
   • Cover Article, Preview feature in *Nature*
   • Highlighted by BBC News

3. Radoshitzky SR, Dong L, Chi X, Clester JC, Retterer C, Spurgers K, Kuhn JH, Sandwick S, Ruthel G, Kota K, Boltz D, Warren T, **Kranzusch PJ**, Whelan SP, Bavari S.
Infectious Lassa virus, but not filoviruses, is restricted by BST-2/tetherin.
Journal of Virology. 2010; 84(20), 10569–10580.

2. Neel C, Etienne L, Li Y, Takehisa J, Rudicell RS, Bass IN, Moudindo J, Mebenga A, Esteban A, Van Heuverswyn F, Liegeois F, **Kranzusch PJ**, Walsh PD, Sanz CM, Morgan DB, Ndjango JB, Plantier JC, Locatelli S, Gonder MK, Leendertz FH, Boesch C, Todd A, Delaporte E, Mpoudi-Ngole E, Hahn BH, Peeters M.
Molecular epidemiology of simian immunodeficiency virus infection in wild-living gorillas.
Journal of Virology. 2009; 84(3), 1464–1476.

1. Rahmeh AA, Li J, **Kranzusch PJ**, Whelan SP.
Ribose 2′-O methylation of the vesicular stomatitis virus mRNA cap precedes and facilitates subsequent guanine-N-7 methylation by the large polymerase protein.
Journal of Virology. 2009; 83(21), 11043–11050.

Reviews and Commentaries

14. Eaglesham JB# and **Kranzusch PJ#**.
Tracing the evolutionary origins of antiviral immunity.
PLOS Biology. 2024; 22(2), e3002481. [Preview] (#co-corresponding)

13. Wassarman DR# and **Kranzusch PJ#**.
The language of bacterial defences expands.
Nature. 2023; 622(7984), 705–706. [Preview] (#co-corresponding)

12. **Kranzusch PJ**.
Editorial Overview: Evolution of antiviral defense.
Current Opinion in Microbiology. 2023. 75, 102352. [Review]
*Guest Editor of Special Issue

11. Slavik KM and **Kranzusch PJ**.
CBASS to cGAS-STING: the origins and mechanisms of nucleotide second messenger immune signaling.
Annual Review of Virology. 2023; 10(1), 423–453. [Review]

10. Richmond-Buccola D and **Kranzusch PJ**.
Viral sponges sequester nucleotide signals to inactivate immunity.
Trends in Microbiology. 2023; 31(6), 552–553. [Preview]

9. Johnson AG and **Kranzusch PJ**.
What bacterial cell death teaches us about life.
PLOS Pathogens. 2022; 18(10), e1010879. [Review]

8. Duncan-Lowey B and **Kranzusch PJ**.
CBASS phage defense and evolution of antiviral nucleotide signaling.
Current Opinion in Immunology. 2022; 74, 156–163. [Review]

7. Lowey B and **Kranzusch PJ**.
CD-NTases and nucleotide second messenger signaling.
Current Biology. 2020; 30, R1106–R1108. [Review]

6. Eaglesham JB and **Kranzusch PJ**.
Conserved strategies for pathogen evasion of cGAS-STING immunity.
Current Opinion in Immunology. 2020; 66, 27–34. [Review]

5. **Kranzusch PJ**.
cGAS and CD-NTase enzymes: structure, mechanism, and evolution.
Current Opinion in Structural Biology. 2019; 59, 178–187. [Review]

4. de Oliveira Mann CC and **Kranzusch PJ**.
cGAS conducts micronuclei DNA surveillance.
Trends in Cell Biology. 2017; 27(10), 697–698. [Preview]

3. **Kranzusch PJ** and Vance RE.
cGAS dimerization entangles DNA recognition.
Immunity. 2013; 39(6), 992–994. [Preview]

2. Morin B, **Kranzusch PJ**, Rahmeh AA, Whelan SP.
The polymerase of negative-stranded RNA viruses.
Current Opinion in Virology. 2013; 3(2), 103–110. [Review]

