Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Inherited and acquired corona of coronavirus in the host: Inspiration from the biomolecular corona of nanoparticles

Jie Gao a,g, Li Zeng a,g, Linlin Yao a,g, Ziniu Wang a,g, Xiaoxi Yang a,e,f,g, Jianbo Shi a,e,f,g, Ligang Hu a,e,f,g, Qian Liu a,e,f,g, Chunying Chen b,⁎, Tian Xia c,⁎, Guangbo Qu a,e,f,g,⁎⁎, Xian-En Zhang d, Guibin Jiang a,e,f,g

a State Key Laboratory of Environmental Chemistry and Ecotoxicology, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing 100085, China
b CAS Key Laboratory for Biomedical Effects of Nanomaterials and Nanosafety, CAS Centre for Excellence in Nanoscience, National Center for Nanoscience and Technology of China, Beijing 100190, China
c Division of NanoMedicine, Department of Medicine, Centre for Environmental Implications of Nanotechnology, University of California, Los Angeles, Los Angeles, CA 90095, United States
d National Laboratory of Biomacromolecules, CAS Center for Excellence in Biomacromolecules, Institute of Biophysics, Chinese Academy of Sciences, Beijing 100101, China
e School of Environment, Hangzhou Institute for Advanced Study, UCAS, Hangzhou 310000, China
f Institute of Environmental and Health, Jianghan University, Wuhan 430056, China
g University of Chinese Academy of Sciences, Beijing 100049, China

ABSTRACT

The family of coronavirus are named for their crown shape. Encoded by the genetic material inherited from the coronavirus itself, this intrinsic well-known “viral corona” is considered an “inherited corona”. After contact with mucosa or the entrance into the host, bare coronaviruses can become covered by a group of dissolved biomolecules to form one or multiple layers of biomolecules. The layers acquired from the surrounding environment are named the “acquired corona”. We highlight here the possible role of the acquired corona in the pathogenesis of coronaviruses, which will generate fresh insight into the nature of various coronavirus-host interactions.

© 2021 Elsevier Ltd. All rights reserved.

Introduction

Over the last year, the emergence of a novel infectious coronavirus in humans has resulted in the worldwide COVID-19 pandemic. There are four genera of coronavirus, including Alphacoronavirus, Betacoronavirus, Gammacoronavirus, and Deltacoronavirus. Belonging to the genus of Betacoronavirus, SARS-CoV-1, SARS-CoV-2, and MERS-CoV are able to infect humans and cause severe respiratory syndrome. SARS-CoV-2 has resulted in the ongoing global COVID-19 pandemic. An efficient therapeutic strategy requires a better understanding of the interaction between SARS-CoV-2 and the host [1].

Coronaviruses are a class of enveloped viruses with a positive-sense single-stranded ribonucleic acid (RNA) genome (Fig. 1). There are generally four types of protein in SARS-CoV-2, including the spike glycoprotein (S protein), membrane protein (M protein), nucleo-protein (N protein), and the envelope small membrane protein (E protein). SARS-CoV-2 can be transmitted via respiratory droplets, direct contact of skin mucous membrane and aerosol. In addition to the respiratory organs, genetic matters of SARS-CoV-2 can also be detected in the kidneys, liver, pancreas, gastrointestinal tract, brain, nerves and heart, suggesting that SARS-CoV-2 can access most of the tissues [3].

Coronaviruses are named for their most prominent feature, the “crown of spikes” around the virion (“corona” means “crown” in Latin). This viral “corona” is composed of a lipid membrane and the
M, E, and the trimeric S protein. Since this well-known corona is encoded by the genetic material inherited from the virion itself, it can be considered an “inherited corona”. This inherited corona undoubtedly has a crucial role in the interaction of the virus with host cells’ replication, and the construction of new virions [2]. The S protein mediates the entry of coronaviruses into the host cell through the attachment of the virus to cell receptors. The M protein maintains the structure of the viral envelope, through the interaction with other major structural proteins. As the smallest of the major structural proteins, the E protein is also involved in the coronavirus assembly. It is also involved in other aspects of the coronavirus replication cycle and the host’s cellular response to viral infection. All four proteins are critical in the biogenesis of new virions after entry into host cells. Through binding to the RNA genome, the N protein’s function is to construct the nucleocapsid. In host cells, the N protein is also responsible for the replication cycle and the virion formation.

