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## Structural biochemistry of the pentraxins

Noone, D.P.

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## References

1. Chaplin DD. Overview of the immune response. *Journal of Allergy and Clinical Immunology*. 2010;125(2, Supplement 2):S3-S23.
2. Paludan SR, Pradeu T, Masters SL, Mogensen TH. Constitutive immune mechanisms: mediators of host defence and immune regulation. *Nature Reviews Immunology*. 2021;21(3):137-50.
3. Shanley LC, Mahon OR, Kelly DJ, Dunne A. Harnessing the innate and adaptive immune system for tissue repair and regeneration: Considering more than macrophages. *Acta Biomaterialia*. 2021;133:208-21.
4. Matzinger P. The Danger Model: A Renewed Sense of Self. *Science*. 2002;296(5566):301-5.
5. Noia JMD, Neuberger MS. Molecular Mechanisms of Antibody Somatic Hypermutation. *Annu Rev Biochem*. 2007;76(1):1-22.
6. Sherwood ER, Burelbach KR, McBride MA, Stothers CL, Owen AM, Hernandez A, et al. Innate Immune Memory and the Host Response to Infection. *The Journal of Immunology*. 2022;208(4):785-92.
7. Daniel Ricklin, George Hajishengallis, Kun Yang, John D. Lambris. Complement: a key system for immune surveillance and homeostasis. *Nature Immunology* 2010;11(9).
8. Ugurlar D, Howes SC, Kreuk B-Jd, Koning RI, Jong RNd, Beurskens FJ, et al. Structures of C1-IgG1 provide insights into how danger pattern recognition activates complement. *Science*. 2018;359(6377):794-7.
9. Sharp TH, Boyle AL, Diebold CA, Kros A, Koster AJ, Gros P. Insights into IgM-mediated complement activation based on in situ structures of IgM-C1-C4b. *Proc Natl Acad Sci USA*. 2019;116(24):11900-5.
10. Baudino L, Sardini A, Ruseva MM, Fossati-Jimack L, Cook HT, Scott D, et al. C3 opsonization regulates endocytic handling of apoptotic cells resulting in enhanced T-cell responses to cargo-derived antigens. *Proc Natl Acad Sci USA*. 2014;111(4):1503-8.
11. Dempsey PW, Allison MED, Akkaraju S, Goodnow CC, Fearon DT. C3d of Complement as a Molecular Adjuvant: Bridging Innate and Acquired Immunity. *Science*. 1996;271(5247):348-50.
12. Fearon DT. The complement system and adaptive immunity. *Semin Immunol*. 1998;10(5):355-61.
13. Pepys M, B., Hirschfield G, M. . C-reactive protein: a critical update. *The Journal of Clinical Investigation*. 2003;111(12):1805-12.
14. Beltrame MH, Catarino SJ, Goeldner I, Boldt ABW, de Messias-Reason IJ. The Lectin Pathway of Complement and Rheumatic Heart Disease. *Front Pediatr*. 2015;2(21):148.
15. Ma Y, Jie, Doni A, Skjoedt M-O, Honoré C, Arendrup M, Mantovani A, Garred P. Heterocomplexes of Mannose-binding Lectin and the Pentraxins PTX3 or Serum Amyloid P Component Trigger Cross-activation of the Complement System. *Journal of Biological Chemistry*. 2011;286(5):3405-17.
16. Ghai R, Waters P, Roumenina LT, Gadjeva M, Kojouharova MS, Reid KBM, et al. C1q and its growing family. *Immunobiology*. 2007;212(4):253-66.
17. Païdassi H, Tacnet-Delorme P, Garlatti V, Darnault C, Ghebrehiwet B, Gaboriaud C, et al. C1q Binds Phosphatidylserine and Likely Acts as a Multiligand-Bridging Molecule in Apoptotic Cell Recognition1. *The Journal of Immunology*. 2008;180(4):2329-38.

## Dylan Paul Noone - Structural biochemistry of the pentraxins

18. Roumenina LT, Popov KT, Bureeva SV, Kojouharova M, Gadjeva M, Rabheru S, et al. Interaction of the globular domain of human C1q with *Salmonella typhimurium* lipopolysaccharide. *Biochimica et Biophysica Acta (BBA) - Proteins and Proteomics*. 2008;1784(9):1271-6.
19. Diniz SN, Nomizo R, Cisalpino PS, Teixeira MM, Brown GD, Mantovani A, et al. PTX3 function as an opsonin for the dectin-1-dependent internalization of zymosan by macrophages. *J Leukoc Biol*. 2004;75(4):649-56.
20. Vandendriessche S, Cambier S, Proost P, Marques PE. Complement Receptors and Their Role in Leukocyte Recruitment and Phagocytosis. *Front Immunol*. 2021;9(11):624025.
21. Bohlson SS, O'Conner SD, Hulsebus HJ, Ho M-M, Fraser DA. Complement, C1q, and C1q-Related Molecules Regulate Macrophage Polarization. *Front Immunol*. 2014;5(21):402.
22. Lu J, Mold C, Du Clos TW, Sun PD. Pentraxins and Fc Receptor-Mediated Immune Responses. *Front Immunol*. 2018;9(13):2607.
23. Tron K, Manolov DE, Röcker C, Kächele M, Torzewski J, Nienhaus GU. C-reactive protein specifically binds to Fcγ receptor type I on a macrophage-like cell line. *Eur J Immunol*. 2008;38(5):1414-22.
24. Lu J, Marnell LL, Marjon KD, Mold C, Du Clos TW, Sun PD. Structural recognition and functional activation of FcγR by innate pentraxins. *Nature*. 2008;456(7224):989-92.
25. Menny A, Serna M, Boyd CM, Gardner S, Joseph AP, Morgan BP, et al. CryoEM reveals how the complement membrane attack complex ruptures lipid bilayers. *Nature Communications*. 2018;9(1):5316.
26. Zipfel PF, Skerka C. Complement regulators and inhibitory proteins. *Nature Reviews Immunology*. 2009;9(10):729-40.
27. Gershov D, Kim S, Brot N, Elkon KB. C-Reactive Protein Binds to Apoptotic Cells, Protects the Cells from Assembly of the Terminal Complement Components, and Sustains an Antiinflammatory Innate Immune Response: Implications for Systemic Autoimmunity. *Journal of Experimental Medicine*. 2000;192(9):1353-64.
28. Doorduijn DJ, Rooijakkers SHM, Heesterbeek DAC. How the Membrane Attack Complex Damages the Bacterial Cell Envelope and Kills Gram-Negative Bacteria. *Bioessays*. 2019;41(10):1900074.
29. Klos A, Tenner AJ, Johswich K-O, Ager RR, Reis ES, Köhl J. The role of the anaphylatoxins in health and disease. *Molecular Immunology*. 2009;46(14):2753-66.
30. Miyazawa K, Inoue K. Complement activation induced by human C-reactive protein in mildly acidic conditions. *J Immunol*. 1990;145(2):650-4.
31. Bonavita E, Gentile S, Rubino M, Maina V, Papait R, Kunderfranco P, et al. PTX3 Is an Extrinsic Oncosuppressor Regulating Complement-Dependent Inflammation in Cancer. *Cell*. 2015;160(4):700-14.
32. Kovács RÁ, Vadászi H, Bulyáki É, Török G, Tóth V, Mátyás D, et al. Identification of Neuronal Pentraxins as Synaptic Binding Partners of C1q and the Involvement of NP1 in Synaptic Pruning in Adult Mice. *Front Immunol*. 2021;11(8):599771.
33. Shrive AK, Metcalfe AM, Cartwright JR, Greenhough TJ. C-reactive protein and SAP-like pentraxin are both present in *Limulus polyphemus* haemolymph: crystal structure of *Limulus* SAP11Edited by R. Huber. *Journal of Molecular Biology*. 1999;290(5):997-1008.
34. Annette K. Shrive, Graham M. T. Cheetham, David Holden, Dean A. A. Myles, William G. Turnell, John E. Volanakis, et al. Three dimensional structure of human C-reactive protein. *Nature Structural Biology*. 1996;3(4):346-54.

