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OF THE PAKISTAN ACADEMY OF SCIENCES:

B. Life and Environmental Sciences



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Proceedings of AASSA-PAS Webinar I

Sub-Theme: SDGs and Pandemics

April 27, 2021 (Tuesday)

Pakistan Academy of Sciences (PAS) and the Association of Academies and Societies of Sciences in Asia (AASSA) with the support of InterAcademy Partnership (IAP) organized an AASSA-PAS Webinar I on “SDGs and Pandemics” on April 27, 2021, in the Pakistan Academy of Sciences. H.E. Senator Shibli Faraz, Federal Minister for Science and Technology inaugurated the Webinar.

Prof. Khalid Mahmood Khan, President Pakistan Academy of Sciences presented the welcome address. He emphasized the importance of media and sharing of data to counter the emerging pandemic potential. The Minister of Science & Technology, Senator H.E. Shibli Faraz appreciated the efforts of PAS, AASSA, and IAP for timely taking up the important issue of Pandemics. He inaugurated the webinar and mentioned that among the most pressing issues in preparing for the global response to a pandemic situation are the design, development, manufacture, and dissemination of vaccines. The response to this pandemic has shown that when leading vaccine manufacturers are fully engaged in a global response, it might be possible for them to manufacture substantial doses of vaccine on timelines faster than envisioned previously. Prof. Yoo Hang Kim (President AASSA) reiterated his support to the academies in Asia for holding such events and containing coronavirus in the region. There is a flood of information on COVID-19. But misinformation is, unfortunately, a big part of the problem we face in confronting the pandemic.

Under the sub-theme “SDGs and Pandemics”, experts from four countries (Turkey, UAE, Nepal, and Pakistan) shared their views. The speakers covered the themes of the role of collaborative efforts of Science academies in the preparedness of pandemics; the impact of Covid-19 on women and publishers and their role in facilitating the publishing and engaging scholarly community. Some other focus areas were:

- Dealing of Virus Infected Biological Samples using Modern Mass Spectrometry Tools: Hepatitis C Virus as an Example
- Tracking the pandemic in Sindh: From training and Capacity Building for COVID-19 testing to Exploring the Emerging Variants
- COVID-19 pandemic and other co-epidemics: a challenge for the overburdened healthcare system in developing countries
- COVID-19 pandemic as a test case in the anthropocene epoch; the interplay of environment, ethics, and psychology on the global stage
- Alternative Therapies for Pandemic Diseases using Herbal Drinks
- Artificial Intelligence and Predictive Survival Analysis for Covid-19
- Development of an Assessment Method for Investigating the Impact of Climate of Lahore on Confirmed Cases of COVID-19

The main recommendation from the webinar was on “Building the Global Vaccine Manufacturing Capacity” to respond to Pandemics” and equity issues of Low and Middle-Income Countries. A nationalistic rather than global approach to vaccine delivery is not only morally wrong but will also delay any return to a level of “normality” (including relaxed border controls) because no country can be safe until all countries are safe.

Way Forward

The organizer of the event, Prof. Zabta Khan Shinwari spoke about the way forward to combat COVID-19. He remarked that what emerges next will partly depend on the ongoing evolution of SARS-CoV-2, on the behavior of citizens, on the government's decisions about how to respond to the pandemic, on progress in vaccine development (its distribution, WTO regime, and IPR issue) and treatments, and also in a broader range of disciplines in the sciences and humanities that focus both on bringing this pandemic to an end and learning how to reduce the impacts of future zoonosis (focusing on One Health), and on the extent to which the international community can stand together in its efforts to control COVID-19. Many factors will determine the overall outcome of the pandemic.