Role of the host’s extracellular soluble biomolecules in virus interactions

The virus-cell interaction can lead to various changes in the host’s biology, such as stimulation of the host’s immune system and potentially serious clinical symptoms [4]. Dissolved biomolecules in biological fluids are an important part of virus-cell interactions [5]. For instance, the complement protein C4 can inhibit infection through the direct inactivation of viral capsid proteins required for infection [6]. The interaction of soluble proteins with viruses can also enhance viral infectivity. For instance, as a dissolved biomolecule, prostatic acid phosphatase fragments in the semen of a host, can facilitate human immunodeficiency virus (HIV) infection [7]. The interaction between soluble heparin-sulfonated proteoglycan cell surface attachment factors and virions initiates the infection of target cells by the human papillomavirus (HPV) [8]. Soluble biomolecules in host biofluids also play important roles in the response of host cells to the invasion of pathogens. It has been reported that coagulation factor X absorbed onto the surface of a virus could be internalized by macrophages along with the virion triggering innate immune recognition [9]. The interaction of these biomolecules with coronaviruses could modulate the virus-cell interaction or cellular response.

Biomolecular corona of exogenous particles or viruses

As discussed above, some effects of soluble extracellular proteins on the behavior of infectious viruses have been revealed in recent decades. Nevertheless, after entering biological fluids, particles not only absorb a single protein but can also dynamically interact with hundreds to thousands of soluble proteins to form the “protein corona” [10–13]. In addition to proteins, nanoparticles can also absorb other biomolecules, including lipids, sugars, and small molecules such as hormones and metabolites [14–17]. These interactions can form one or multiple layers of biomolecules on the surfaces of the nanoparticles [18], which are known as a “biomolecular corona” [19]. When entering into the natural environment, the binding or coating of biomolecules such as dissolved organic matter (DOM) on the surface of nanoparticles could form biomolecular corona or “eco-corona” [14,17,20,21]. The components of this corona can endow invading particles with properties that are distinct from the intrinsic properties of bare nanoparticles. This affects their environmental behavior, and their interactions with cells, including particle recognition, cellular internalization, stimulation of intracellular signaling pathways, and subsequent biological activities [10,22,23].

As natural particles at the nanoscale, viruses can also interact with groups of molecules in biological fluids simultaneously as discussed above [6–9,24]. Recently, the understanding of the interaction of soluble proteins with viruses has begun to evolve from considering single proteins to encompassing multiple proteins [25]. Ezzat et al. studied the protein corona absorbed onto respiratory syncytial virus (RSV) and herpes simplex virus type 1 (HSV-1) in different biological fluids [25]. Hundreds of proteins were found to absorb onto the viruses, and distinct profiles were observed because of the different surface properties of the two types of virus. This protein corona has important functions in viral infectivity, immune recognition, and induction of amyloid aggregation [25].

Possible role of the “Acquired Corona” in the host-coronavirus interaction

It can be speculated that when coronaviruses are enveloped in different compartments, a dynamic biomolecular corona will form on the surface of the virion. Compared with the inherited corona described above, because this “corona” is acquired, it is referred to as the “acquired corona” (Fig. 2). A vast spectrum of biomolecules can form an acquired corona (or eco-corona) on the surface of coronaviruses in the ambient environment, such as wastewater, inanimate surfaces, and oral droplets (Fig. 3A). In the host environment, the acquired corona could form in different mucosa or pulmonary surfactants (Fig. 3B). Because the altered biomolecular components in different biological fluids, the components of the acquired corona may change dynamically when SARS-CoV-2 is
enveloped in different tissue microenvironments (Fig. 3C). After entry into the cells, release into the bloodstream, and arrival at the target tissue, some biomolecules in the acquired corona of coronaviruses might be exchanged with new biomolecules (Fig. 3C).