## Dylan Paul Noone - Structural biochemistry of the pentraxins

35. Noone DP, van der Velden TT, Sharp TH. Cryo-Electron Microscopy and Biochemical Analysis Offer Insights Into the Effects of Acidic pH, Such as Occur During Acidosis, on the Complement Binding Properties of C-Reactive Protein. *Front Immunol.* 2021;12(16):757633. .
36. Noone DP, Dijkstra DJ, van der Klugt TT, van Veelen PA, de Ru AH, Hensbergen PJ, et al. PTX3 structure determination using a hybrid cryoelectron microscopy and AlphaFold approach offers insights into ligand binding and complement activation. *Proc Natl Acad Sci USA.* 2022;119(33):e2208144119.
37. Emsley J, White HE, O'Hara BP, Oliva G, Srinivasan N, Tickle IJ, et al. Structure of pentameric human serum amyloid P component. *Nature.* 1994;367(6461):338-45.
38. Suzuki K, Elegheert J, Song I, Sasakura H, Senkov O, Matsuda K, et al. A synthetic synaptic organizer protein restores glutamatergic neuronal circuits. *Science.* 2020;369(6507).
39. Garlanda C, Bottazzi B, Bastone A, Mantovani A. Pentraxins at the crossroads between innate immunity, inflammation, matrix deposition, and female fertility. *Annu Rev Immunol.* 2005;23(1):337-66.
40. Inforzato A, Rivieccio V, Morreale A, P., Bastone A, Salustri A, Scarchilli L, et al. Structural characterization of PTX3 disulfide bond network and its multimeric status in cumulus matrix organization. *J Biol Chem.* 2008;283(15):10147-61.
41. Inforzato A, Baldock C, Jowitt T, A., Holmes D, F., Lindstedt R, Marcellini M, et al. The angiogenic inhibitor long pentraxin PTX3 forms an asymmetric octamer with two binding sites for FGF2. *J Biol Chem.* 2020;285(23):17681-92.
42. Xu D HC, Reddy R, Cho RW, Guo L, Lanahan A, Petralia RS, Wenthold RJ, O'Brien RJ, Worley P. Narp and NP1 form heterocomplexes that function in developmental and activity-dependent synaptic plasticity. *Neuron.* 2003;39(3):513-28.
43. Morris OM, Torpey JH, Isaacson RL. Intrinsically disordered proteins: modes of binding with emphasis on disordered domains. *Open Biol.* 2021;11(10):210222.
44. Deban L, Jarva H, Lehtinen M, J., Bottazzi B, Bastone A, Doni A, et al. Binding of the long pentraxin PTX3 to factor H: interacting domains and function in the regulation of complement activation. *J Immunol.* 2008;181(12):8433-40.
45. Camozzi M, Rusnati M, Bugatti A, Bottazzi B, Mantovani A, Bastone A, et al. Identification of an antiangiogenic FGF2-binding site in the N terminus of the soluble pattern recognition receptor PTX3. *J Biol Chem.* 2006;281(32):22605-13.
46. Leali D, Inforzato A, Ronca R, Bianchi R, Belleri M, Coltrini D, et al. Long pentraxin 3/tumor necrosis factor-stimulated gene-6 interaction: a biological rheostat for fibroblast growth factor 2-mediated angiogenesis. *Arteriosclerosis, thrombosis, and vascular biology.* 2012;32(3):696-703.
47. De Beer FC, Pepys MB. Isolation of human C-reactive protein and serum amyloid P component. *Journal of Immunological Methods.* 1982;50(1):17-31.
48. Wang M-Y, Ji S-R, Bai C-J, Kebir iE, Li H-Y, Shi J-M, et al. A redox switch in C-reactive protein modulates activation of endothelial cells. *FASEB J.* 2011;25(9):3186-96.
49. Hoffmann MH, Griffiths HR. The dual role of Reactive Oxygen Species in autoimmune and inflammatory diseases: evidence from preclinical models. *Free Radical Biology and Medicine.* 2018;125:62-71.
50. Inforzato A, Peri G, Doni A, Garlanda C, Mantovani A, Bastone A, et al. Structure and function of the long pentraxin PTX3 glycosidic moiety: fine-tuning of the interaction with C1q and complement activation. *Biochemistry.* 2006;45(38):11540-51.

## Dylan Paul Noone - Structural biochemistry of the pentraxins

51. Reading P, C., Bozza S, Gilbertson B, Tate M, Moretti S, Job E, R., et al. Antiviral activity of the long chain pentraxin PTX3 against influenza viruses. *J Immunol.* 2008;180(5).
52. Deban L, Russo C, Remo,, Sironi M, Moalli F, Scanziani M, Zambelli V, et al. Regulation of leukocyte recruitment by the long pentraxin PTX3. . *Nat Immunol.* 2010;11(4):328-34.
53. Job ER, Bottazzi B, Gilbertson B, Edenborough KM, Brown LE, Mantovani A, et al. Serum Amyloid P Is a Sialylated Glycoprotein Inhibitor of Influenza A Viruses. *PLOS ONE.* 2013;8(3):e59623.
54. Gabay C, Kushner I. Acute-Phase Proteins and Other Systemic Responses to Inflammation. *Engl J Med.* 1999;340(6):448-54.
55. Kinoshita CM, Ying SC, Hugli TE, Siegel JN, Potempa LA, Jiang H, et al. Elucidation of a protease-sensitive site involved in the binding of calcium to C-reactive protein. *Biochemistry.* 1989;28(25):9840-8.
56. Chapman G, Shanmugalingam U, Smith PD. The Role of Neuronal Pentraxin 2 (NP2) in Regulating Glutamatergic Signaling and Neuropathology. *Front Cell Neurosci.* 2020;13(575).
57. Han B, Ma X, Zhang J, Zhang Y, Bai X, Hwang DM, et al. Protective effects of long pentraxin PTX3 on lung injury in a severe acute respiratory syndrome model in mice. *Lab Invest.* 2012;92(9):1285-96.
58. Munoz LE, Gaipol US, Franz S, Sheriff A, Voll RE, Kalden JR, Herrmann M. SLE—a disease of clearance deficiency? *Rheumatology.* 2005;44(9):1101-7.
59. Berman SF, Gewurz H, Mold C. Binding of C-reactive protein to nucleated cells leads to complement activation without cytolysis. *J Immunol.* 1986;136(4):1354-9.
60. Hong S, Beja-Glasser VF, Nfonoyim BM, Frouin A, Li S, Ramakrishnan S, et al. Complement and microglia mediate early synapse loss in Alzheimer mouse models. *Science.* 2016;352(6286):712-6.
61. Rovere P, Peri G, Fazzini F, Bottazzi B, Doni A, Bondanza A, et al. The long pentraxin PTX3 binds to apoptotic cells and regulates their clearance by antigen-presenting dendritic cells. *Blood.* 2000;96(13):4300-6.
62. Gitlin JD, Gitlin JL, Gitlin D. Localization of C-reactive protein in synovium of patients with rheumatoid arthritis. *Arthritis Rheum.* 1977;20(8):1491-9.
63. Robey FA, Jones KD, Tanaka T, Liu TY. Binding of C-reactive protein to chromatin and nucleosome core particles. A possible physiological role of C-reactive protein. *Journal of Biological Chemistry.* 1984;259(11):7311-6.
64. Meyer O. Anti-CRP antibodies in systemic lupus erythematosus. *Joint Bone Spine.* 2010;77(5):384-9.
65. van Schaarenburg RA, Magro-Checa C, Bakker JA, Teng YKO, Bajema IM, Huizinga TW, et al. C1q Deficiency and Neuropsychiatric Systemic Lupus Erythematosus. *Front Immunol.* 2016;7(647).
66. Rodriguez W, Mold C, Kataranovski M, Hutt J, Marnell LL, Du Clos TW. Reversal of ongoing proteinuria in autoimmune mice by treatment with C-reactive protein. *Arthritis Rheum.* 2005;52(2):642-50.
67. Thanei S, Vanhecke D, Trendelenburg M. Anti-C1q autoantibodies from systemic lupus erythematosus patients activate the complement system via both the classical and lectin pathways. *Clinical Immunology.* 2015;160(2):180-7.
68. Ma H, Liu C, Shi B, Zhang Z, Feng R, Guo M, et al. Mesenchymal Stem Cells Control Complement C5 Activation by Factor H in Lupus Nephritis. *EBioMedicine.* 2018;32:21-30.
69. Wang S, Wu M, Chiriboga L, Zeck B, Belmont HM. Membrane attack complex (mac) deposition in lupus nephritis is associated with hypertension and poor clinical response to treatment. *Seminars in Arthritis and Rheumatism.* 2018;48(2):256-62.

70. Zhou Z-h, Wild T, Xiong Y, Sylvers LH, Zhang Y, Zhang L, et al. Polyreactive Antibodies Plus Complement Enhance the Phagocytosis of Cells Made Apoptotic by UV-Light or HIV. *Scientific Reports.* 2013;3(1):2271.
71. Quartier P, Potter PK, Ehrenstein MR, Walport MJ, Botto M. Predominant role of IgM-dependent activation of the classical pathway in the clearance of dying cells by murine bone marrow-derived macrophages in vitro. *Eur J Immunol.* 2005;35(1):252-60.
72. Norata GD, Marchesi P, Pulakazhi Venu VK, Pasqualini F, Anselmo A, Moalli F, et al. Deficiency of the long pentraxin PTX3 promotes vascular inflammation and atherosclerosis. *Circulation.* 2009;120(8):699-708.
73. Torzewski J, Torzewski M, Bowyer DE, Fröhlich M, Koenig W, Waltenberger J, et al. C-Reactive Protein Frequently Colocalizes With the Terminal Complement Complex in the Intima of Early Atherosclerotic Lesions of Human Coronary Arteries. *Arterioscler Thromb Vasc Bio.* 1998;18(9):1386-92.
74. Lagrand WK, Niessen HWM, Wolbink G-J, Jaspars LH, Visser CA, Verheugt FWA, et al. C-Reactive Protein Colocalizes With Complement in Human Hearts During Acute Myocardial Infarction. *Circulation.* 1997;95(1):97-103.
75. A. Riemann, A. Ihling, J. Thomas, B. Schneider, O. Thews, M. Gekle. Acidic environment activates inflammatory programs in fibroblasts via a cAMP-MAPK pathway. *Biochimica et Biophysica Acta.* 2015;1853(2):299-307.
76. Nagoba B, Suryawanshi NM, Wadher BJ, Selkar SP. Acidic Environment and Wound Healing : A Review. *Wounds: A Compendium of Clinical Research and Practice.* 2015;27:5-11.
77. Kato Y, Ozawa S, Miyamoto C, Maehata Y, Suzuki A, Maeda T, Baba Y. Acidic extracellular microenvironment and cancer. *Cancer Cell International.* 2013;13(1):89.
78. D. S. Leake. Does an acidic pH explain why low density lipoprotein is oxidised in atherosclerotic lesions? *Arterosclerosis.* 1997;129(2):149-57.
79. Agnès Bellocq, Sidonie Suberville, Carole Philippe, France Bertrand, Joëlle Perez, Bruno Fouqueray, et al. Low environmental pH is responsible for the induction of nitric-oxide synthase in macrophages. Evidence for involvement of nuclear factor-kappaB activation. *Journal of Biological Chemistry* 1998;273(9):5086-92.
80. I. A. Silver, R. J. Murrills, D. J. Etherington. Microelectrode studies on the acid microenvironment beneath adherent macrophages and osteoclasts. *Experimental Cell Research.* 1988;175(2):266-76.
81. Paul S. Treuhaft, Daniel J. McCarty. Synovial fluid pH, lactate, oxygen and carbon dioxide partial pressure in various joint diseases. *Arthritis and Rheumatism.* 1971;14(4):475-84.
82. Anne Lardner. The effects of extracellular pH on immune function. *Journal of Leukocyte Biology.* 2001;69(4):522-30.
83. Doni A, Musso T, Morone D, Bastone A, Zambelli V, Sironi M, et al. An acidic microenvironment sets the humoral pattern recognition molecule PTX3 in a tissue repair mode. *Journal of Experimental Medicine.* 2015;212(6):905-25.
84. Shou-Lei Li, Jun-Rui Feng, Hai-Hong Zhou, Chun-Miao Zhang, Guang-Bo Lv, Yu-Bo Tan, et al. Acidic pH promotes oxidation-induced dissociation of C-reactive protein. *Molecular Immunology.* 2018;104(1):47-53.
85. David J. Hammond J, Sanjay K. Singh, James A. Thompson, Bradley W. Beeler, Antonio E. Rusiñol, Michael K. Pangburn, et al. Identification of Acidic pH-dependent ligands of pentameric C-reactive protein. *The Journal of Biological Chemistry.* 2010;285(46):36235-44.

