International Journal of Microbial Science, Volume 1, Issue 1, December 2020, pp. 54-57
Available online at https://internationaljournalofmicrobialscience.com/
doi: http://dx.doi.org/10.55347/theijms.v1i1.8

Review

Molecular Interaction, Behaviors and Effect of Temperature on glycoprotein receptors of SARS-CoV-2: Review

[1]Ganguly B
[1]Department of Chemistry, Bir Bikram Memorial College, Agartala, Tripura, India.

Article Info

Article history:
Received: November 20, 2020
Accepted: December 5, 2020
Published: December 13, 2020

Keywords:SARS-CoV-2, Temperature, Spike Glycoproteins

Corresponding Author:
Banti Ganguly,
Email: banti.ganguly@gmail.com

Abstract

SARS-CoV-2 has created tremendous chaos in the world due to infections caused by it that affected the human cells. Its glycoprotein receptors have greater contribution in attaching the viral particle to Receptor Binding Domain (RBD) of host cells. In this review, the effect of temperature on SARS-COV 2 spike glycoproteins and their binding molecular interactions and behaviors have been analyzed and found that temperature affects the mechanism of virus-host cell interactions.

1. Introduction:

Recently, SARS-COV-2, known as Severe Acute Respiratory Syndrome Coronavirus 2, infected the human respiratory system's cells in very steady manner. The first outbreak of Covid-19 was observed in November 2019 in Wuhan city of China, where the temperature around 17° C in the morning and 80°C at night was reported. Current studies have found that the virus also intermingles with the digestive system's cells, kidney system, pancreas, liver, brain as well as eyes [1]. It is established to cause dangerous sickness and is lethal in many cases [2].

It is believed that the virus was naturally found in bats, and consequently transferred to humans. Moreover, it progressively spread throughout almost all the nations via aerial diffusion resulting in one of the most horrible known global pandemics [3]. The whole-genome arrangement of SARS-CoV-2 was soon determined [21]. The infection of the virus differs from other viruses. The common cold differs from virus to virus. In a century, there were different types of corona viruses like HCoV-OC43, HCoV-229E, SARS-CoV, HCoV-HKU1, HCoV-NL63 and MERS-CoV were studied [4]. Such viruses had affected the human population in larger scale.

Reports showed by Cai, Q. C. et al. [5] suggested that tropical and stifling nations, for instance, Thailand, Malaysia, and Indonesia, which are having more temperature in addition to increased relative water content in the air did not have leading community outbreaks of SARS [6-7]. The viral sensitivity for temperature has been recorded many times by researchers [8].

The sustainability of SARS-COV-2 was quantified on various surfaces by Rath et al. [9], where it was proved that the virus drips didn't get killed at as low as 4°C but immediately disengaged at 50°C. Soaps along with washing powders showed to collapse the virus's membrane and their structural protein to show how the sustainability of virus regulates the atmospheric environment [10].

SARS-CoV-2 has the potential to attack the cells of the lungs [11]. Spike glycoprotein is the largest structural protein residing mainly in corona virus, which consists of a homotrimer where every monomer comprises protein of 1,273 amino acids with interlinking with each other. Every monomer showed two domains known as S1 and S2 [12]. These are allocated at a furin site through the protease enzyme of a cell of the host [13]. A class I transmembrane domain (S2 domain) trips across the bilayer in addition with ends at the inner part of the lipid membranes [10].

Proteins mostly consist of enhanced thermal stability, whereas some of them denature at increased temperatures [14,15]. The mutation capability of Spike glycoprotein exhibits a high intensity of thermal stability [16]. Pursuance of the SARS-CoV-2 lessened substantially at far above the ground temperatures in comparison to that of SARS-CoV. India, a tropical country with temperature of around 40-45^{0}C has shown the presence of immense cases of viral infections in question and are existing until now [17-19]. In this review, the effect of temperature on the virus SARS-COV 2 spike glycoproteins and their molecular interaction and behaviors have been analyzed and found that temperature affects the mechanism of virus-host cell interactions.

2. Temperature effectiveness with spike glycoproteins of SARS-CoV-2:

SARS-CoV-2 employs its spike glycoprotein to attach its receptor and facilitate membrane fusion and its entry. The spike protein regulates the solubility of corona virus, and in turn, the viral infectivity since the protein of spike is the longest protein situated on the envelope. As a result, the spike protein is reliably concerned with the stability in addition to functions of the viruses in question. It is interesting to know that the receptor-binding domain (RBD) of the Spike glycoprotein is a probable objective [20,21].

SARS-CoV-2 spike protein shows lower free energy resulting from virus progression to the host since SARS-like corona viruses typically arrived from bats, which were recognized with increased temperature of the body than human beings [22-23]. The spike glycoprotein is responsible for the binding of a host cell with the receptor domain. Hence, the spike protein receptor binding domain (RBD) becomes perilous for corona viruses for infection of cells of the host. Experimental studies by Kampf G et al. [24] using molecular dynamics simulations were used to inspect the RBD proteins' vibrant properties for SARS-CoV-2 and free energies of the free RBD proteins for SARS-CoV-2.