The acquired corona is capable of covering the inherited corona, at least in part, which could modify the surface properties of coronaviruses, and the subsequent virus-host interaction. (1) Coronaviruses have the potential to perturb the normal structure of biomolecules in the acquired corona. For example, protein conformation arising from the binding of some viruses can mediate extracellular pathogenesis [25]. Whether coronavirus-mediated alterations of protein could lead to abnormal response is not clear. Meanwhile, the acquired corona may affect the stability of the coronavirus envelope. (2) The acquired corona may perturb or modulate the virus-cell interface. In the lung, the acquired corona may either interrupt the binding of the coronaviruses to the known cell
receptors or mediate the binding of virions with the unidentified cell receptors. It has been reported that lung surfactant protein D (SP-D) can interact with the S-protein of SARS-CoV-1. However, as with other collectins, SP-A and mannan-binding lectin in the blood circulation show no interaction with S-protein [24]. The preincubation of S-protein with SP-D increases binding to dendritic cells but not macrophages, suggesting a regulatory function for SP-D in virus-host cell interactions. Therefore, similar to SARS-CoV-1, SARS-CoV-2 may also interact with surfactant and form an acquired corona, which could affect the behavior of SARS-CoV-2 in the host. (3) Although a large number of intracellular signaling pathways, cell-cell interactions, and intercellular communication events have been predicted to participate in the infection syndromes associated with coronaviruses [26], the role of the acquired corona in the multilayer of biological process is not clear. Because of the intracellular translocation of biomolecules in this multi-layered biological process that interact with viruses, the acquired corona may mediate the stimulation of the immune system and the possible poor outcomes in patients. As an acidic membrane-bound organelle, lysosome could digest intruding coronaviruses. However, recent evidence suggested SARS-CoV-2 could lead to the loss of function of the lysosome, allowing the survival and release of SARS-CoV-2 from cells [27]. The role of the acquired corona formed in cytoplasm or lysosome may contribute to the exocytosis of SARS-CoV-2. The interaction of coronaviruses with intracellular biomolecules and the acquired corona as observed in the cellular response should be investigated. (4) After leaving cells, the acquired corona in the blood may affect the spread, penetration of biological barriers, and biodistribution of coronaviruses in different tissues (Fig. 4). When the coronaviruses reach a given tissue, it is still unclear whether the acquired corona is involved in the observed clinical syndromes in different tissues, such as gastrointestinal disease, pinkeye, runny nose, loss of taste and smell, heart failure, and kidney failure [28]. Recently, it has been demonstrated that SARS-CoV-2 can be transport to the nervous system through penetration of the neural–mucosal interface in the olfactory mucosa [29]. Given that SARS-CoV-2 has the potential to attack the central nervous system [30], the acquired corona formed in the mucosa and cerebrospinal fluid in the neural system may have a role in the infectivity of SARS-CoV-2 (Fig. 4). (5) Selective pressures and the instability of the RNA genome drive mutations in the SARS-CoV-2 genome, which could generate more variants and alter the inherited corona [31]. Thus, the acquired corona on different coronaviruses may be altered, potentially contributing to variations in symptoms induced by individual SARS-CoV-2 variants.

After leaving hosts, the acquired corona is also an important factor in the environmental behavior of coronaviruses (Fig. 4), which is crucial to the transmission and infectivity of coronaviruses [32–35]. Therefore, the acquired corona should be considered in order to understand in depth the environmental behaviors of coronaviruses under realistic environmental conditions outside the host [34].