1. **Kranzusch PJ** and Whelan SP.
Architecture and regulation of negative-strand viral enzymatic machinery.
RNA Biology. 2012; 9(7), 941–948. [Review]

Patents

03/2023 **PRODUCTION OF 2′3′-CYCLIC GMP-AMP (cGAMP) AND METHOD OF USE THEREOF**
US Provisional Patent Application No. 63/486,766 (DFCI/HMS/CU-Boulder)
Authors: Whiteley AT, Tak UV, **Kranzusch PJ**, Mekalanos JJ

04/2022 **COMPOSITION AND METHODS FOR ALTERING CYCLIC ADP-RIBOSE SECOND MESSENGER SIGNALING**
US Provisional Patent Application No. 63/334,217 (DFCI/Weizmann Institute of Science)
Authors: Sorek RS, Amitai G, Leavitt A, Yirmiya E, Lu A, **Kranzusch PJ**

03/2020 **CGAS/DNCV-LIKE NUCLEOTIDYLTRANSFERASES AND USES THEREOF**
WO/2020/051197, International PCT/US2019/049478 (DFCI/HMS)
Authors: Whiteley AT, Eaglesham JB, Mekalanos JJ, **Kranzusch PJ**

02/2020 **STRUCTURE OF THE HUMAN cGAS-DNA COMPLEX AND USES THEREOF**
WO/2020/006038, International PCT/US2019/039171 (DFCI/HMS)
Authors: Zhou W, Whiteley AT, Mekalanos JJ, **Kranzusch PJ**

Invited Research Talks

Local

2023 **Invited Seminar – Seminars in Oncology Lecture Series**
Evolution of antiviral immunity
Dana-Farber Cancer Institute, Boston, MA

2021 **Invited Seminar – Immunology Seminar Series**
Evolution of antiviral immunity
Harvard Medical School, Boston, MA

2019 **Medical Oncology Departmental Retreat**
Dana-Farber Cancer Institute, Quincy, MA

2019 **Microbiology Departmental Retreat**
Harvard Medical School, Falmouth, MA

2019 **Cancer Immunology & Virology Departmental Retreat**
Dana-Farber Cancer Institute, Dedham, MA

2018 **Hale Center for Pancreatic Cancer**
Dana-Farber Cancer Institute, Boston, MA

2018 **Center for Functional Cancer Epigenetics**
Dana-Farber Cancer Institute, Boston, MA

2017 **Cancer Immunology Working Group**
Dana-Farber Cancer Institute, Boston, MA

2017 **Center for Virology and Vaccine Research Seminar Series**
Beth Israel Deaconess Medical Center, Boston, MA

2016 **Joint Retreat, Cancer Biology and Cancer Immunology & Virology (DFCI)**
Broad Institute, Cambridge, MA

2016 **Graduate Student Retreat, Program in Virology**
Harvard Medical School, Boston, MA

2016 **Program in Virology Seminar Series**
Harvard Medical School, Boston, MA

2016 **Microbiology and Immunobiology Departmental Retreat**
Harvard Medical School, Falmouth, MA

2015 **Microbiology and Immunobiology Special Seminar**
Harvard Medical School, Boston, MA

Regional

2024 **Invited Seminar – Microbial Pathogenesis and Immunology Seminar Series**
Evolution of antiviral immunity
Boston University Chobanian & Avedisian School of Medicine, Boston, MA

2023 **Invited Seminar**
Evolution of antiviral immunity
Moderna, Cambridge, MA

2022 **Invited Seminar**
Evolution of antiviral immunity
New England Biolabs, Ipswich, MA

2021 **Invited Seminar – Department of Medicine**
Evolution of antiviral immunity
University of Massachusetts Medical School, Worcester, MA

2019 **Invited Seminar – DFCI/NIBR Research Symposium**
cGAS-like enzymes in human immunity and host-microbe signaling
Novartis, Cambridge, MA

2019 **Invited Seminar**
Regulation of cGAS-STING immunity
Novartis, Cambridge, MA

2018 **Invited Seminar – MIT Center for Microbiome Informatics and Therapeutics**
cGAS-like enzymes in human immunity and bacteria–host signaling
Broad Institute, Cambridge, MA