From the Gibbs free energy, the binding energy may be represented as $\Delta G = \Delta E - T\Delta S$, where ΔE represents interaction energy, ΔS indicates loss of entropy after binding, and T represents the system's temperature. It was found experimentally by Shang, J. et al. [25] that ΔS is negative so that the binding free energy will become accelerated, and the binding will be weaker with the increase in temperature T. Hence, the binding efficiency will be shown to have decreased affinity for SARS-CoV-2 with the temperature rise.

It can be stated that SARS-CoV-2 is temperature-sensitive in binding with RBD. SARS-CoV-2 has been shown to decrease infection capability in enhanced temperature conditions. Thus, disease prevention and monitoring would be preferably simpler when the weather or seasons gets warmer.

Shang J. et al [26] revealed that spike proteins may cause changes in the dynamics of the protein. As a result, experimental procedure was carried out to follow simulations at three different temperatures [27] like 10°C, 30°C, and 50°C. Thus, it was confirmed that protein dynamics play an important role in the temperature-dependent conformation of spike glycoproteins.

3. Conclusion:

The spike protein of SARS-CoV-2 indicates low free energy, stability along with ability to stay alive at an increased temperature, and high flexibility with high entropy, and the temperature affects the mechanism of virus-host cell interactions.

Acknowledgement:

The author is grateful to Prof R.K.Nath, Department of Chemistry, Tripura University, for his constant encouragement to write this review article.

Authors' contributions: BG: Developed an idea and wrote the manuscript and verified it.

Competing Interest: Author declares that no competing interest exists.

Ethical Statement:

Since it is review article, no ethical permission required.

Grant Support Details:

Author did not received funding for this work from any agency.

References:

1.Gordon, D. E., Jang, G. M., Bouhaddou, M., Xu, J., Obernier, K., White, K. M. (2020). A SARS-CoV-2 protein interaction map reveals targets for drug repurposing. *Nature*, *583*(7816), 459–468. doi:10.1038/s41586-020-2286-9

2.World Health Organization (WHO). (2020). *WHO coronavirus disease (COVID-19) dashboard*. Geneva: World Health Organization.

3.MacKenzie, J. S., & Smith, D. W. (2020). COVID-19: A novel zoonotic disease caused by a coronavirus from china: What we know and what we don't. *Microbiology Australia*, *41*, MA20013. doi:10.1071/MA20013

4.Gao, H., Yao, H., Yang, S., & Li, L. (2016). From SARS to MERS: Evidence and speculation. *Frontiers of Medicine*, *10*(4), 377–382. doi:10.1007/s11684-016-0466-7

5.Cai, Q. C., Lu, J., Xu, Q. F., Guo, Q., Xu, D. Z., Sun, Q. W., . . . Jiang, Q. W. (2007). Influence of meteorological factors and air pollution on the outbreak of severe acute respiratory syndrome. *Public Health*, *121*(4), 258–265. doi:10.1016/j.puhe.2006.09.023

6.Tan, J., Mu, L., Huang, J., Yu, S., Chen, B., & Yin, J. (2005). An initial investigation of the association between the SARS outbreak and weather: With the view of the environmental temperature and its variation. *Journal of Epidemiology and Community Health*, *59*(3), 186–192. doi:10.1136/jech.2004.020180

7.Chan, K. H., Peiris, J. S. M., Lam, S. Y., Poon, L. L. M., Yuen, K. Y., & Seto, W. H. (2011). The effects of temperature and relative humidity on the viability of the SARS coronavirus. *Advances in Virology*, *2011*, 734690. doi:10.1155/2011/734690

8.Chin, A. W. H., Chu, J. T. S., Perera, M. R. A., Hui, K. P. Y., Yen, H. L., Chan, M. C. W. (2020). Stability of SARS-CoV-2 in different environmental conditions. *Lancet Microbe*, *1*(1), e10. doi:10.1016/S2666-5247(20)30003-3

9.Rath, S. L., & Kumar, K. (2020). Investigation of the effect of temperature on the structure of SARS-CoV-2 spike protein by Molecular Dynamics simulations. *Frontiers in Molecular Biosciences*, *7*, 583523. doi:10.3389/fmolb.2020.583523

10.Julió Plana, L., Nadra, A. D., Estrin, D. A., Luque, F. J., & Capece, L. (2019). Thermal stability of globins: Implications of flexibility and heme coordination studied by molecular dynamics simulations. *Journal of Chemical Information and Modeling*, *59*(1), 441–452. doi:10.1021/acs.jcim.8b00840

11.Astuti, I., & Ysrafil. (2020). Severe acute respiratory syndrome coronavirus. *Diabetes and Metabolic Syndrome: Clinical Research and Reviews* 14, *2* (SARS-CoV-2): an overview of viral structure and host response, 407–412. doi:10.1016/j.dsx.2020.04.020

12.Walls, A. C., Tortorici, M. A., Bosch, B. J., Frenz, B., Rottier, P. J. M., DiMaio, F., . . . Veesler, D. (2016). Cryo-electron microscopy structure of a coronavirus spike glycoprotein trimer. *Nature*, *531*(7592), 114–117. doi:10.1038/nature16988

13.Belouzard, S., Chu, V. C., & Whittaker, G. R. (2009). Activation of the SARS coronavirus spike protein via sequential proteolytic cleavage at two distinct sites. *Proceedings of the National Academy of Sciences of the United States of America*, *106*(14), 5871–5876. doi:10.1073/pnas.0809524106

14.Dong, Y. W., Liao, M. L., Meng, X. L., & Somero, G. N. (2018). Structural flexibility and protein adaptation to temperature: Molecular dynamics analysis of malate dehydrogenases of marine molluscs. *Proceedings of the National Academy of Sciences of the United States of America*, *115*(6), 1274–1279. doi:10.1073/pnas.1718910115

15.Julió Plana, L., Nadra, A. D., Estrin, D. A., Luque, F. J., & Capece, L. (2019). Thermal stability of globins: Implications of flexibility and heme coordination studied by molecular dynamics simulations. *Journal of Chemical Information and Modeling*, *59*(1), 441–452. doi:10.1021/acs.jcim.8b00840

16.Xiong, X., Qu, K., Ciazynska, K. A., Hosmillo, M., Carter, A. P., Ebrahimi, S. (2020). A thermostable, closed SARS-CoV-2 spike

protein trimer. *Nature Structural and Molecular Biology*, 27(10), 934–941. doi:10.1038/s41594-020-0478-5

17. Bukhari, Q., & Jameel, Y. (March 17, 2020). Available at SSRN. Will coronavirus pandemic diminish by summer?. doi:10.2139/ssrn.3556998

18. Wu, Y., Jing, W., Liu, J., Ma, Q., Yuan, J., Wang, Y., . . . Liu, M. (2020). Effects of temperature and humidity on the daily new cases and new deaths of COVID-19 in 166 countries. *Science of the Total Environment*, *729*, 139051. doi:10.1016/j.scitotenv.2020.139051

19. He, Y., Zhou, Y., Liu, S., Kou, Z., Li, W., Farzan, M., & Jiang, S. (2004). Receptor-binding domain of SARS-CoV spike protein induces highly potent neutralizing antibodies: Implication for developing subunit vaccine. *Biochemical and Biophysical Research Communications*, *324*(2), 773–781. doi:10.1016/j.bbrc.2004.09.106

20. Tai, W., He, L., Zhang, X., Pu, J., Voronin, D., Jiang, S. (2020). Characterization of the Receptor-Binding Domain (RBD) of 2019 novel coronavirus: Implication for development of rbd protein as a viral attachment inhibitor and vaccine. *Cellular and Molecular Immunology*, *17*(6), 613–620. doi:10.1038/s41423-020-0400-4

21. Banerjee, A., Kulcsar, K., Misra, V., Frieman, M., & Mossman, K. (2019). Bats and coronaviruses. *Viruses*, *11*(1), 41. doi:10.3390/v11010041

22. Fan, Y., Zhao, K., Shi, Z. L., & Zhou, P. (2019,). Bat coronaviruses in China. *Viruses*, *11*(3), 210. doi:10.3390/v11030210

23. Song, W., Gui, M., Wang, X., & Xiang, Y. (2018). Cryo-EM structure of the SARS coronavirus spike glycoprotein in complex with its host cell receptor ACE2. *PLOS Pathogens*, *14*(8), e1007236. doi:10.1371/journal.ppat.1007236

24. Wan, Y., Shang, J., Graham, R., Baric, R. S., & Li, F. (2020). Receptor recognition by novel coronavirus from Wuhan: An analysis based on decade-long structural studies of SARS. *Journal of Virology*, *94*(7), e00127-20. doi:10.1128/JVI.00127-20

25. Kampf, G., Todt, D., Pfaender, S., & Steinmann, E. (2020). Persistence of coronaviruses on inanimate surfaces and its inactivation with biocidal agents. *Journal of Hospital Infection*, *S0195–6701*(20)30046–3. doi:10.1016/j.jhin.2020.01.022

26. Shang, J., Wan, Y., Liu, C., Yount, B., Gully, K., Yang, Y., . . . Li, F. (2020). Structure of mouse coronavirus spike protein complexed with receptor reveals mechanism for viral entry. *PLOS Pathogens*, *16*(3), e1008392. doi:10.1371/journal.ppat.1008392

27. Wang, C., Horby, P. W., Hayden, F. G., & Gao, G. F. (2020). A novel coronavirus outbreak of global health concern. *Lancet*, *395*(10223), 470–473. doi:10.1016/S0140-6736(20)30185-9

Cite this article as: Ganguly B. Molecular Interaction, Behaviors and Effect of Temperature on glycoprotein receptors of SARS-CoV-2: Review. International Journal of Microbial Science [Internet]. 2020;1(1). Available from: http://dx.doi.org/10.55347/theijms.v1i1.8