Perspective

The components of the acquired corona in different biological fluids or environmental matrices outside the host could be revealed through high-throughput mass spectrometry proteomics, lipidomics, and other target or non-target mass spectrometry. The composition of the acquired corona is highly dependent on the surface properties of virions so could vary in different coronavirus
variants [11,15,36,37]. In the future, with sufficient information on the acquired corona formed on different types of coronavirus obtained, in silico models could be established to predict the components of an acquired corona on different novel coronavirus variants. The protein corona may form rapidly upon virus incorporation into biological fluids [38], and the time-resolved dynamics of the interaction between coronaviruses and biomolecule should be evaluated. Because of the differences in the surface properties of engineered hard nanoparticles or other virions, the interface between coronaviruses and the acquired corona is also likely to be different. Better knowledge of the driving forces at the dynamic interface between viruses and soluble biomolecules will help in understanding the dynamic process of acquired corona formation (Fig. 5). In situ coronavirus–biomolecule interactions in suspended biological fluids also need to be studied to differentiate between soft acquired corona and hard acquired corona of coronaviruses [39,40].

Information on the biomolecules that attach to coronaviruses is critical to elucidate the mechanisms underlying their interactions with host cells. This interface is the basis of the interaction between coronaviruses and host cells in vivo. We should, therefore, consider both the inherited and acquired corona in different environments. More detailed knowledge of coronaviruses could pave the way for a deeper understanding of the pathogenesis of coronaviruses, better control of the pandemic, and improved strategies for the development of drugs and vaccines.

**Declaration of Competing Interest**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

**References**

[1] S. Berkley, COVID-19 needs a big science approach, Science 367 (2020) 1407.
[2] H. Zhang, J.M. Penninger, Y. Li, N. Zhong, A.S. Slutsky, Angiotensin-converting enzyme 2 (ACE2) as a SARS-CoV-2 receptor: molecular mechanisms and potential therapeutic target, Intensive Care Med. 46 (2020) 586–590.
[3] W. Trypsteen, J. Van Cleemput, W.V. Snippenberg, S. Gerlo, L. Vandekerckhove, On the whereabouts of SARS-CoV-2 in the human body: a systematic review, PLoS Pathog. 16 (2020) e1009037.
[4] W.J. Guan, Z.Y. Ni, Y. Hu, W.H. Liang, C.Q. Ou, J.X. He, L. Liu, H. Shan, C.L. Lei, D.S.C. Hui, B. Du, L.J. Li, G. Zeng, K.Y. Yuens, R.C. Chen, C.L. Tang, T. Wang, P.Y. Chen, J. Xiang, S.Y. Li, J.L. Wang, Z.J. Liang, Y.X. Peng, L. Wei, Y. Liu, Y.H. Hu, P. Peng, J.M. Wang, J.Y. Liu, Z. Chen, G. Li, Z.J. Zheng, S.Q. Qiu, J. Luo, C.J. Ye, S.Y. Zhu, N.S. Zhong, C. China, Medical Treatment Expert Group for, N. Engl. J. Med. 382 (2020) 1708–1720.
J. Gao, L. Zeng, L. Yao et al. Nano Today 39 (2021) 101611

[5] M. Mahmoodi, I. Lynch, M.R. Ejtehadi, M.P. Monopoli, F.B. Bombelli, S. Laurent, Protein-nanoparticle interactions: opportunities and challenges. Chem. Rev. 111 (2011) 5160–5190.

[6] M. Bottemler, S. Foss, S.L. Dify, D. Clicht, L.M. van Tienen, M. Vaynsburg, J. Cruckshank, K. O’Connell, J. Clark, K. Mayes, K. Higgins, H.E. Lode, M.B. McAdam, I. Sandlie, J.T. Andersen, L.C. James. Complement C4 prevents viral entry through effectors of cell activation. Cell Host Microbe 25 (2019) 617–629.