Proceedings of AASSA-PAS Webinar II

Sub-Theme: Pandemics Preparedness, One Health: Lessons Learnt

May 4, 2021 (Tuesday)

Pakistan Academy of Sciences (PAS) and the Association of Academies and Societies of Sciences in Asia (AASSA) with the support of InterAcademy Partnership (IAP) organized an AASSA-PAS Webinar II on “**Pandemics Preparedness, One Health: Lessons Learnt**” on May 4, 2021, in the Pakistan Academy of Sciences. Speakers from Pakistan, Bangladesh, China, Indonesia, Japan, Turkey, and Sri Lanka delivered talks. **Dr. Fazal e Hadi, Chairman Islamabad Healthcare Regulatory Authority** inaugurated the Webinar. **Dr. Fazal e Hadi** noted that the Islamabad Healthcare Regulatory Authority (IHRA) is an autonomous health regulatory body enacted under the Islamabad Health Regulation Act, 2018, and discussed the efforts of the IHRA for educating and making people aware to follow standard operating procedures (SOPs) and standardize their living to counter this pandemic. He stressed on the need to provide evidence for awareness. He recommended that strengthening of leadership and provision of vaccines to everybody is the only way forward to combat the pandemic.

Prof. Khalid Mahmood Khan, President of the Pakistan Academy of Sciences welcomed all the speakers, guests, and organizers of the webinar. He appreciated the efforts of PAS and AASSA for arranging these webinars in this difficult time of the COVID-19 pandemic. **Prof. Yoo Hang Kim, President AASSA**, appreciated the collective efforts of various stakeholders in organizing the webinar for the awareness and strengthening of SOPs across the world. He recommended inviting more people in the future to speak about this epidemic. He emphasized on making people aware of this pandemic. **Prof. Zabta Khan Shinwari**, Chief Organizer of the Webinar, thanked all the speakers of the Inaugural Session and the Chief Guest for being part of the Webinar Series. He explained scientific reasons as to why to observe social distancing. **Coronavirus drifts through the air in microscopic droplets: the science of the infectious aerosols.** Wearing masks and practicing social distancing can, in large part, prevent people from spreading or inhaling aerosols.

Prof. Muhammad Ali (Vice Chancellor, Quaid-i-Azam University, Islamabad, Pakistan) and Prof. Zabta Khan Shinwari (Chief Organizer of the Webinar) served as the moderators of this webinar. Different countries shared their experiences on covid-19. **Prof. Nariyoshi Shinomi**, from Japan, highlighted the current situation of COVID-19 in Japan, while **Prof. Zabta Shinwari** sensitized the participants about biosecurity & neglected aspects of pandemics in Pakistan. The keynote address by **Prof. Jinghua Cao** (Executive Director, Alliance of International Science Organizations, ANSO) discussed the efforts of ANSO members to counter the COVID-19 epidemic. He emphasized the role of ANSO to bring people together and promote solidarity and unity within ANSO to oppose the spread of this epidemic collectively. **Prof. Dr. Mehmet Bulut (Member, TUBA)** emphasized the importance and role of social finance in achieving SDGs objectives. He expressed the need for sustainable development that incorporates meeting the needs of the present and future. Other issues discussed included:

- Vaccinomics and probable prevention strategy against avenging zoonotics
- Nanotechnologies for COVID-19 theranostics
- Development of biodegradable surgical facemask made of marine algae to confront COVID-19 pandemic challenges.

- Understanding COVID-19 pandemic concerning anti-scientific and pseudoscientific world views
- The effective role of the scientists to counter the infodemic
- Practices of complementary & alternative medicines in COVID-19 pandemic

While giving concluding remarks Prof. Zabta Shinwari, emphasized on collective working to share data and lead the research on the pandemic to reduce the overall impact of this epidemic. All the stakeholders and researchers should work together to collaborate and find out how epidemics can be controlled and the economy can be improved. He gave recommendations on regulating media, proper law enforcement, and handling misinformation to support each other against this pandemic.