## Dylan Paul Noone - Structural biochemistry of the pentraxins

86. Darren Thompson, Mark B. Pepys, Steve P. Wood. The physiological structure of human C-reactive protein and its complex with phosphocholine Structure 1999;7(2):169-77.
87. Guillon C, Bigouagou UM, Folio C, Jeannin P, Delneste Y, Gouet P. A Staggered Decameric Assembly of Human C-Reactive Protein Stabilized by Zinc Ions Revealed by X-ray Crystallography Protein & Peptide Letters. 2015;22(3):248-55.
88. Uday Kishore, Rohit Ghai, Trevor J. Greenhough, Annette K. Shrive, Domenico M. Bonifati, Mihaela G. Gadjeva, et al. Structural and functional anatomy of the globular domain of complement protein C1q Immunology Letters. 2004;95(2):113-28.
89. Christine Gaboriaud, Jordi Juanhuix, Arnaud Gruez, Monique Lacroix, Claudine Darnault, David Pignol, et al. The Crystal Structure of the Globular Head of Complement Protein C1q Provides a Basis for Its Versatile Recognition Properties. The Journal of Biological Chemistry. 2003;278(47):46974-82.
90. Alok Agrawal, Annette K. Shrive, Trevor J. Greenhough, John E. Volanakis. Topology and structure of the C1q-binding site on C-reactive protein. Journal of Immunology 2001;166(6):3998-4004.
91. Bang R, Marnell L, Mold C, Stein M-P, Du. Clos K, T., Chivington-Buck C, Du. Clos T, W. . Analysis of Binding Sites in Human C-reactive Protein for Fc<sub>Y</sub>RI, Fc<sub>Y</sub>RIIA, and C1q by Site-directed Mutagenesis. The Journal of Biological Chemistry. 2005;280(26):25095-102.
92. Alok A, John EV. Probing the C1q-binding site on human C-reactive protein by site-directed mutagenesis. The Journal of Immunology. 1994;1(152):5404-10.
93. R. F. Rees, H. Gewurz, J. N. Siegel, J. Coon, Lawrence A. Potempa. Expression of a C-Reactive Protein Neoantigen (neo-CRP) in Inflamed Rabbit Liver and Muscle. Clinical Immunology and Immunopathology 1988;48(1):95-107.
94. M. Torzewski, C. Rist, R. F. Mortensen, T. P. Zwaka, M. Bienek, J. Waltenberger, et al. C-Reactive Protein in the Arterial Intima: Role of C-Reactive Protein Receptor-Dependent Monocyte Recruitment in Atherogenesis. Atherosclerosis, Thrombosis and Vascular Biology. 2000;20(9):2094-9.
95. Irving Kushner, Melvin H. Kaplan. An immunohistochemical method for the localisation of Cx-reactive protein in rabbits. Association with necrosis in local inflammatory lesions. The Journal of Experimental Medicine 1961;114(6):961-74.
96. P. A. J. Krijnen, C. Ciurana, T. Cramer, T. Hazes, C. J. L. M. Meijer, C. A. Visser, et al. IgM colocalises with complement and C-reactive protein in infarcted human myocardium. Journal of Clinical Pathology. 2005;58(4):382-8.
97. Basavraj S. Nagoba, Namdev Suryawanshi, Bharat Wadher, Sohan Selkar. Acidic Environment and Wound Healing: A Review Wounds: A Compendium of Clinical Research and Practice. 2015;27(1):5-11.
98. Sanjay K. Singh, Avinash Thirumalai, David J. Hammond J, Michael K. Pangburn, Vinod K. Mishra, David A. Johnson, et al. Exposing a hidden functional site of C-reactive protein by site-directed mutagenesis The Journal of Biological Chemistry. 2012;287(5):3550-8.
99. Lawrence A. Potempa, Joan N. Siegel, Barry A. Fiedel, Rita T. Potempa, Henry Gewurz. Expression, Detection and Assay of a Neoantigen (Neo-CRP) Associated with a Free, Human C-Reactive Protein Subunit. Molecular Immunology. 1987;24(5).
100. David Braig, Benedict Kaiser, Jan R. Thiele, Holger Bannasch, Karlheinz Peter, G. Björn Stark, et al. A conformation change of C-reactive protein in burn wounds unmasks its proinflammatory properties. International Immunology. 2014;26(8):467-78.

## Dylan Paul Noone - Structural biochemistry of the pentraxins

101. Jian-Min Lv, Ming-Yu Wang. In vitro generation and bioactivity evaluation of C-reactive protein intermediate PLoS one 2018;13(5).
102. Croll T, Ian. ISOLDE: a physically realistic environment for model building into low-resolution electron-density maps. *Acta Crystallographica Section D, Structural Biology*. 2018;74(6):519-30.
103. Afonine P, V. , Poon B, K. , Read R, J. , Sobolev O, V. , Terwilliger T, C. , Urzhumtsev A, Adams P, D. Real-space refinement in PHENIX for cryo-EM and crystallography. *Acta Crystallographica Section D, Structural Biology*. 2018;74(6):531-44.
104. Mikolajekay H, Kolstoe S, E. , Pye V, E. , Mangione P, Pepys M, B., Wood S, P. Structural basis of ligand specificity in the human pentraxins, C-reactive protein and serum amyloid P component. *Journal of Molecular Recognition* 2010;24(2):371-7.
105. Mohamed A. M. Ramadan, Annette K. Shrive, David Holden, Dean A. A. Myles, John E. Volanakis, Larry J. DeLucas, Trevor J Greenhough. The three-dimensional structure of calcium-depleted human C-reactive protein from perfectly twinned crystals. *Acta Crystallographica Section D, Structural Biology*. 2002;58(6):992-1001.
106. Jeroen D. Langereis, Eva S. van der Pasch, Marien I. de Jonge. Serum IgM and C-Reactive Protein Binding to Phosphorylcholine of Nontypeable *Haemophilus influenzae* Increases Complement-Mediated Killing. *Infection and Immunity*. 2019;87(8).
107. Braig D, Nero TL, Koch H-G, Kaiser B, Wang X, Thiele JR, et al. Transitional changes in the CRP structure lead to the exposure of proinflammatory binding sites. *Nature Communications*. 2017;8(1):14188.
108. Azubuike I. Okemefuna, Lasse Stach, Sudeep Rana, Akim J. Ziai Buetas, Jayesh Gor, Stephen J. Perkins. C-reactive Protein Exists in an NaCl Concentration-dependent Pentamer-Decamer Equilibrium in Physiological Buffer. *The Journal of Biological Chemistry*. 2009;285(2):1041-52.
109. I. R. Rowe, Anne K. Soutar, Mark B. Pepys. Agglutination of intravenous lipid emulsion ('Intralipid') and plasma lipoproteins by C-reactive protein. *Clinical and Experimental Immunology*. 1986;66(1):241-7.
110. Geoffrey Hulman. The pathogenesis of fat embolism. *The Journal of Pathology* 1995;176(1):3-9.
111. Mark B. Pepys, Gideon M. Hirschfield, Glenys A. Tennent, J. Ruth Gallimore, Melvyn C. Kahan, Vittorio Bellotti, et al. Targeting C-reactive protein for the treatment of cardiovascular disease. *Nature* 2006;440(7088):1217-21.
112. Azubuike I. Okemefuna, Ruodan Nan, Ami Miller, Jayesh Gor, Stephen J. Perkins. Complement factor H binds at two independent site to C-reactive protein in acute phase concentrations *The Journal of Biological Chemistry*. 2010;285(2):1053-65.
113. Simon E. Kolstoe, Basil H. Ridha, Vittorio Bellotti, Nan Wang, Carol V. Robinson, Sebastian J. Crutch, et al. Molecular dissection of Alzheimer's disease neuropathology by depletion of serum amyloid P component. *PNAS*. 2009;106(18):7619-23.
114. Moreau C, Bally I, Chouquet A, Bottazzi B, Ghebrehiwet B, Gaboriaud C, Thieliens N. Structural and Functional Characterization of a Single-Chain Form of the Recognition Domain of Complement Protein C1q. *Frontiers in Immunology*. 2016;7(79).
115. Shawn Q. Zheng, Eugene Palovcak, Jean-Paul Armache, Kliment A. Verba, Yifan Cheng, David A. Agard. MotionCor2: anisotropic correction of beam-induced motion for improved cryo-electron microscopy. *Nature Methods*. 2017;14(4):331-2.
116. Scheres S, H. W. Amyloid structure determination in RELION-3.1. *Acta Crystallographica Section D, Structural Biology*. 2020;76(1):94-101.