[7] J. Monk, E. Bucker, L. Stander, K. Adermann, C. Goffinet, M. Schindler, S. Wilmott, R. Chinnadurai, D. Rajan, S. Specht, G. Gimenez-Gallego, P.C. Sanchez, D.M. Fowler, A. Koulow, J.W. Kelly, W. Mothes, J.C. Grivel, L. Margolits, G.T. Kepeperl, W. Fuchsman, F. Kirchhoff, Sonne-derived amyloid fibrils drastically enhance HIV infection, cell 131 (2007) 1059–1071.

[8] Z. Surviladze, A. Dzidzusko, M.A. Ozhun, Essential roles for soluble virion-associated heparan sulfated proteoglycans and growth factors in human papilloma virus (HPV) infection, Virologia 1260 (2012) 82–89.

[9] K. Ezzat, M. Pernemalm, S. Palsson, T.C. Roberts, P. Jarver, A. Dondalska, B. Bestas, G. Caracciolo, O.C. Farokhzad, M. Mahmoudi, Biological identity of nanoparticles: a requirement to modulate to enhance transferrin binding and cellular delivery, Nat. Commun. 8 (2017) 1542.

[10] R. Cai, C. Chen, The crown and the scepter: roles of the protein corona in nanomedicine, Nano Today 39 (2021) 101161.

[11] M. Bottermann, S. Foss, S.L. Caddy, D. Clift, L.M. van Tienen, M. Vaynsburg, J. Munch, E. Rucker, L. Standker, K. Adermann, C. Goffinet, M. Schindler. 14265–14270.

[12] P.C. Ke, S. Lin, W.J. Parak, T.P. Davis, F. Caruso, A decade of the protein corona, ACS Nano 8 (2014) 2439–2455.

[13] M. Lundqvist, J. Stigler, G. Elia, I. Lynch, T. Cedervall, K.A. Dawson, Physical-chemical aspects of the protein corona: relevance to in vitro and in vivo biological impacts of nanoparticles, J. Am. Chem. Soc. 133 (2011) 2525–2534.

[14] T. Cedervall, J.B. Olsen, G. Song, R. Liu, H. Guo, D.W. Olsen, Y. Cohen, A. Emili, W.C. Chan, Protein corona fingerprinting predicts the cellular interaction of gold and silver nanoparticles, ACS Nano 8 (2014) 2439–2455.

[15] S. Lin, M. Mortimer, R. Chen, A. Kakinen, J.E. Riviere, T.P. Davis, F. Ding, P.C. Ke, Nanotoxicology beyond toxicity – focusing on biocorona, Environ. Sci. Nanotechnology 7 (2017) 701–713.

[16] J. Zhan, Q.S. Liu, Z. Sun, Q. Zhou, L. Hu, G. Jiang, Evidence of foodborne transmission of the coronavirus (COVID-19) through the animal products food supply chain, Environ. Sci. Technol. 55 (2021) 2713–2716.

[17] Ziniu Wang, Jie Gao, L. Zeng, Q. Liu, Q. Zhou, H. Zhang, D. Lu, J. Fu, Q.S. Liu, M. Li, X. Zhan, X. Hou, J. Shi, L. Liu, Y. Guo, Y. Wang, G.-G. Ying, Y. Cai, M. Yao, Z. Cai, Environmental impacts on the transmission and evolution of COVID-19 combining the knowledge of pathogenic respiratory coronaviruses, Environ. Pollut. 257 (2020) 115621.

[18] J. Yang, L. Zeng, Q. Liu, Z. Sun, Q. Zhou, L. Hu, G. Jiang, B. Zhao, G. Jiang, Detection of coronaviruses in environmental surveillance and risk monitoring for pandemic control, Chem. Soc. Rev. 50 (2021) 3656–3676.

[19] R. Cai, C. Chen, The crown and the scepter: roles of the protein corona in nanomedicine, Adv. Mater. 19 (2017) 1805740.

[20] L. Shang, G.U. Nienhaus, In situ characterization of protein adsorption onto nanoparticles: a fluorescence correlation spectroscopy, Acc. Chem. Res. 50 (2017) 387–395.

[21] J. Keppler, J.J. Gao, Y.N. Li, Y. Li, C. Bleck, A.P. Yusovskaya, M. Suthar, M.R. Straus, C. Rader, M. Farzan, H. Choe, SARS-CoV-2 spike protein D614G mutation increases virion spike density and infectivity, Nat. Commun. 11 (2020) 6013.

[22] J. Yang, L. Zeng, Q. Liu, Z. Sun, Q. Zhou, L. Hu, G. Jiang, B. Zhao, G. Jiang, Detection of coronaviruses in environmental surveillance and risk monitoring for pandemic control, Chem. Soc. Rev. 50 (2021) 3656–3676.

[23] L. Zhang, C.B. Jackson, H. Mou, A. Ohja, H. Peng, B.D. Quinlan, E.S. Rangarajan, A. Pandey, A. Vanderheiden, M.S. Suthar, W. Li, T. Izard, C. Rader, M. Farzan, H. Choe, SARS-CoV-2 spike protein D614G mutation increases virion spike density and infectivity, Nat. Commun. 11 (2020) 6013.

[24] L. Yao, W. Zha, J. Shi, T. Xu, G. Qu, W. Zhou, X.F. Yu, X. Zhang, G. Jiang, Detection of coronaviruses in environmental surveillance and risk monitoring for pandemic control, Chem. Soc. Rev. 50 (2021) 3656–3676.

[25] R. Cai, C. Chen, The crown and the scepter: roles of the protein corona in nanomedicine, Adv. Mater. 19 (2017) 1805740.

[26] L. Shang, G.U. Nienhaus, In situ characterization of protein adsorption onto nanoparticles: a fluorescence correlation spectroscopy, Acc. Chem. Res. 50 (2017) 387–395.

[27] M. Carril, D. Padro, P. del Pino, C. Carrillo-Carmon, M. Gallego, W.J. Parak, In situ detection of the protein corona in complex environments, Nat. Commun. 8 (2017) 1542.

Jie Gao is a Ph.D. student in Research Center for Eco-Environmental Sciences (RCEES), Chinese Academy of Sciences (CAS). She received her master’s degree in RCEES, CAS in 2019. Her research focuses on environmental toxicity and biological effect of nanoparticles.

Li Zeng is currently a postdoctoral fellow at Research Center for Eco-Environmental Sciences (RCEES), Chinese Academy of Sciences (CAS), He was trained as a statistical consultant at School of Public Health, Fudan University, CAS. His Ph.D. degree in 2018. Her research interests focus on reviewing the interaction nature at nano-bio interfaces, and nano-safety and bio-toxicology of engineered nanomaterials in vivo at single cell level.

Lixin Yao is currently a postdoctoral fellow at Research Center for Eco-Environmental Sciences (RCEES), Chinese Academy of Sciences (CAS). She obtained her Ph.D. in Groundwater Science and Engineering at China University of Geosciences, in 2017. She visited the Department of Environmental Science at Baylor University (The United States of America) as a research scholar for the period of 2015 through 2016. Her research focuses on toxicity evaluation of emerging contaminants by using cells, zebrafish and mouse. She has published 12 papers in SCI journals.

Ziming Wang is now a Ph.D. student at Research Center for Eco-Environmental Sciences (RCEES), Chinese Academy of Sciences (CAS). He graduated from Wuhan University in 2019 with a bachelor’s degree in life science. He is interested in the toxicity of environmental pollutants and the mechanisms behind.

Xiaoxi Yang is an assistant professor in Research Center for Eco-Environmental Sciences (RCEES), Chinese Academy of Sciences (CAS). She obtained her Ph.D. in Environmental Science at RCEES, CAS in 2018. Her research is mainly focused on toxicity evaluation of emerging contaminants by using cells, zebrafish and mouse. He has published 11 papers in SCI journals, which have been cited more than 4800 times.
Ligang Hu is a Professor at RCEES, CAS. His research focuses on health effect/toxicology of metals, metalloids, and related particles. He has developed various methods on investigation of metalloproteins and identified a series of new metal-associated proteins from bacteria as well as mammalian cells.

Qian Liu is a full Professor at Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences (RCEES, CAS). He obtained his Ph.D. in 2009 from Hunan University. Prof. Liu is the recipient of the National Science Fund for Distinguished Young Scholars and the NSFC Science Fund for Excellent Young Scholars. He has won the XPLORER Prize, Second Prize of State Natural Science Award, and MIT Technology Review Innovators Under 35 China (MIT TR35 China). His research interests include mass spectrometry, environmental nanotechnology, characterization and tracing of micro/nanoparticles, environmental isotopic chemistry, aerosol chemistry, and health effect of particulate pollution.

Chunying Chen is a principal investigator at CAS Key Laboratory for Biomedical Effects of Nanomaterials and Nanosafety, National Center for Nanoscience and Technology of China. She received her Bachelor’s degree in Chemistry (1991) and Ph.D. degree in Biomedical Engineering (1996) from Huazhong University of Science and Technology of China. Her research interests include the interaction of nanoparticles with biological systems, therapies for malignant tumors using theranostic nanomedicine systems and vaccine adjuvants using nanomaterials, which are supported by the China MOST 973 Programs, EU-FP6 and FP7 and IAEA. She was awarded China Outstanding Young Female Scientists and the National Science Fund for Distinguished Young Scholars.

Tian Xia is a Professor at University of California Los Angeles. Currently, Prof. Xia’s major research interests involve in fundamental understanding of the interaction at the nano-bio interface between engineered nanomaterials and biology, which lead to the beneficial effects including nanomedicine and nanotheranostics or adverse health effects that may lead to diseases.

Guangbo Qu is a professor of Research Center for Eco-Environmental Sciences (RCEES), Chinese Academy of Sciences (CAS). He obtained his Ph.D. in Environmental Science at RCEES, CAS, in 2011. His major research interests are the evaluation of the biological effects of emerging nanomaterials and halogenated organic pollutants, as well as their molecular mechanisms.

Xian-En Zhang graduated from Hubei University in 1987 and later received MPhil (microbiology) and Ph.D. (biochemistry) from Wuhan Institute of Virology and Institute of Microbiology, Chinese Academy of Sciences (CAS), respectively. He became a full professor in Wuhan Institute of Virology, CAS in 1993. Currently he is professor of Institute of Biophysics, CAS. He has long been committed to developing biosensors, nanobiology and synthetic biology to study biological and health problems. He holds the Honorary Doctor of Science Degree granted by the University of Alberta, Canada, and is a Fellow of the Royal Society of Chemistry (RSC) and Fellow of the American Institute for Medical and Biological Engineering (AIMBE). He acts as the vice president of Chinese Society of Biotechnology, member of the permanent organizing committee of the World Congress on Biosensors, founding co-chair of the Division of Nanobiotechnology/Biosensors/Biochips, Asian Federation of Biotechnology (AFOB), and founding chair of the Biosensors/Biochips/Nanobiotechnology Committee of the Chinese Society of Biotechnology.

Guibin Jiang is a professor of environmental chemistry and toxicology at Research Center for Eco-Environmental Sciences (RCEES), Chinese Academy of Sciences (CAS). He obtained his Ph.D. at RCEES, CAS, in 1991. Prof. Jiang is the founding director of the State Key Laboratory of Environmental Chemistry and Ecotoxicology, president of China Association for Instrumental Analysis (CAIA), and associate editor of *Environmental Science and Technology* (ES&T). He is also an academician of the Chinese Academy of Sciences, fellow of the Third World Academy of Sciences (TWAS), and fellow of the Royal Society of Chemistry (FRSC). He has contributed more than 900 articles in peer-reviewed scientific journals, which have been cited more than 32,000 times. He is also the author of 20 scientific books.