2017 **Invited Seminar – Biochemistry Department**
Ancient cGAS-STING pathways reveal new mechanisms of human innate immune activation
Brandeis University, Waltham, MA

2016 **Invited Seminar**
Ancient cGAS-STING pathways reveal new mechanisms of human innate immune activation

Novartis, Cambridge, MA

National

2024 **Invited Seminar – Department of Microbiology-Immunology**
Evolution of antiviral immunity
Northwestern University Feinberg School of Medicine, Chicago, IL

2023 **Invited Seminar – Integrative Immunobiology Seminar Series**
Evolution of antiviral immunity
Duke University, Durham, NC

2023 **Gordon Research Conference – Nucleic Acids (Invited Speaker)**
Evolution of antiviral immunity
Grand Summit Hotel at Sunday River, Newry, ME

2022 **Invited Seminar – Microbiology Seminar Series**
Evolution of antiviral immunity
New York University, New York, NY

2022 **Invited Seminar – Molecular Microbiology and Immunology Seminar Series**
Evolution of antiviral immunity
Johns Hopkins Bloomberg School of Public Health, Baltimore, MD

2021 **Invited Seminar – Laboratory of Viral Diseases Guest Researcher Seminar Series**
Evolution of antiviral immunity
National Institute of Allergy and Infectious Diseases, Bethesda, MD

2021 **Invited Seminar – Pfizer Boulder Seminar Series**
Evolution of antiviral immunity
Pfizer Boulder Research and Development, Boulder, CO

2021 **Invited Seminar – Molecular Microbiology Seminar Series**
Evolution of antiviral immunity
Washington University in St. Louis, St. Louis, MO

2021 **Invited Seminar – Excellence in Immunology Lecture Series**
Evolution of antiviral immunity
The University of Texas Southwestern Medical Center, Dallas, TX

2021 **Invited Seminar – Biophysics/Bioinformatics/Chemical Biology Seminar Series**
Evolution of antiviral immunity
University of California-San Francisco, San Francisco, CA

2020 **Invited Seminar – Microbiology & Molecular Genetics Department**
cGAS-like enzymes in immunity and host-microbe signaling
Michigan State University, East Lansing, MI

2020 **Invited Seminar – Microbiology Graduate Program Seminar**
cGAS-like enzymes in immunity and host-microbe signaling
Yale University, New Haven, CT

2020 **Invited Seminar – Microbiology Department**
cGAS-like enzymes in immunity and host-microbe signaling
University of Pennsylvania, Philadelphia, PA

2019 **Invited Seminar – Microbiology Department**
cGAS-like enzymes in immunity and host-microbe signaling
University of Washington, Seattle, WA (Student Selected Speaker)

2019 **Invited Seminar – Microbiology and Immunology Department**
cGAS-like enzymes in immunity and host-microbe signaling
University of Maryland, Baltimore, MD

2019 **Invited Seminar – Biochemistry Department**
cGAS-like enzymes in immunity and host-microbe signaling
University of Utah, Salt Lake City, UT

2019 **Invited Seminar – Biology Department**
cGAS-like enzymes in immunity and host-microbe signaling
University of California–San Diego, San Diego, CA

2019 **Invited Seminar**
cGAS-like enzymes in immunity and host-microbe interactions
Parker Institute for Cancer Immunotherapy Retreat, Napa, CA

2017 **Invited Seminar**
Human cGAS and bacterial cGAS-like enzymes

Aduro Biotech, San Francisco, CA

2017 **Invited Seminar – Biology Department**
Ancient cGAS-STING pathways link bacterial signaling and human innate immunity
Florida State University, Tallahassee, FL

2017 **American Society of Microbiology Meeting**
Ancient cGAS-STING pathways link bacterial signaling and human innate immunity
New Orleans, LA

2015 **Invited Seminar – Department of Molecular Microbiology & Immunology**
Ancient cGAS homologs reveal evolution of innate immune signaling
USC Keck School of Medicine, Pasadena, CA

International

2023 **Infectious Diseases Through an Evolutionary Lens (Invited Speaker)**
Evolution of antiviral immunity
British Medical Association House, London, United Kingdom

2023 **Small Molecule Signaling Across the Tree of Life Symposium (Invited Speaker)**
Evolution and evasion of antiviral immunity
Wenner-Gren Center, Stockholm, Sweden

2023 **Symposium on the Immune System of Bacteria (Invited Speaker, Conference Co-Organizer)**
Evolution and evasion of antiviral immunity
Weizmann Institute, Rehovot, Israel

2022 **Nucleic Acid Immunity Meeting (Invited Speaker)**
Evolution of antiviral immunity
Royal College of Physicians of Edinburgh, Edinburgh, Scotland

2022 **Immunity and Host-Microbes Interactions Symposium (Invited Speaker)**
Evolution of antiviral immunity
Max Planck, Berlin, Germany

2022 **33rd Pezcoller Symposium – What are the obstacles to cancer immunotherapy success? (Invited Speaker)**
cGAS-like receptors reveal new signals controlling innate immunity
University of Trento, Trento, Italy

2022 **Invited Seminar – Trans-Atlantic exchanges in immune oncology**
cGAS-like receptors reveal new signals controlling innate immunity
Filmed in Boston, MA, USA

2022 **Invited Seminar – Friday Seminar Series**
Evolution of antiviral immunity from bacteria to animal cells
John Innes Center, Norwich, United Kingdom

2020 **Invited Seminar – Gene Center Seminar Series**
cGAS-like enzymes in immunity and host-microbe signaling
Ludwig-Maximilians-Universität, Munich, Germany

2019 **Congressi Stefano Franscini – Nucleic Acid Immunity in Health and Disease (Invited Speaker)**
Regulation of cGAS-STING immunity
Monte Verità, Switzerland

2019 **Invited Seminar – International Seminar Series**
Regulation of cGAS-STING immunity
Netherlands Cancer Institute (NKI), Amsterdam, Netherlands

2018 **SPP 1879 – Nucleotide Second Messenger Signaling in Bacteria (Invited Speaker)**
Discovery of cGAS/DncV-like enzymes and diverse nucleotide second messenger signals
Berlin, Germany

2018 **Invited Seminar**
cGAS-like enzymes in human immunity and bacteria–host signaling
École polytechnique fédérale de Lausanne, Lausanne, Switzerland

2016 **Keystone Symposia – Nucleic Acid Sensing**
Ancient cGAS-STING pathways reveal evolution of human innate immunity
Dresden, Germany

Teaching and Service

2023 – Present	**Instructor, HMS Community Phages DEI Program**	Summer course
2018 – Present	**Co-Course Director, Virology 200 / Introduction to Virology**	Half-year course
2018	**Lecturer, Immuno-Oncology Investigator Training Program**	1 h session; 1× / year

2017	**Group Leader, BBS 330 / Critical Thinking and Research Proposal Writing**	3 h session; 4× / year
2016 – Present	**Lecturer, Immunology 307 / Cancer Immunology**	2 h session; 1× / year
2016 – 2018	**Lecturer/Discussion Leader, Virology 200 / Introduction to Virology**	1.5 h session; 4× / year

2023 – Present	**DFCI Faculty Promotions Committee**	(DFCI)
2023 – Present	**DFCI Limited Applications Grant Committee**	(DFCI)
2022 – Present	**DFCI Executive Committee for Research**	(DFCI)
2021 – Present	**The Mathers Foundation Grant Review Committee**	
2021	**Novartis/Dana-Farber DDTRP Grant Review Committee**	
2021	**The Mark Foundation Grant Review Committee**	
2019, 2023	**Microbiology Department Faculty Search Committee**	(Harvard Medical School)
2019 – Present	**Claudia Adams Barr Grant Review Committee**	(DFCI)
2018	**Co-Organizer, Microbiology and Immunobiology Retreat**	(Harvard Medical School)
2018 – Present	**Charles A. King Trust Fellowship Science Review Committee**	
2020 – 2022	**Internal Scientific Review Council**	(DFCI)
2017		
2022 – Present,	**Member, Graduate Admissions Committee, BBS**	(Harvard Medical School)
2017 – 2020		
2017	**Co-Organizer, Cancer Immunology & Virology Scientific Retreat**	(DFCI)
2016 – Present	**Dissertation Advisory Committee Member (16 students)**	(Harvard Medical School / MIT)
2016 – Present	**Qualifying Exam / Dissertation Defense Committees (20 students)**	(Harvard Medical School / MIT)
2016 – 2021	**Co-Organizer, Cancer Immunology Seminar Series**	(DFCI)
2022 – Present	**Member, Graduate Admissions Committee, Program in Virology**	(Harvard Medical School)
2016 – 2020		

List of Trainees

Name	Years	Lab Position	Awards	Current Position
Samantha G. Fernandez	2023 – Current	Postdoctoral Fellow		
Renee B. Chang	2023 – Current	Graduate Student		
Adelyn E. Ragucci	2023 – Current, 2020 – 2022	Graduate Student, Research Technician		
Joël M.J. Tan	2023 – Current	Graduate Student		
Sonomi Yamaguchi	2023 – Current	Postdoctoral Fellow	JSPS Fellowship, HFSP Fellowship	
Aidan B. Hill	2022 – Current	Research Technician		
Douglas R. Wassarman	2022 – Current	Postdoctoral Fellow		
Hunter C. Toyoda	2022 – Current	Research Technician		
Sarah E. Mooney	2022 – Current	Research Technician		
Sadie P. Antine	2022 – Current	Graduate Student		
J. Maximilian Fels	2021 – Current	Postdoctoral Fellow	Branco Weiss Fellowship	
Desmond Richmond-Buccola	2021 – Current	Graduate Student	NSF Graduate Fellowship	
Allen Lu	2021 – 2023	Research Technician		MD/PhD Student, Cornell University
Yao Li	2021 – Current	Postdoctoral Fellow	Benacerraf Fellowship	
Samuel J. Hobbs	2020 – Current	Postdoctoral Fellow	CRI Fellowship	
Alexander G. Johnson	2020 – Current	Postdoctoral Fellow	LSRF Fellowship	
Nora K. McNamara-Bordewick	2020 – 2022	Research Technician		MD/PhD Student, University of Washington
Kailey M. Slavik	2019 – 2023	Graduate Student	NIH F99 Fellowship	Postdoctoral Fellow, Luciano Marraffini Lab (Rockefeller)
Hsiao-Yun Chen	2018 – 2020	Postdoctoral Fellow		Senior Scientist, New Equilibrium Biosciences
Kacie L. McCarty	2018 – 2020	Research Technician		PhD Student, New York University
Brianna Duncan-Lowey	2018 – 2021	Graduate Student	Herchel Smith Fellowship, Harold M. Weintraub Graduate Student Award	Postdoctoral Fellow, Noah Palm Lab (Yale)

Benjamin R. Morehouse	2017 – 2022	Postdoctoral Fellow	Ruth L. Kirschstein NRSA Fellowship	Assistant Professor, University of California–Irvine
Wen Zhou	2017 – 2021	Postdoctoral Fellow	Benacerraf Fellowship, Charles A. King Trust Award	Associate Professor, Southern University of Science and Technology, China
Apurva A. Govande	2017 – 2021	Graduate Student	NSF Graduate Fellowship	Scientist, Beam Therapeutics
James B. Eaglesham	2017 – 2020	Graduate Student	Harold M. Weintraub Graduate Student Award Albert J. Ryan Foundation Graduate Student Award	Staff Scientist (PI Group Leader), New England Biolabs
Carina C. Baer de Oliveira Mann	2016 – 2019	Postdoctoral Fellow	CRI Fellowship	Assistant Professor, Technical University of Munich
Aaron T. Whiteley	2016 – 2019	Postdoctoral Fellow	JCC Fellowship	Assistant Professor of Biochemistry, University of Colorado Boulder
Eric A. Nieminen	2016 – 2018	Research Technician		Molecular Biology Scientist, Merck