## Dylan Paul Noone - Structural biochemistry of the pentraxins

117. Alexis Rohou, Nikolaus Grigorieff. CTFFIND4: Fast and accurate defocus estimation from electron micrographs. *Journal of Structural Biology*. 2015;192(2):216-21.
118. Kai Zhang. Gctf: Real-time CTF determination and correction. *Journal of Structural Biology*. 2016;193(1):1-12.
119. Bell J, M., Chen M, Durmaz T, Fluty A, C. , Ludtke S, J. . New software tools in EMAN2 inspired by EMDatabank map challenge. *Journal of Structural Biology*. 2018;204(2):283-90.
120. Pettersen E, F., Goddard T, D. , Huang C, C. , Meng E, C. , Couch G, S. , Croll T, I., et al. UCSF ChimeraX: Structure visualization for researchers, educators, and developers. *The Protein Society* 2021;30(1):70-82.
121. Nigel W. Moriarty, Ralf W. Grosse-Kunstleve, Paul D. Adams. electronic Ligand Builder and Optimization Workbench (eLBOW): a tool for ligand coordinate and restraint generation. *Acta Crystallographica Section D, Structural Biology*. 2009;65(10):1074-80.
122. Eric F. Pettersen, Thomas D. Goddard, Conrad C. Huang, Gregory S. Couch, Daniel M. Greenblatt, Elaine C. Meng, Thomas E. Ferrin. UCSF Chimera--a visualization system for exploratory research and analysis. *Journal of Computational Chemistry*. 2004;25(13):1605-12.
123. Zeller J, Cheung Tung Shing KS, Nero TL, McFadyen JD, Krippner G, Bogner B, et al. A novel phosphocholine-mimetic inhibits a pro-inflammatory conformational change in C-reactive protein. *EMBO Mol Med*. 2023;15(1):e16236.
124. Eisenhardt SU, Habersberger J, Murphy A, Chen Y-C, Woppard KJ, Bassler N, et al. Dissociation of Pentameric to Monomeric C-Reactive Protein on Activated Platelets Localizes Inflammation to Atherosclerotic Plaques. *Circ Res*. 2009;105(2):128-37.
125. Ridker PM. A Test in Context: High-Sensitivity C-Reactive Protein. *Journal of the American College of Cardiology*. 2016;67(6):712-23.
126. Rodriguez W, Mold C, Kataranovski M, Hutt JA, Marnell LL, Verbeek JS, Du Clos TW. C-Reactive Protein-Mediated Suppression of Nephrotoxic Nephritis: Role of Macrophages, Complement, and Fc $\gamma$  Receptors. *The Journal of Immunology*. 2007;178(1):530-8.
127. van Meer G, Voelker DR, Feigenson GW. Membrane lipids: where they are and how they behave. *Nature Reviews Molecular Cell Biology*. 2008;9(2):112-24.
128. Vogt B, Führnrohr B, Müller R, Sheriff A. CRP and the disposal of dying cells: Consequences for systemic lupus erythematosus and rheumatoid arthritis. *Autoimmunity*. 2007;40(4):295-8.
129. Zeller J, Bogner B, Kiefer J, Braig D, Winninger O, Fricke M, et al. CRP Enhances the Innate Killing Mechanisms Phagocytosis and ROS Formation in a Conformation and Complement-Dependent Manner. *Front Immunol*. 2021;12(721887).
130. Chang M-K, Binder CJ, Torzewski M, Witztum JL. C-reactive protein binds to both oxidized LDL and apoptotic cells through recognition of a common ligand: Phosphorylcholine of oxidized phospholipids. *Proc Natl Acad Sci USA*. 2002;99(20):13043-8.
131. Wang MS, Messersmith RE, Reed SM. Membrane curvature recognition by C-reactive protein using lipoprotein mimics. *Soft Matter*. 2012;8(30):7909-18.
132. Volanakis JE, Wirtz KWA. Interaction of C-reactive protein with artificial phosphatidylcholine bilayers. *Nature*. 1979;281(5727):155-7.

133. Adrienn Bíró, Zita Rovó, Diana Papp, László Cervenak, Lilian Varga, George Füst, et al. Studies on the interactions between C-reactive protein and complement proteins. *British Society for Immunology*. 2007;121(1):40-50.
134. Merle NS, Church SE, Fremeaux-Bacchi V, Roumenina LT. Complement System Part I – Molecular Mechanisms of Activation and Regulation. *Front Immunol*. 2015;6( 2):262.
135. Bally I, Ancelet S, Moriscot C, Gonnet F, Mantovani A, Daniel R, et al. Expression of recombinant human complement C1q allows identification of the C1r/C1s-binding sites. *Proc Natl Acad Sci USA*. 2013;110(21):8650-5.
136. Roumenina L, T., Ruseva M, M., Zlatarova A, Ghai R, Kolev M, Olova N, et al. Interaction of C1q with IgG1, C-reactive Protein and Pentraxin 3: Mutational Studies Using Recombinant Globular Head Modules of Human C1q A, B and C Chains. *Biochemistry*. 2006;45(13):4093-104.
137. Bally I, Inforzato A, Dalonneau F, Stravalaci M, Bottazzi B, Gaboriaud C, Thielens NM. Interaction of C1q With Pentraxin 3 and IgM Revisited: Mutational Studies With Recombinant C1q Variants. *Front Immunol*. 2019;10(461).
138. Abendstein L, Dijkstra DJ, Tjokrodirijo RTN, van Veelen PA, Trouw LA, Hensbergen PJ, Sharp TH. Complement is activated by elevated IgG3 hexameric platforms and deposits C4b onto distinct antibody domains. *Nature Communications*. 2023;14(1):4027.
139. Diebold CA, Beurskens FJ, de Jong RN, Koning RI, Strumane K, Lindorfer MA, et al. Complement Is Activated by IgG Hexamers Assembled at the Cell Surface. *Science*. 2014;343(6176):1260-3.
140. Bottazzi B, Valérie V-C, Bastone A, De Gioia L, Matteucci C, Peri G, et al. Multimer formation and ligand recognition by the long pentraxin PTX3. Similarities and differences with the short pentraxins C-reactive protein and serum amyloid P component. *J Biol Chem*. 1997;272(52):32817-23.
141. Koning RI, Koster AJ, Sharp TH. Advances in cryo-electron tomography for biology and medicine. *Annals of Anatomy - Anatomischer Anzeiger*. 2018;217:82-96.
142. Dalia Ankur B, Weiser Jeffrey N. Minimization of Bacterial Size Allows for Complement Evasion and Is Overcome by the Agglutinating Effect of Antibody. *Cell Host & Microbe*. 2011;10(5):486-96.
143. Margni RA, Parma EA, Cerone S, Erpelding A, Perdigón G. Agglutinating and non-agglutinating antibodies in rabbits inoculated with a particulate antigen (*Salmonella typhimurium*). *Immunology*. 1983;48(2):351-9.
144. Kindmark CO. Stimulating effect of C-reactive protein on phagocytosis of various species of pathogenic bacteria. *Clin Exp Immunol*. 1971;8(6):941-8.
145. Nakayama S, Mold C, Gewurz H, du Clos TW. Opsonic properties of C-reactive protein in vivo. *The Journal of Immunology*. 1982;128(6):2435-8.
146. Kilpatrick JM, Volanakis JE. Opsonic properties of C-reactive protein. Stimulation by phorbol myristate acetate enables human neutrophils to phagocytize C-reactive protein-coated cells. *J Immunol*. 1985;134(5):3364-70.
147. Borsos T, Rapp HJ. Complement Fixation on Cell Surfaces by 19S and 7S Antibodies. *Science*. 1965;150(3695):505-6.
148. Strasser J, de Jong RN, Beurskens FJ, Wang G, Heck AJR, Schuurman J, et al. Unraveling the Macromolecular Pathways of IgG Oligomerization and Complement Activation on Antigenic Surfaces. *Nano Letters*. 2019;19(7):4787-96.

## Dylan Paul Noone - Structural biochemistry of the pentraxins

149. Eskeland T, Christensen TB. IgM Molecules with and without J Chain in Serum and after Purification, Studied by Ultra-centrifugation, Electrophoresis, and Electron Microscopy. *J Immunol* 1975;4(3):217-28.
150. Hughey CT, Brewer JW, Colosia AD, Rosse WF, Corley RB. Production of IgM Hexamers by Normal and Autoimmune B Cells: Implications for the Physiologic Role of Hexameric IgM1. *The Journal of Immunology*. 1998;161(8):4091-7.
151. Davis AC, Roux KH, Shulman MJ. On the structure of polymeric IgM. *Eur J Immunol*. 1988;18(7):1001-8.
152. Bally I, Rossi V, Lunardi T, Thielens NM, Gaboriaud C, Arlaud GJ. Identification of the C1q-binding Sites of Human C1r and C1s: A Refined Three-Dimensional Model of the C1 Complex of Complement. *Journal of Biological Chemistry*. 2009;284(29):19340-8.
153. Degn SE, Kjaer TR, Kidmose RT, Jensen L, Hansen AG, Tekin M, et al. Complement activation by ligand-driven juxtaposition of discrete pattern recognition complexes. *Proc Natl Acad Sci USA*. 2014;111(37):13445-50.
154. Kremer JR, Mastronarde DN, McIntosh JR. Computer Visualization of Three-Dimensional Image Data Using IMOD. *Journal of Structural Biology*. 1996;116(1):71-6.
155. Castaño-Díez D, Kudryashev M, Arheit M, Stahlberg H. Dynamo: A flexible, user-friendly development tool for subtomogram averaging of cryo-EM data in high-performance computing environments. *Journal of Structural Biology*. 2012;178(2):139-51.
156. Almitairi JOM, Venkatraman Girija U, Furze CM, Simpson-Gray X, Badakshi F, Marshall JE, et al. Structure of the C1r–C1s interaction of the C1 complex of complement activation. *Proc Natl Acad Sci USA*. 2018;115(4):768-73.
157. Budayova-Spano M, Lacroix M, Thielens NM, Arlaud GJ, Fontecilla-Camps JC, Gaboriaud C. The crystal structure of the zymogen catalytic domain of complement protease C1r reveals that a disruptive mechanical stress is required to trigger activation of the C1 complex. *The EMBO Journal*. 2002;21(3):231-9.
158. Perry AJ, Wijeyewickrema LC, Wilmann PG, Gunzburg MJ, D'Andrea L, Irving JA, et al. A Molecular Switch Governs the Interaction between the Human Complement Protease C1s and Its Substrate, Complement C4. *Journal of Biological Chemistry*. 2013;288(22):15821-9.
159. Lozano R, Naghavi M, Foreman K, Lim S, Shibuya K, Aboyans V, et al. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. *The Lancet*. 2012;380(9859):2095-128.
160. Ference BA, Ginsberg HN, Graham I, Ray KK, Packard CJ, Bruckert E, et al. Low-density lipoproteins cause atherosclerotic cardiovascular disease. 1. Evidence from genetic, epidemiologic, and clinical studies. A consensus statement from the European Atherosclerosis Society Consensus Panel. *European Heart Journal*. 2017;38(32):2459-72.
161. Tsimikas S. A Test in Context: Lipoprotein(a): Diagnosis, Prognosis, Controversies, and Emerging Therapies. *Journal of the American College of Cardiology*. 2017;69(6):692-711.
162. Gui Y, Zheng H, Cao RY. Foam Cells in Atherosclerosis: Novel Insights Into Its Origins, Consequences, and Molecular Mechanisms. *Front Cardiovasc Med*. 2022;9(13):845942.
163. Haberland ME, Mottino G, Le M, Frank JS. Sequestration of aggregated LDL by macrophages studied with freeze-etch electron microscopy. *Journal of Lipid Research*. 2001;42(4):605-19.
164. Yurdagul A, Doran AC, Cai B, Fredman G, Tabas IA. Mechanisms and Consequences of Defective Efferocytosis in Atherosclerosis. *Front Cardiovasc Med*. 2018;4(8):86.

## Dylan Paul Noone - Structural biochemistry of the pentraxins

165. Collins R, Reith C, Emberson J, Armitage J, Baigent C, Blackwell L, et al. Interpretation of the evidence for the efficacy and safety of statin therapy. *The Lancet*. 2016;388(10059):2532-61.
166. Libby P, Hansson GK. From Focal Lipid Storage to Systemic Inflammation: JACC Review Topic of the Week. *Journal of the American College of Cardiology*. 2019;74(12):1594-607.
167. Schloss M, Swirski F, Nahrendorf M. Modifiable Cardiovascular Risk, Hematopoiesis, and Innate Immunity. *Circulation Research*. 2020;126:1242-59.
168. Ross R, Neeland IJ, Yamashita S, Shai I, Seidell J, Magni P, et al. Waist circumference as a vital sign in clinical practice: a Consensus Statement from the IAS and ICCR Working Group on Visceral Obesity. *Nature Reviews Endocrinology*. 2020;16(3):177-89.
169. Griselli M, Herbert J, Hutchinson WL, Taylor KM, Sohail M, Krausz T, Pepys MB. C-Reactive Protein and Complement Are Important Mediators of Tissue Damage in Acute Myocardial Infarction. *Journal of Experimental Medicine*. 1999;190(12):1733-40.
170. Paffen E, deMaat MPM. C-reactive protein in atherosclerosis: A causal factor? *Cardiovascular Research*. 2006;71(1):30-9.
171. Badimon L, Peña E, Arderiu G, Padró T, Slevin M, Vilahur G, Chiva-Blanch G. C-Reactive Protein in Atherothrombosis and Angiogenesis. *Front Immunol*. 2018;9(2):430.
172. Speidl WS, Kastl SP, Huber K, Wojta J. Complement in atherosclerosis: friend or foe? *J Thromb Haemost*. 2011;9(3):428-40.
173. Ritchie GE, Moffatt BE, Sim RB, Morgan BP, Dwek RA, Rudd PM. Glycosylation and the Complement System. *Chemical Reviews*. 2002;102(2):305-20.
174. Nunomura W, Hatakeyama M. Binding of low density lipoprotein (LDL) to C-reactive protein (CRP): a possible binding through apolipoprotein B in LDL at phosphorylcholine-binding site of CRP. *The Hokkaido journal of medical science*. 1990;65(5):474-80.
175. Christ A, Günther P, Lauterbach MAR, Duewell P, Biswas D, Pelka K, et al. Western Diet Triggers NLRP3-Dependent Innate Immune Reprogramming. *Cell*. 2018;172(1):162-75.e14.
176. William Harnett, Margaret M. Harnett. Phosphorylcholine: friend or foe of the immune system? *Immunology Today*. 1999;20(3):125-9.
177. Adams SP, Sekhon SS, Wright JM. Rosuvastatin for lowering lipids. *Cochrane Database of Systematic Reviews*. 2014(11).
178. Šilhavý J, Zídek V, Landa V, Šimáková M, Mlejnek P, Škop V, et al. Rosuvastatin Can Block Pro-Inflammatory Actions of Transgenic Human C-Reactive Protein Without Reducing its Circulating Levels. *Cardiovasc Ther*. 2014;32(2):59-65.
179. Ridker PM, Danielson E, Fonseca FAH, Genest J, Gotto AM, Kastelein JJP, et al. Rosuvastatin to Prevent Vascular Events in Men and Women with Elevated C-Reactive Protein. *N Engl J Med*. 2008;359(21):2195-207.
180. Kruth HS. Sequestration of aggregated low-density lipoproteins by macrophages. *J Lipid Res*. 2002;43(5):483-8.
181. Denk S, Neher MD, Messerer DAC, Wiegner R, Nilsson B, Rittirsch D, et al. Complement C5a Functions as a Master Switch for the pH Balance in Neutrophils Exerting Fundamental Immunometabolic Effects. *The Journal of Immunology*. 2017;198(12):4846-54.
182. Pereira Silva JAD, Elkon KB, Hughes GRV, Dyck RF, Pepys MB. C-reactive protein levels in systemic lupus erythematosus: a classification criterion? *Arthritis Rheum*. 1980;23(6):770-1.

## Dylan Paul Noone - Structural biochemistry of the pentraxins

183. Yang EY, Shah K. Nanobodies: Next Generation of Cancer Diagnostics and Therapeutics. *Front Oncol.* 2020;10.
184. Oloketyl S, Bernedo R, Christmann A, Borkowska J, Cazzaniga G, Schuchmann HW, et al. Native llama Nanobody Library Panning Performed by Phage and Yeast Display Provides Binders Suitable for C-Reactive Protein Detection. *Biosensors (Basel)*. 2021;11(12):496.
185. Wang L, Wang N, Zhang W, Cheng X, Yan Z, Shao G, et al. Therapeutic peptides: current applications and future directions. *Signal Transduction and Targeted Therapy*. 2022;7(1):48.
186. Tegler LT, Nonglaton G, Büttner F, Caldwell K, Christopeit T, Danielson UH, et al. Powerful Protein Binders from Designed Polypeptides and Small Organic Molecules—A General Concept for Protein Recognition. *Angew Chem Int Ed*. 2011;50(8):1823-7.
187. Jones NR, Pegues MA, McCrory MA, Singleton W, Bethune C, Baker BF, et al. A Selective Inhibitor of Human C-reactive Protein Translation Is Efficacious In Vitro and in C-reactive Protein Transgenic Mice and Humans. *Molecular Therapy - Nucleic Acids*. 2012;1:e52.
188. Warren MS, Hughes SG, Singleton W, Yamashita M, Genovese MC. Results of a proof of concept, double-blind, randomized trial of a second generation antisense oligonucleotide targeting high-sensitivity C-reactive protein (hs-CRP) in rheumatoid arthritis. *Arthritis Research & Therapy*. 2015;17(1):80.
189. Mattecka S, Brunner P, Hänel B, Kunze R, Vogt B, Sheriff A. PentraSorb C-Reactive Protein: Characterization of the Selective C-Reactive Protein Adsorber Resin. *Ther Apher Dial*. 2019;23(5):474-81.
190. Esposito F, Matthes H, Schad F. Seven COVID-19 Patients Treated with C-Reactive Protein (CRP) Apheresis. *J Clin Med*. 2022;11(7):1956.
191. Sagné C, Isambert M-F, Henry J-P, Gasnier B. SDS-resistant aggregation of membrane proteins: application to the purification of the vesicular monoamine transporter. *Biochemical Journal*. 1996;316(3):825-31.
192. Ngai PKM, Ackermann F, Wendt H, Savoca R, Bosshard HR. Protein A antibody-capture ELISA (PACE): an ELISA format to avoid denaturation of surface-adsorbed antigens. *Journal of Immunological Methods*. 1993;158(2):267-76.
193. Ishizawa T, Kawakami T, Reid PC, Murakami H. TRAP Display: A High-Speed Selection Method for the Generation of Functional Polypeptides. *Journal of the American Chemical Society*. 2013;135(14):5433-40.
194. Choi J-S, Joo SH. Recent Trends in Cyclic Peptides as Therapeutic Agents and Biochemical Tools. *Biomolecules & Therapeutics*. 2020;28(1):18-24.
195. Ji S-R, Wu Y, Zhu L, Potempa LA, Sheng F-L, Lu W, Zhao J. Cell membranes and liposomes dissociate C-reactive protein (CRP) to form a new, biologically active structural intermediate: mCRPm. *2007;21(1):284-94*.
196. Wu K-L, Liang Q-H, Huang B-T, Ding N, Li B-W, Hao J. The plasma level of mCRP is linked to cardiovascular disease in antineutrophil cytoplasmic antibody-associated vasculitis. *Arthritis Research & Therapy*. 2020;22(1):228.
197. Goto Y, Katoh T, Suga H. Flexizymes for genetic code reprogramming. *Nature Protocols*. 2011;6(6):779-90.
198. Murakami H, Ohta A, Ashigai H, Suga H. A highly flexible tRNA acylation method for non-natural polypeptide synthesis. *Nature Methods*. 2006;3(5):357-9.
199. Jeck WR, Iafrae AJ, Nardi V. Nanopore Flongle Sequencing as a Rapid, Single-Specimen Clinical Test for Fusion Detection. *The Journal of Molecular Diagnostics*. 2021;23(5):630-6.

200. Salustri A, Garlanda C, Hirsch E, Acetis M, Maccagno A, Bottazzi B, et al. PTX3 plays a key role in the organization of the cumulus oophorus extracellular matrix and in *in vivo* fertilization. *Development* (Cambridge, England). 2004;131:1577-86.
201. Brunetta E, Folci M, Bottazzi B, De Santis M, Gritti G, Protti A, et al. Macrophage expression and prognostic significance of the long pentraxin PTX3 in COVID-19. *Nature Immunology*. 2021;22(1):19-24.
202. Gutmann C, Takov K, Burnap SA, Singh B, Ali H, Theofilatos K, et al. SARS-CoV-2 RNAemia and proteomic trajectories inform prognostication in COVID-19 patients admitted to intensive care. *Nature Communications*. 2021;12(1):3406.
203. Jumper J, Evans R, Pritzel A, Green T, Figurnov M, Ronneberger O, et al. Highly accurate protein structure prediction with AlphaFold. *Nature*. 2021;596(7873):583-9.
204. Inforzato A, Reading P, C., Barbati E, Bottazzi B, Garlanda C, Mantovani A. The "sweet" side of a long pentraxin: how glycosylation affects PTX3 functions in innate immunity and inflammation. *Front Immunol*. 2013;7(3):407.
205. Cornelis A, M, de Haan , Marel dW, Lili K, Cynthia M-M, Bart L, Haagmans, Susan R, Weiss, et al. The glycosylation status of the murine hepatitis coronavirus M protein affects the interferogenic capacity of the virus *in vitro* and its ability to replicate in the liver but not the brain. *Virology*. 2003;312(2):395-406.
206. Strelkov SV, Burkhard P. Analysis of alpha-helical coiled coils with the program TWISTER reveals a structural mechanism for stutter compensation. *J Struct Biol*. 2002;137(1-2):54-64.
207. Vincent TL, Green PJ, Woolfson DN. LOGICOIL—multi-state prediction of coiled-coil oligomeric state. *Bioinformatics*. 2012;29(1):69-76.
208. Scarchilli L CA, Bottazzi B, Negri V, Doni A, Deban L, Bastone A, Salvatori G, Mantovani A, Siracusa G, Salustri A. PTX3 interacts with inter-alpha-trypsin inhibitor: implications for hyaluronan organization and cumulus oophorus expansion. *J Biol Chem*. 2007;282(41):30161-70.
209. Gómez de San José N, Massa F, Halbgieber S, Oeckl P, Steinacker P, Otto M. Neuronal pentraxins as biomarkers of synaptic activity: from physiological functions to pathological changes in neurodegeneration. *Journal of Neural Transmission*. 2022;129(2):207-30.
210. Braunschweig A, Józsi M. Human pentraxin 3 binds to the complement regulator c4b-binding protein. *PLoS one*. 2011;6(8):e23991-e.
211. Gershov D, Kim S, Brot N, Elkon K, B. . C-Reactive Protein Binds to Apoptotic Cells, Protects the Cells from Assembly of the Terminal Complement Components, and Sustains an Anti-inflammatory Innate Immune Response: Implications for Systemic Autoimmunity. *The Journal of Experimental Medicine*. 2000;192(9):1353-64.
212. Wisniewski HG, Hua JC, Poppers DM, Naime D, Vilcek J, Cronstein BN. TNF/IL-1-inducible protein TSG-6 potentiates plasmin inhibition by inter-alpha-inhibitor and exerts a strong anti-inflammatory effect *in vivo*. *J Immunol*. 1996;156(4):1609-15.
213. Maina V, Cotena A, Doni A, Nebuloni M, Pasqualini F, Milner CM, et al. Coregulation in human leukocytes of the long pentraxin PTX3 and TSG-6. Erratum in: *J Leukoc Biol*. 2009;86(1):123-32.
214. Presta M, Foglio E, Churraca Schuind A, Ronca R. Long Pentraxin-3 Modulates the Angiogenic Activity of Fibroblast Growth Factor-2. *Frontiers in immunology*. 2018;9:2327-.
215. Stravalaci M, Pagani I, Paraboschi EM, Pedotti M, Doni A, Scavello F, et al. Recognition and inhibition of SARS-CoV-2 by humoral innate immunity pattern recognition molecules. *Nature Immunology*. 2022;23(2):275-86.

## Dylan Paul Noone - Structural biochemistry of the pentraxins

216. Imai M, Watanabe T, Hatta M, Das SC, Ozawa M, Shinya K, et al. Experimental adaptation of an influenza H5 HA confers respiratory droplet transmission to a reassortant H5 HA/H1N1 virus in ferrets. *Nature*. 2012;486(7403):420-8.
217. Tegunov D, Cramer P. Real-time cryo-electron microscopy data preprocessing with Warp. *Nature Methods*. 2019;16(11):1146-52.
218. Testa OD, Moutevelis E, Woolfson DN. CC+: a relational database of coiled-coil structures. *Nucleic Acids Research*. 2008;37(suppl\_1):D315-D22.
219. Freedman SJ, Song HK, Xu Y, Sun Z-YJ, Eck MJ. Homotetrameric Structure of the SNAP-23 N-terminal Coiled-coil Domain. *Journal of Biological Chemistry*. 2003;278(15):13462-7.
220. Tarbouriech N, Curran J, Ruigrok RWH, Burmeister WP. Tetrameric coiled coil domain of Sendai virus phosphoprotein. *Nature Structural Biology*. 2000;7(9):777-81.
221. Kumar P, Woolfson DN. Socket2: A Program for Locating, Visualising, and Analysing Coiled-coil Interfaces in Protein Structures. *Bioinformatics*. 2021;37(23):4575-7.
222. Mirdita M, Schütze K, Moriwaki Y, Heo L, Ovchinnikov S, Steinegger M. ColabFold - Making protein folding accessible to all. *Research Square*; 2021.
223. Perez-Riverol Y, Bai J, Bandla C, García-Seisdedos D, Hewapathirana S, Kamatchinathan S, et al. The PRIDE database resources in 2022: a hub for mass spectrometry-based proteomics evidences. *Nucleic Acids Research*. 2021;50(D1):D543-D52.
224. Li D, Wu M. Pattern recognition receptors in health and diseases. *Signal Transduction and Targeted Therapy*. 2021;6(1):291.
225. Zhang P, Liu X, Cao X. Extracellular pattern recognition molecules in health and diseases. *Cellular & molecular immunology*. 2015;12(3):255-7.
226. Bale S, Goebrecht G, Stano A, Wilson R, Ota T, Tran K, et al. Covalent Linkage of HIV-1 Trimers to Synthetic Liposomes Elicits Improved B Cell and Antibody Responses. 2017;91(16):e00443-17.
227. Gout E, Moriscot C, Doni A, Dumestre-Pérard C, Lacroix M, Pérard J, et al. M-ficolin interacts with the long pentraxin PTX3: a novel case of cross-talk between soluble pattern-recognition molecules. *J Immunol*. 2011;186(10):5815-22.
228. Nauta AJ, Bottazzi B, Mantovani A, Salvatori G, Kishore U, Schwaeble WJ, et al. Biochemical and functional characterization of the interaction between pentraxin 3 and C1q. 2003;33(2):465-73.
229. Bastrup-Birk S, Skjoedt M-O, Munthe-Fog L, Strom JJ, Ma YJ, Garred P. Pentraxin-3 Serum Levels Are Associated with Disease Severity and Mortality in Patients with Systemic Inflammatory Response Syndrome. *PLOS ONE*. 2013;8(9):e73119.
230. Gürses D, Oğuz M, Yilmaz M, Aybek H, Akpinar F. Pentraxin 3 Levels and Correlation With Disease Severity in Patients With Acute Rheumatic Fever. *Archives of Rheumatology*. 2021;36.
231. Doni A, Peri G, Chieppa M, Allavena P, Pasqualini F, Vago L, et al. Production of the soluble pattern recognition receptor PTX3 by myeloid, but not plasmacytoid, dendritic cells. 2003;33(10):2886-93.
232. Rolph MS, Zimmer S, Bottazzi B, Garlanda C, Mantovani A, Hansson GK. Production of the Long Pentraxin PTX3 in Advanced Atherosclerotic Plaques. 2002;22(5):e10-e4.
233. Klouche M, Peri G, Knabbe C, Eckstein H-H, Schmid F-X, Schmitz G, Mantovani A. Modified atherogenic lipoproteins induce expression of pentraxin-3 by human vascular smooth muscle cells. *Atherosclerosis*. 2004;175(2):221-8.