The consensus emerged on “A One Health Approach to Preventing the Next Pandemic”. Instead of waiting for the next deadly microbe to spill over into humans, public health experts and policy-makers must confront the drivers of zoonotic diseases. Some countries have a long tradition of people eating wild animals and using them in traditional medicines—practices that likely increase the transmission risks of microbes from animals to humans, causing what are called zoonotic diseases. The beginning of this pandemic is reminiscent of another disease caused by a coronavirus, severe acute respiratory syndrome (SARS), which also originated in a live animal market in China. A chef who regularly cooked with exotic animals was one of the earliest persons to be diagnosed with SARS. A coronavirus is also responsible for causing Middle East respiratory syndrome (MERS). MERS viral genomic studies suggest that the virus is endemic to camels in Saudi Arabia. With a mortality rate estimated at nearly 35%, MERS is much deadlier than its coronavirus cousins but more difficult to contract. For MERS, the initial camel-to-human transmission appears to have occurred via nasal secretions from four sick camels.



Proceedings of AASSA-PAS Webinar III / Hybrid Workshop

Sub-Themes: “How to Counter Infodemics: Role of Scientists & Role of Complementary Medicine in Pandemics” & “Diagnosis, Critical Care; Vaccines and Herd Immunity”

May 25, 2021 (Tuesday)

The Pakistan Academy of Sciences (PAS) and the Association of Academies and Societies of Sciences in Asia (AASSA) with the support of InterAcademy Partnership (IAP) organized an AASSA-PAS Webinar III/ Hybrid Workshop on 25 May 2021, in the Pakistan Academy of Sciences. The webinar/Hybrid Workshop covered specific themes i.e. “**How to Counter Infodemics: Role of Scientists & Role of Complementary Medicine in Pandemics**” and “**Diagnosis, Critical Care; Vaccines and Herd Immunity**”. In total, 13 lectures were delivered by leading experts, of which five were delivered by international speakers from Iran, Korea, Russia, USA, and Vietnam and eight by Pakistani speakers. **H.E. Zartaj Gul, Minister of State for Climate Change, Government of Pakistan (GoP)** was the Chief Guest of the Webinar.

Prof. Khalid Mahmood Khan, President-PAS, welcomed the guests and participants and appreciated the endeavours of PAS, AASSA, IAP, the organizers, participants and webinar attendees to cooperatively organize these webinar series and discussed the role of these webinars for improving the situation in this epidemic. **Prof. Yoo Hang Kim, President-AASSA**, appreciated the efforts of AASSA, PAS, Prof. Zabta Khan Shinwari, the organizers, participants (both at the venue and online), and all the people who contributed to the webinar. He gave various recommendations for COVID-19 that included global coordination, global organization, and adoption of all the safety and biosecurity measures suggested by the World Health Organization (WHO).

In her inaugural address, **H.E. Zartaj Gul, Minister of State for Climate Change, Government of Pakistan** extended her thanks to AASSA, PAS & IAP, and all the organizers for arranging the webinar, and to guests of honour, faculty, and participants for attending the sessions. Given the adverse impacts of COVID-19, she emphasized arranging more webinars on the topic in the future. She further added that science and policy-making are two very distinct cultures. Hence, someone has to bridge this gap and the Pakistan Academy of Sciences is already playing this pivotal role effectively. Hence, there is increasing recognition of the importance of boundary roles and structures in linking these cultures. The question is how to achieve the targets of SDGs?; will a new set of goals help the world shift from a dangerous business-as-usual path to one of truly sustainable development? With the growing fear of pandemic and epidemic infectious diseases, scientists are using biotechnology to develop new diagnostic tools for rapid and sensitive detection of pathogens. In conclusion, on behalf of the Ministry of Climate Change, she assured full support and all-out help to see Pakistani’s collaboration in all aspects to control the current crises due to COVID-19.

Prof. Tasawar Hayat, Secretary General PAS gave a brief account of the Pakistan Academy of Sciences (PAS) in terms of its aims and objectives and key success stories. **Prof. Zabta Khan Shinwari, Chief Organizer of the Webinar**, appreciated the efforts of AASSA and young scientists at PAS in arranging this webinar. He announced a prize that was constituted by the president of AASSA for the best poster and appreciated the number of posters being presented. He also informed that the webinars in

the series had attracted an average of nearly 500 registered participants from 15 different countries. He also appreciated the efforts of IAP for sponsoring such events and producing reports on pandemics that are guidelines for preparedness (<https://www.interacademies.org/publication/interdisciplinary-research-epidemic-preparedness-and-response>). **Prof. Dr. Shahid Mahmood Baig** (Chairman, PSF) and **Maj. Gen. Aamer Ikram** (Executive Director, NIH) were the moderators of the Technical Sessions. Lessons learnt from Canada, Korea, Pakistan, Russia, USA, and Vietnam and were shared.

Other issues discussed included:

- COVID-19 and priorities for research & development: findings from a PAS Round Table
- COVID-19 Vaccines; Pakistan's perspective
- Utilitarianism Ethics and COVID-19: resource allocation and priority-setting
- Plant Biotechnology; an important avenue for medicine against COVID-19 and future pandemics
- Understanding COVID-19 pandemic with reference to anti-scientific and pseudoscientific world views
- The Effective role of the Scientists to counter the Infodemics
- Practices of Complementary Medicine in the COVID-19 Pandemic
- Efficacy of Different Treatment Regimens against the Symptoms of COVID-19: A cross-sectional study
- COVID-19 Response in the Republic of Korea
- Fight against Viruses (COVID-19): Peace among nations
- Digital Hygiene against Infodemics
- Building the Global Vaccine Manufacturing Capacity needed to Respond to Pandemics
- COVID-19 Pandemic Control: Lesson from Vietnam

The concluding session of the Workshop was chaired by **H.E. Masood Khan, President AJ&K**. In his address, **H.E. Masood Khan** emphasized on parameters such as convening power, evidence of preparedness, state-based ownership, technological evidence, and codes of conduct to ensure the security of people in this epidemic. He encouraged promoting the role of scientists to counter the epidemic. He congratulated Prof. Dr. Zabta Khan Shinwari for the timely organization of this international webinar. He also recognized the concrete recommendations made during the webinar series by the expert faculty and participants from Pakistan and around the world. He added that Covid-19 has been the most potent and destabilizing threat to our health systems this century, causing huge losses of human lives and a deficit of trillions of dollars in national economies. The latest count shows 167 million cases worldwide and 3.46 million deaths. In hindsight, it is clear that the entire world, including the countries with the most advanced health systems, was not ready for Covid-19. We had forgotten about outbreaks of SARS, MERS, and Ebola because they were confined to certain regions and were contained. Lessons learnt from the Russian Flu in the 1890s and the Spanish Flu in 1918 were buried in the pages of history. So this novel virus struck ominously and without prior warning, but it has taught us a hard lesson that this is not the last global outbreak and that we have to be prepared to deal with future emergencies which can ruthlessly destroy lives and tear apart global and national economic and social fabrics. The pandemic has demonstrated once again our interdependence and mutual vulnerability necessitating a coherent and cohesive approach at the national, regional, and international levels. **A threat to even one individual is a threat to us all.** What is puzzling is that nations with fewer resources were able to fight better than the ones equipped with the most advanced biomedical facilities. Finally, scientists should be given a pivotal role in fighting pandemics.

Maj. Gen. Aamer Ikram explained the present situation of Covid-19 in Pakistan and the efforts of the Pakistani government to contain it and reduce the damage. Prof. Dr. Zabta Khan Shinwari discussed social safety, economy, the One Health concept, CAM therapies, vaccinomics and vaccinations, the SDGs, social financing, nanotechnology, ethics, biodegradation, the use of surgical masks, and how the PAS had successfully achieved the goal of discussing all the major objectives of the webinar series in detail. He mentioned that scientists are collaborating to make vaccines to combat COVID-19 and discussed the

collaborations of AASSA-PAS with UNESCO, WHO, and all the social issues that can overall increment the impact of COVID-19.

Finally, as the conclusion of the webinar series, Prof. Tasawar Hayat, PAS Secretary General, announced the gold, silver, and bronze medals for the best posters by young graduates in the Poster Competition. The prize money was donated by the AASSA President. A partial contribution was also made by the organizers of the workshop.



Proceedings of AASSA-PAS Webinar IV / Hybrid Workshop COVID-19 and Higher Education: Addressing Food Insecurity through Policy Support and Research June 24, 2021 (Thursday)

The Pakistan Academy of Sciences (PAS) and the Association of Academies and Societies of Sciences in Asia (AASSA), with the support of the InterAcademy Partnership (IAP), organized an AASSA-PAS Webinar VI/Hybrid Workshop on **COVID-19 and Higher Education: Addressing Food Insecurity through Policy Support and Research**: 24 June 2021, in the Pakistan Academy of Sciences. In total, 13 lectures were delivered by leading experts, of which four were delivered by international speakers from Australia, Canada, China, and the UK, and eight lectures by Pakistani speakers. **H.E. Syed Fakhar Imam**, Federal Minister, National Food Security, and Research, inaugurated the webinar.

Prof. Khalid M. Khan, President Pakistan Academy of Sciences (PAS), welcomed the guests, speakers, organizers, and webinar participants to the fourth workshop of this series on Pandemic Preparedness, Science, and Countermeasures. He added that in the previous three webinars, PAS had successfully covered important aspects including gender, poverty, food, and marginalized income, and other aspects to create awareness among the public. He thanked **Federal Minister for National Food Security & Research, Syed Fakhar Imam** for managing time to grace the occasion with his online participation and to inaugurate the event.

Prof. Zabta Khan Shinwari, Treasurer-AASSA, and Fellow PAS appreciated the efforts of AASSA-PAS, organizers, attendees, and speakers to collectively participate in this webinar and for their communication about the topics for webinar-IV. He recognized the participation of all in this webinar and emphasized arranging other similar webinars in the future with the collaboration of AASSA and IAP. He thanked all the eminent personalities and other participants from various ministries of the Government of Pakistan for their physical presence to participate in this webinar. **Prof. Yoo Hang Kim, President of AASSA**, acknowledged the efforts of AASSA for organizing this webinar. He expressed his gratitude to **President PAS and Treasurer AASSA** for their cooperation to make this webinar a success.

In his keynote address, **Prof. Viktor Bogatov, Academician of Russian Academy of Sciences and Chief Academic Secretary of Far Eastern Branch of Russian Academy of Sciences**, discussed the imbalance in COVID-19 cases across the world and emphasized the role of science and technology in tackling the pandemic.

H.E. Syed Fakhar Imam, Federal Minister, National Food Security, and Research, Government of Pakistan, inaugurated the webinar and highlighted the impact of the pandemic on people. He conceded the role of institutions and the armed forces to maintain, organize and collect statistics about the pandemic from all over the world. He expressed his desire to improve exports from Pakistan's food and agriculture sector. He added that some 8.4 million tons of rice, 8.4 million tons of maize, and 1 million tons of sugarcane are produced, contributing to GDP growth in Pakistan, and said emphasis should also be on food and livestock production.

Prof. Dr. Tasawar Hayat, Secretary General, PAS thanked Prof. Dr. Zabta Khan Shinwari (Chief organizer of the Webinar Series) for his contributions to the organization of the webinar.

Prof. Dr. Iqrar A. Khan (VC-UAF), Prof. Dr. Kausar A. Malik (Fellow, PAS), and Prof. Dr. Zia Ul-Qayyum (VC, AIOU) were the moderators of the Technical Sessions. Speakers delivered lectures on different issues and topics:

- Food Security Challenge and Options
- Enhance Food and Nutritional Security
- Plant Genetic Resources Management under Pandemic Constraint Context
- CropWatch for Ensuring Food Security under COVID-19
- Soybean as an Intercrop
- Precision for Efficient Agriculture
- Biotech Role in Ensuring Food Security
- COVID-19: Higher Education challenges and responses
- No student left behind in remote areas like Waziristan with less or no Internet connectivity in pandemic Covid19
- Way forward for Higher Education in Pandemics
- COVID-19 Reshape the World: Can it be a positive catalyst for ecological sustainability and Sustainable Development Goals: A case study from Swat
- Post-Covid Higher Education: Responses, Recovery, and Resilience.

In the concluding session, Prof. Yoo Hang Kim, President-AASSA, appreciated the efforts of the AASSA-PAS webinar organizers, participants, and speakers to make this event a success. **Mrs. Farah Hamid Khan, Federal Secretary, Education, and Professional Training**, Chief Guest of the **Concluding Session**, expressed her views about misinformation in the epidemic. She suggested exploring new ways of learning to standardize the provision of education to the people. She was happy to notice that the webinar focused on educators and researchers in different parts of the world to find out how COVID-19 has affected them and how they are coping with the changes. She expressed that, through this webinar, we will also be able to highlight lessons learned and potential positive outcomes of the global lockdown for higher education. She further added that these workshops are forums at which we share our experiences, successes, and failures as well, and learn from each other for the benefit of humankind. The valuable lessons we learned at this workshop must not remain only among ourselves. These must be propagated as widely as possible. I also urge this workshop, through the collective intelligence of the participants, to formulate good recommendations to all stakeholders, including policymakers, scientists, and the general public. In conclusion, Mrs. Farah Hamid Khan thanked all the delegates (who joined virtually) and assured the audience that from the Government's side, ministry authorities shall always be there to assist PAS and other institutions in endeavours to combat the pandemic.

Prof. Zabta Khan Shinwari gave recommendations for countering this epidemic. While appreciating the efforts of AASSA and IAP for supporting such events, he said recommendations of the current webinars will add to the IAP communique: <https://www.interacademies.org/publication/iap-communique-covid-19> about covid-19. He suggested the realization of the needs of students' learning and encouraged universities to revive their policies for providing education in this epidemic as students face internet connectivity issues in far-off places. He proposed collaboration and countering of misinformation to fight against this epidemic and recommended for provision of the following opportunities to students and others:

- Awareness to students about various communication platforms for learning.
- Peer mentors and student leaders are a need of the hour to cultivate a sense of learning.

- Provision of opportunities to people to share their experiences and engaging them with necessary tools to make learning more efficient.
- Encouraging collaboration and understanding all the problems of students would help in standardizing the culture of learning at the national level.
- Provision of vaccines to all people within our community.

Towards the end of the concluding session, Medals/Cash Prizes were distributed among the winners of a poster competition.



AASSA-PAS Webinar Series / Hybrid Workshops 2021 Recommendations

The AASSA-PAS Webinar Series 2021 on “**Pandemic Preparedness: Science and Countermeasures**” was organized jointly by the Pakistan Academy of Sciences (PAS) and the Association of Academies and Societies of Sciences in Asia (AASSA) with the support of the InterAcademy Partnership (IAP). The series consisted of four webinars, each covering a specific theme of the current pandemic scenario/situation and scheduled on 27 April 2021, 4 May 2021, 25 May 2021 and 24 June 2021. The webinars provided an opportunity to share lessons learnt among the participating countries and scientists about COVID-19 and its relation to the UN Sustainable Development Goals (SDGs); strategies for the current issues and challenges while facing pandemics; and the increasing awareness about the preparedness of the future pandemics. Use of emerging technologies like Artificial Intelligence applications in tracking health behaviours during disease epidemics and encouraging the use of ICT technologies and social media for tackling the spread of misinformation regarding different aspects of the pandemic were discussed as well as issues of biosafety, biosecurity and ethics.

In total, 48 lectures were delivered in the AASSA-PAS Webinar series 2021 by leading experts. Of these, 18 were presented by international speakers and 30 by speakers from Pakistan. The resource persons in the webinars were leading foreign experts from different countries i.e., Australia, Bangladesh, China, Indonesia, Iran, Japan, Korea, Kyrgyzstan, Malaysia, Nepal, Pakistan, Russia, Turkey, United Arab Emirates (UAE), USA and Vietnam. More than 2,000 national and international participants registered to participate in the AASSA-PAS Webinar series 2021 (including 748 participants in Webinar I, 760 participants in Webinar II, 428 participants in Webinar III, and more than 300 in Webinar IV). At the conclusion of the AASSA-PAS Webinar Series, participants worked together to develop a list of recommendations that will further help in creating a better and more robust pandemic response. These recommendations are:

1. A global vaccination drive for COVID-19 should be considered as the top priority. However, vaccine safety should be ensured. Advanced countries with the capacity to manufacture vaccines should assist in building the capacity for vaccine manufacturing in developing countries.
2. COVID-19 vaccinations should be made available to everyone. However, governments should ethically ensure their availability and distribution. International organizations like the World Health Organization (WHO) should take the lead in providing COVID vaccines across underdeveloped and developing regions, especially the Least Developed Countries (LDCs) and Low- and Middle-Income Countries (LMICs).
3. COVID-19 passports could play an important role in reopening societies and restoring the civil liberties that were reduced to mitigate the spread of the virus. But at the same time, they bring important ethical concerns. COVID-19 passports can bring unjust forms of exclusion that should be avoided. Given the global inequality in access to vaccines, the introduction of COVID-19 passports could lead to a deepening of global divides. Unjust travel limitations for those who did not have access to vaccines should be avoided. The unequal treatment of people based on having and not having a COVID-19 passport can cause a stigma and a social dichotomy (Adopted from the UNESCO recommendation on COVID-19 passports).
4. Despite impressive scientific achievements, barriers such as the vaccine cold chain and multiple forms of intellectual property (IP) protection like TRIP-WTO stand in the way of equitable access

and fair allocation of vaccines and other medical technologies. These need to be relaxed especially for pandemics, which will encourage LMICs to develop their own vaccines, etc.

5. While a global vaccination drive is extremely important to build immunity for COVID-19, these vaccinations must not mask other mass vaccination programmes, for example, the routine paediatric vaccinations, as well as vaccines for polio. Suitable measures should be taken to ensure the continuity of the different vaccination drives.
6. Awareness campaigns and counselling of people regarding vaccinations should be given an equal priority as they would help in decreasing vaccine hesitancy. The use of digital forums, mainstream and social media should be encouraged for spreading public health awareness.
7. The healthcare infrastructures must be strengthened as co-pandemics can be a serious threat to vulnerable healthcare infrastructures, like those in LDCs and LMICs.
8. The environmental integrity and conservation of biodiversity should be a global priority as it is often zoonoses that are the major drivers of emerging and re-emerging infections. Therefore, concepts like “One Health” should be embraced, and organizations, NGOs and other stakeholders should be encouraged to propagate sustainable and eco-friendly paradigms.
9. A surge in the use of disposable face masks during these unprecedented times are polluting water bodies and becoming a threat to aquatic life. Research into the development of biodegradable facemasks should be supported, and the use of biodegradable facemasks promoted and adopted widely.
10. Robust biosecurity and biosafety structures must be in place. Students and policymakers must be made aware and educated regarding these concepts, which are now considered extremely important amid the pandemic. In this regard, the recently published Tianjin Guidelines for Codes of Conduct for Scientists (<https://www.interacademies.org/news/iap-endorses-tianjin-biosecurity-guidelines>) can be a useful resource.
11. The use of computer-based technologies, simulations and artificial intelligence, etc. are strongly recommended for the prediction of the trends in infections.
12. Existing knowledge regarding medicinal plants can be used in the search for anti-SARS-COV-2 therapies. Such folkloric knowledge and practices could be used to develop a knowledge base that should be scientifically assessed and verified in anti-viral therapies. However, pseudo-science needs to be discouraged.
13. Tackling misinformation regarding the COVID-19 outbreak is as crucial as searching for a cure. It is critical to tackle falsified or fabricated facts. Advanced IT/computer-aided technologies are required to cope with infodemic situations.
14. Governments should prioritize research and development (R&D), especially in the health sector. Policy-making regarding areas like health, environment, science and technology, etc. should be informed by science and include input from expert scientists in the respective domains.
15. The COVID-19 pandemic has been a source of psychological burden which needs critical attention from scientists, doctors and health workers. Counselling strategies should be developed to cope with the mental health consequences of the pandemic.

16. Public and private research organizations should redouble their commitment to open access to data, knowledge and information especially in the current crisis.
17. Collaborative science between technologically less advanced countries and advanced countries should be encouraged. Such global synergies in the different STEM fields can be helpful in the creation of knowledge as well as in answering pressing healthcare challenges.
18. The COVID-19 pandemic threat is not one of health alone. SDG #2: Zero Hunger and #4: Quality Education, for example, come together when considering the needs of students from marginalized communities in LMICs who may be suffering from the burden of food insecurity while attempting to continue their learning online. Information about physical, mental and healthy coping strategies, as well as on affordable, healthy food options is needed.
19. The biggest risk for food security is not considered to be food availability, but rather consumers' access to food. As lockdown measures and other COVID-19-related disruptions lead to a global recession, millions are losing their livelihoods or experiencing a severe drop in income. Social safety nets and food assistance programmes are thus essential to avoid an increase in hunger and food insecurity. Establishing regional genebanks and community seed banks, with safety duplications, can help alleviate some of these issues.
20. Considering virtual education, institutions should apply the following practices to build community and student belonging:
 - Meet students' basic needs;
 - Keep students informed using various communication platforms;
 - Use peer mentors and student leaders to cultivate a sense of community;
 - Provide students with ample opportunities to share their experiences and demonstrate that they are heard by following through with appropriate support;
 - Engage parents and families, providing them with tools and resources to support their students;
 - Increase collaboration to ensure that students are at the centre of all decisions; and
 - Demonstrate care and compassion.

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2. W. Bialek, and S. Setayeshgar. Cooperative sensitivity and noise in biochemical signaling. *Physical Review Letters* 100: 258–263 (2008).
3. R.K. Robert, and C.R.L.Thompson. Forming patterns in development without morphogen gradients: differentiation and sorting. *Cold Spring Harbor Perspectives in Biology* 1(6) (2009).
4. D. Fravel. Commercialization and implementation of biocontrol. *Annual Reviews of Phytopathology* 43: 337359 (2005).

b. Books

5. W.R. Luellen. Fine-Tuning Your Writing. *Wise Owl Publishing Company, Madison, WI, USA* (2001).
6. U. Alon, and D.N. Wegner (Ed.). An Introduction to Systems Biology: Design Principles of Biological Circuits. *Chapman & Hall/CRC, Boca Raton, FL, USA* (2006).

c. Book Chapters

7. M.S. Sarnthein, and J.D. Stanford. Basal sauropodomorpha: historical and recent phylogenetic developments. In: The Northern North Atlantic: A Changing Environment. P.R. Schafer, & W. Schluter (Ed.), *Springer, Berlin, Germany*, pp. 365–410 (2000).
8. J.E. Smolen, and L.A. Boxer. Functions of Europhiles. In: Hematology, 4th ed. W.J. