frontiers in Virology

SPECIALTY GRAND CHALLENGE
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Fundamental Virology: Curiosity-Oriented Basic Virus Research

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FUNDAMENTAL VIROLOGY

The conceptualization of viruses as infectious, filterable, and host-dependent agents was established in the early twentieth century (1, 2). Since then, the research on a wide variety of viruses has greatly contributed to the progress of life sciences as a whole. Many Nobel prizes afforded to the top scientists in the relevant fields have indicated and highlighted the high scientific quality of virology research. The viruses targeted in these monumental achievements belong to numerous viral species such as yellow fever virus (for anti-yellow fever vaccine), poliovirus (cell culture for virus production), various retroviruses (discovery of oncogenic virus, viral reverse transcriptase, oncogenes, tumor suppressor genes, and HIV as causative virus for AIDS), adenovirus (RNA splicing), papillomavirus (HPV as causative virus for cervical cancer), hepatitis C virus (HCV as causative virus for viral hepatitis), and phages (replication and genetic structure of viruses)[1].

The emergence of SARS-CoV-2 in late 2019 has severely and globally damaged our economics, social life, and public health. On the other hand, the successful application of a novel technology to the virus, the mRNA vaccine, has indeed dramatically changed our current strategy against pathogenic viruses and infectious diseases. Further developments in these strategic arms against the other viruses are well-anticipated in the very near future. Today, while we know something about particular viruses and have been able to get weapons against them, we still do not know completely about virus entities. Understanding viruses is becoming more and more important because of serious concerns about the emergence of unknown viruses by environmental factors including the zoonotic infection and global warming etc.

The advent of viruses was ∼3 billion years ago at a similar era when the first living cells came into existence, though the concept of "virus" was built up far much later as described above. We are now aware that viruses are everywhere and exist in all organisms on earth, such as eubacteria, archaea, protists, plants, fungi, and animals. Viruses that we have already recognized and identified may represent minor virus members, and furthermore, only some of them are known to be pathogenic for their hosts. Fundamental Virology section of "Frontiers in Virology" (3) is willing to accept submissions exploring the nature of all viruses on earth regardless of their pathogenicity. It reports significant new information on all kinds of viruses and provides new future directions in the virus research.

"RESEARCH QUESTIONS" FIRST

Viruses have a quite simple structure consisting of a nucleic acid fragment(s) and a shell formed by viral capsid proteins (1–6). With this apparent structural simplicity, why and how can all viruses mysteriously survive long in their host individuals and populations? This is because viruses sophisticatedly interact with their hosts and cunningly utilize them, and because viruses can

[1] Available online at: https://www.nobelprize.org/prizes/medicine/.

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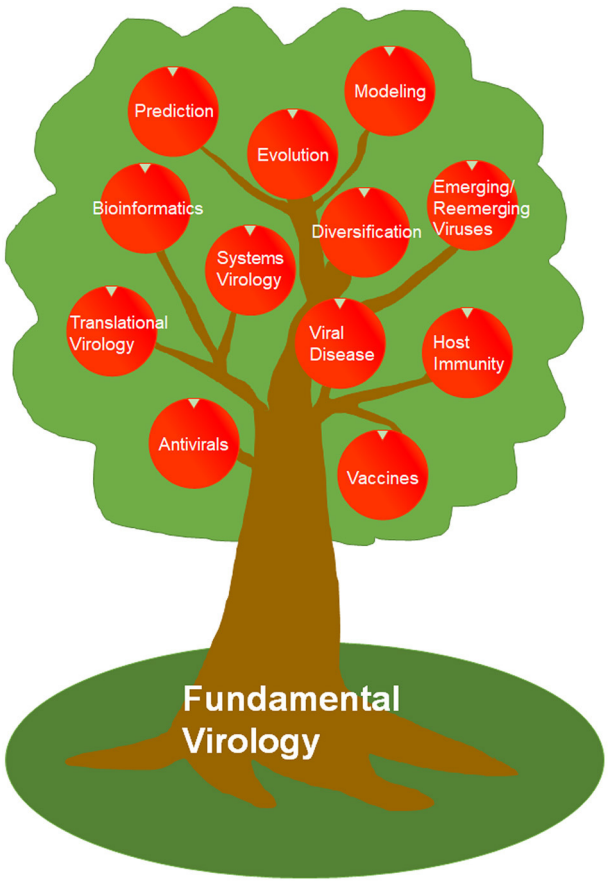

FIGURE 1 | Fruits of the virus research tree. Various research aims/targets for "Frontiers in Virology" (3) are symbolically depicted. For detailed descriptions of various specialty sections in "Frontiers in Virology," see references (3, 7–15).

maintain their functional diversity by adapting and evolving themselves to various environments (1–6). These biological properties are the fundamental aspects of viruses. Viral adaptive mutations, evolutions and phenotypic changes are far beyond our current expectations; the ingenious acquisitions by persistently disease-causing HIV of the capability to resist anti-viral drugs and to evade/escape from host immunity; the emergence of novel pathogenic and highly transmittable viruses like SARS-CoV-2. Currently, we virologists trace viral adaptation/phenotypic changes by using various techniques available and then tackle to deal with them as hard as possible. Through profound understanding the essentials of viral biological properties, we may, or must, establish advanced technologies and/or systems for predicting viral changes beforehand to control viral abilities. Should it be truly possible, we can confront with viruses in a totally different way. To achieve this goal, it is critical for us virologists to look at viruses themselves closely and carefully, and to have keen interests in their life cycle, potentials to replicate and/or persist, and diversifications. Then, we need to deeply consider what we do not know about viruses, what we should know about viruses, and what and how experiments we should do. Needless to mention, toward obtaining biologically significant demonstrative results, all these approaches should be science-based, i.e., curiosity-based. Curiosity-oriented research questions are the main engines for the scientific research, and thus ought to be clearly described in all scientific activities. If necessary, new techniques must be developed and made full use to validate and solve the research questions/issues in concern.

WHAT IS THE VIROLOGICAL/BIOLOGICAL SIGNIFICANCE?

Successful development of technologies in the virus research in recent years has enabled us to much more quickly and readily gain and access to a vast amount of information from the comprehensive analyses ever than before. Moreover, novel technologies like the artificial intelligence containing the deep learning system have a strong potential to transform the way to perform the virus research through handling a huge amount of basic and clinical research data. Although this is of course very good for us researchers, the most important matter is to find out research subjects, which are scientifically novel and virologically significant, from a large mass of the value-unknown information. It is also pivotal that the findings obtained can serve to rationally and purposively understand the fundamental properties, the adaptive phenotypic changes, of viruses for their survival in their hosts and various environments. We have to keep making every effort to accumulate knowledge on the features characteristic of the viruses concerned. "Fundamental Virology" provides basic core information, and thus can support the other sections of "Frontiers in Virology" as a powerful driving force (**Figure 1**). We are looking forward to your studies/investigations in which both the scientific virological themes to be elucidated and the virological/biological significance of findings obtained by practicing the works are clearly indicated.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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