234. Baruah P, Dumitriu IE, Peri G, Russo V, Mantovani A, Manfredi AA, Rovere-Querini P. The tissue pentraxin PTX3 limits C1q-mediated complement activation and phagocytosis of apoptotic cells by dendritic cells. *J Leukoc Biol.* 2006;80(1):87-95.
235. Stancheva VG, Li X-H, Hutchings J, Gomez-Navarro N, Santhanam B, Babu MM, et al. Combinatorial multivalent interactions drive cooperative assembly of the COPII coat. *Journal of Cell Biology.* 2020;219(11).
236. Hutchings J, Stancheva V, Miller EA, Zanetti G. Subtomogram averaging of COPII assemblies reveals how coat organization dictates membrane shape. *Nature Communications.* 2018;9(1):4154.
237. Ievoli E, Lindstedt R, Inforzato A, Camaioni A, Palone F, Day AJ, et al. Implication of the oligomeric state of the N-terminal PTX3 domain in cumulus matrix assembly. *Matrix Biology.* 2011;30(5):330-7.
238. Hsiao Y-W, Chi J-Y, Li C-F, Chen L-Y, Chen Y-T, Liang H-Y, et al. Disruption of the pentraxin 3/CD44 interaction as an efficient therapy for triple-negative breast cancers. *2022;12(1):e724.*
239. Wijdeven RH, Cabukusta B, Behr FM, Qiu X, Amiri D, Borras DM, et al. CRISPR Activation Screening Identifies VGLL3–TEAD1–RUNX1/3 as a Transcriptional Complex for PD-L1 Expression. *The Journal of Immunology.* 2022;209(5):907-15.
240. Corey RA, Pyle E, Allen WJ, Watkins DW, Casiraghi M, Miroux B, et al. Specific cardiolipin–SecY interactions are required for proton-motive force stimulation of protein secretion. *2018;115(31):7967-72.*
241. Rusnati M, Camozzi M, Moroni E, Bottazzi B, Peri G, Indraccolo S, et al. Selective recognition of fibroblast growth factor-2 by the long pentraxin PTX3 inhibits angiogenesis. *Blood.* 2004;104(1):92-9.
242. Hu K, Wang Z-M, Li J-N, Zhang S, Xiao Z-F, Tao Y-M. CLEC1B Expression and PD-L1 Expression Predict Clinical Outcome in Hepatocellular Carcinoma with Tumor Hemorrhage. *Translational Oncology.* 2018;11(2):552-8.
243. Huysamen C, Brown GD. The fungal pattern recognition receptor, Dectin-1, and the associated cluster of C-type lectin-like receptors. *FEMS Microbiology Letters.* 2009;290(2):121-8.
244. Kell DB, Laubscher GJ, Pretorius E. A central role for amyloid fibrin microclots in long COVID/PASC: origins and therapeutic implications. *Biochemical Journal.* 2022;479(4):537-59.
245. Feitosa TA, de Souza Sá MV, Pereira VC, de Andrade Cavalcante MK, Pereira VRA, da Costa Armstrong A, do Carmo RF. Association of polymorphisms in long pentraxin 3 and its plasma levels with COVID-19 severity. *Clinical and Experimental Medicine.* 2022.
246. Roberto A, Silvia A, Ciro C, Elisabetta B, Alessandro S, Chiara T, Federico Ss. Long pentraxin 3 as a marker of COVID-19 severity: evidences and perspectives. *Biochem Med.* 2022;32(020901).
247. Libby P, Ridker PM, Maseri A. Inflammation and Atherosclerosis. *Circulation.* 2002;105(9):1135-43.
248. Sobue A, Komine O, Yamanaka K. Neuroinflammation in Alzheimer's disease: microglial signature and their relevance to disease. *Inflammation and Regeneration.* 2023;43(1):26.
249. Muldoon LL, Alvarez JI, Begley DJ, Boado RJ, del Zoppo GJ, Doolittle ND, et al. Immunologic Privilege in the Central Nervous System and the Blood–Brain Barrier. *Journal of Cerebral Blood Flow & Metabolism.* 2013;33(1):13-21.
250. Paolicelli RC, Bolasco G, Pagani F, Maggi L, Scianni M, Panzanelli P, et al. Synaptic Pruning by Microglia Is Necessary for Normal Brain Development. *Science.* 2011;333(6048):1456-8.
251. O'Brien R, Xu D, Mi R, Tang X, Hopf C, Worley P. Synaptically Targeted Narp Plays an Essential Role in the Aggregation of AMPA Receptors at Excitatory Synapses in Cultured Spinal Neurons. *2002;22(11):4487-98.*

## Dylan Paul Noone - Structural biochemistry of the pentraxins

252. Zhou J, Wade SD, Graykowski D, Xiao M-F, Zhao B, Giannini LAA, et al. The neuronal pentraxin Nptx2 regulates complement activity and restrains microglia-mediated synapse loss in neurodegeneration. 2023;15(689):eadf0141.
253. Figueiro-Silva J, Gruart A, Clayton KB, Podlesniy P, Abad MA, Gasull X, et al. Neuronal Pentraxin 1 Negatively Regulates Excitatory Synapse Density and Synaptic Plasticity. 2015;35(14):5504-21.
254. O'Brien RJ, Xu D, Petralia RS, Steward O, Huganir RL, Worley P. Synaptic Clustering of AMPA Receptors by the Extracellular Immediate-Early Gene Product Narp. *Neuron*. 1999;23(2):309-23.
255. Tsui C, Copeland N, Gilbert D, Jenkins N, Barnes C, Worley P. Narp, a novel member of the pentraxin family, promotes neurite outgrowth and is dynamically regulated by neuronal activity. 1996;16(8):2463-78.
256. Sia G-M, Béïque J-C, Rumbaugh G, Cho R, Worley PF, Huganir RL. Interaction of the N-Terminal Domain of the AMPA Receptor GluR4 Subunit with the Neuronal Pentraxin NP1 Mediates GluR4 Synaptic Recruitment. *Neuron*. 2007;55(1):87-102.
257. Kirkpatrick LL, Matzuk MM, Dodds DNC, Perin MS. Biochemical Interactions of the Neuronal Pentraxins: Neuronal Pentraxin (NP) Receptor Binds To Taipoxin And Taipoxin-Associated Calicum-Binding Protein 49 Via NP1 and NP2. *Journal of Biological Chemistry*. 2000;275(23):17786-92.
258. Lee S-J, Wei M, Zhang C, Maxeiner S, Pak C, Botelho SC, et al. Presynaptic Neuronal Pentraxin Receptor Organizes Excitatory and Inhibitory Synapses. 2017;37(5):1062-80.
259. Dorszewska J, Kozubski W, Waleszczyk W, Zabel M, Ong K. Neuroplasticity in the Pathology of Neurodegenerative Diseases. *Neural Plasticity*. 2020;2020:4245821.
260. Zhou J, Fonseca MI, Pisalyaput K, Tenner AJ. Complement C3 and C4 expression in C1q sufficient and deficient mouse models of Alzheimer's disease. 2008;106(5):2080-92.
261. Garlatti V, Martin L, Lacroix M, Gout E, Arlaud G, Thielens N, Gaboriaud C. Structural Insights into the Recognition Properties of Human Ficolins. *Journal of innate immunity*. 2010;2:17-23.
262. Dodds DNC, Omeis IA, Cushman SJ, Helms JA, Perin MS. Neuronal Pentraxin Receptor, a Novel Putative Integral Membrane Pentraxin That Interacts with Neuronal Pentraxin 1 and 2 and Taipoxin-associated Calcium-binding Protein 49\*. *Journal of Biological Chemistry*. 1997;272(34):21488-94.
263. Brodsky B, Thiagarajan G, Madhan B, Kar K. Triple-helical peptides: An approach to collagen conformation, stability, and self-association. 2008;89(5):345-53.
264. Lu J, Kishore U. C1 Complex: An Adaptable Proteolytic Module for Complement and Non-Complement Functions. 2017;8.
265. Kanehisa K, Koga K, Maejima S, Shiraishi Y, Asai K, Shiratori-Hayashi M, et al. Neuronal pentraxin 2 is required for facilitating excitatory synaptic inputs onto spinal neurons involved in pruriceptive transmission in a model of chronic itch. *Nature Communications*. 2022;13(1):2367.
266. Bjartmar L, Huberman AD, Ullian EM, Rentería RC, Liu X, Xu W, et al. Neuronal Pentraxins Mediate Synaptic Refinement in the Developing Visual System. 2006;26(23):6269-81.
267. Sticco MJ, Peña Palomino PA, Lukacsovich D, Thompson BL, Földy C, Ressl S, Martinelli DC. C1QL3 promotes cell-cell adhesion by mediating complex formation between ADGRB3/BAI3 and neuronal pentraxins. 2021;35(1):e21194.
268. Clayton KB, Podlesniy P, Figueiro-Silva J, López-Doménech G, Benítez L, Enguita M, et al. NP1 Regulates Neuronal Activity-Dependent Accumulation of BAX in Mitochondria and Mitochondrial Dynamics. 2012;32(4):1453-66.

## Dylan Paul Noone - Structural biochemistry of the pentraxins

269. Stevens B, Allen NJ, Vazquez LE, Howell GR, Christopherson KS, Nouri N, et al. The Classical Complement Cascade Mediates CNS Synapse Elimination. *Cell*. 2007;131(6):1164-78.
270. Benarroch EE. Glutamatergic synaptic plasticity and dysfunction in Alzheimer disease. Emerging mechanisms. *2018;91(3):125-32*.
271. Abad MA, Enguita M, DeGregorio-Rocasolano N, Ferrer I, Trullas R. Neuronal Pentraxin 1 Contributes to the Neuronal Damage Evoked by Amyloid- $\beta$  and Is Overexpressed in Dystrophic Neurites in Alzheimer's Brain. *2006;26(49):12735-47*.
272. Ma Q-L, Teng E, Zuo X, Jones M, Teter B, Zhao EY, et al. Neuronal pentraxin 1: A synaptic-derived plasma biomarker in Alzheimer's disease. *Neurobiology of Disease*. 2018;114:120-8.
273. Begcevic I, Tsolaki M, Brinc D, Brown M, Martinez-Morillo E, Lazarou I, et al. Neuronal pentraxin receptor-1 is a new cerebrospinal fluid biomarker of Alzheimer's disease progression [version 1; peer review: 4 approved]. *2018;7(1012)*.
274. Sathe G, Na CH, Renuse S, Madugundu AK, Albert M, Moghekar A, Pandey A. Quantitative Proteomic Profiling of Cerebrospinal Fluid to Identify Candidate Biomarkers for Alzheimer's Disease. *2019;13(4):1800105*.
275. Xiao M-F, Xu D, Craig MT, Pelkey KA, Chien C-C, Shi Y, et al. NPTX2 and cognitive dysfunction in Alzheimer's Disease. *eLife*. 2017;6:e23798.
276. Schafer Dorothy P, Lehrman Emily K, Kautzman Amanda G, Koyama R, Mardinly Alan R, Yamasaki R, et al. Microglia Sculpt Postnatal Neural Circuits in an Activity and Complement-Dependent Manner. *Neuron*. 2012;74(4):691-705.
277. Miskimon M, Han S, Lee JJ, Ringkamp M, Wilson MA, Petralia RS, et al. Selective expression of Narp in primary nociceptive neurons: Role in microglia/macrophage activation following nerve injury. *Journal of Neuroimmunology*. 2014;274(1):86-95.
278. Pardi N, Hogan MJ, Porter FW, Weissman D. mRNA vaccines — a new era in vaccinology. *Nature Reviews Drug Discovery*. 2018;17(4):261-79.
279. Dejnirattisai W, Huo J, Zhou D, Zahradník J, Supasa P, Liu C, et al. SARS-CoV-2 Omicron-B.1.1.529 leads to widespread escape from neutralizing antibody responses. *Cell*. 2022.
280. Sterner RC, Sterner RM. CAR-T cell therapy: current limitations and potential strategies. *Blood Cancer Journal*. 2021;11(4):69.
281. de Castro MJ, Pardo-Seco J, Martinón-Torres F. Nonspecific (Heterologous) Protection of Neonatal BCG Vaccination Against Hospitalization Due to Respiratory Infection and Sepsis. *Clinical Infectious Diseases*. 2015;60(11):1611-9.
282. Ajona D, Ortiz-Espinosa S, Moreno H, Lozano T, Pajares MJ, Agorreta J, et al. A Combined PD-1/C5a Blockade Synergistically Protects against Lung Cancer Growth and Metastasis. *Cancer Discovery*. 2017;7(7):694-703.
283. Davitt E, Davitt C, Mazer MB, Areti SS, Hotchkiss RS, Remy KE. COVID-19 disease and immune dysregulation. *Best Practice & Research Clinical Haematology*. 2022;35(3):101401.
284. Kaul A, Gordon C, Crow MK, Touma Z, Urowitz MB, van Vollenhoven R, et al. Systemic lupus erythematosus. *Nature Reviews Disease Primers*. 2016;2(1):16039.
285. Svensson BO. Serum Factors Causing Impaired Macrophage Function in Systemic Lupus Erythematosus. *1975;4(2):145-50*.

## Dylan Paul Noone - Structural biochemistry of the pentraxins

286. Cairns AP, Crockard AD, McConnell JR, Courtney PA, Bell AL. Reduced expression of CD44 on monocytes and neutrophils in systemic lupus erythematosus: relations with apoptotic neutrophils and disease activity. 2001;60(10):950-5.
287. Toller-Kawahisa JE, Vigato-Ferreira ICC, Pancoto JAT, Mendes-Junior CT, Martinez EZ, Palomino GM, et al. The variant of CD11b, rs1143679 within ITGAM, is associated with systemic lupus erythematosus and clinical manifestations in Brazilian patients. *Human Immunology*. 2014;75(2):119-23.
288. Mahajan A, Herrmann M, Muñoz LE. Clearance Deficiency and Cell Death Pathways: A Model for the Pathogenesis of SLE. 2016;7.
289. Shoenfeld Y, Kravitz MS, Witte T, Doria A, Tsutsumi A, Tatsuya A, et al. Autoantibodies against Protective Molecules—C1q, C-Reactive Protein, Serum Amyloid P, Mannose-Binding Lectin, and Apolipoprotein A1. 2007;1108(1):227-39.
290. Kumaresan RP, Devaraj S, Huang W, Lau EY, Liu R, Lam KS, Jialal I. Synthesis and Characterization of a Novel Inhibitor of C-Reactive Protein–Mediated Proinflammatory Effects. 2013;11(3):177-84.
291. Gaboriaud C, Thielens NM, Gregory LA, Rossi V, Fontecilla-Camps JC, Arlaud GJ. Structure and activation of the C1 complex of complement: unraveling the puzzle. *Trends in Immunology*. 2004;25(7):368-73.
292. Hu Y-B, Dammer EB, Ren R-J, Wang G. The endosomal-lysosomal system: from acidification and cargo sorting to neurodegeneration. *Translational Neurodegeneration*. 2015;4(1):18.
293. Pillai SR, Damaghi M, Marunaka Y, Spugnini EP, Fais S, Gillies RJ. Causes, consequences, and therapy of tumors acidosis. *Cancer and Metastasis Reviews*. 2019;38(1):205-22.
294. Pilely K, Fumagalli S, Rosbjerg A, Genster N, Skjoedt M-O, Perego C, et al. C-Reactive Protein Binds to Cholesterol Crystals and Co-Localizes with the Terminal Complement Complex in Human Atherosclerotic Plaques. *Frontiers in Immunology*. 2017;8.
295. Hammerschmidt DE, Greenberg CS, Yamada O, Craddock PR, Jacob HS. Cholesterol and atheroma lipids activate complement and stimulate granulocytes. A possible mechanism for amplification of ischemic injury in atherosclerotic states. *The Journal of laboratory and clinical medicine*. 1981;98 1:68-77.
296. Seifert PS, Kazatchkine MD. Generation of complement anaphylatoxins and C5b-9 by crystalline cholesterol oxidation derivatives depends on hydroxyl group number and position. *Molecular Immunology*. 1987;24(12):1303-8.
297. Rajamäki K, Nordström T, Nurmi K, Åkerman KEO, Kovanen PT, Öörni K, Eklund KK. Extracellular Acidosis Is a Novel Danger Signal Alerting Innate Immunity via the NLRP3 Inflammasome. *Journal of Biological Chemistry*. 2013;288(19):13410-9.
298. Öörni K, Rajamäki K, Nguyen SD, Lähdesmäki K, Plihtari R, Lee-Rueckert M, Kovanen PT. Acidification of the intimal fluid: the perfect storm for atherogenesis. *Journal of Lipid Research*. 2015;56(2):203-14.
299. Lee-Rueckert M, Lappalainen J, Leinonen H, Plihtari R, Nordström T, Åkerman K, et al. Acidic extracellular pH promotes accumulation of free cholesterol in human monocyte-derived macrophages via inhibition of ACAT1 activity. *Atherosclerosis*. 2020;312:1-7.
300. Woolfson DN. Understanding a protein fold: The physics, chemistry, and biology of  $\alpha$ -helical coiled coils. *Journal of Biological Chemistry*. 2023;299(4).
301. Fletcher JM, Boyle AL, Bruning M, Bartlett GJ, Vincent TL, Zaccai NR, et al. A Basis Set of de Novo Coiled-Coil Peptide Oligomers for Rational Protein Design and Synthetic Biology. *ACS Synthetic Biology*. 2012;1(6):240-50.

Dylan Paul Noone - Structural biochemistry of the pentraxins

302. Martinez de la Torre Y, Fabbri M, Jaillon S, Bastone A, Nebuloni M, Vecchi A, et al. Evolution of the Pentraxin Family: The New Entry PTX4. 2010;184(9):5055-64.
303. Gonzalez OA, Kirakodu S, Novak MJ, Stromberg AJ, Orraca L, Gonzalez-Martinez J, et al. Comparative analysis of microbial sensing molecules in mucosal tissues with aging. Immunobiology. 2018;223(3):279-87.
304. Oggioni M, Mercurio D, Minuta D, Fumagalli S, Popolek-Barczyk K, Sironi M, et al. Long pentraxin PTX3 is upregulated systemically and centrally after experimental neurotrauma, but its depletion leaves unaltered sensorimotor deficits or histopathology. Scientific Reports. 2021;11(1):9616.
305. Uhlén M, Fagerberg L, Hallström BM, Lindskog C, Oksvold P, Mardinoglu A, et al. Tissue-based map of the human proteome. 2015;347(6220):1260419.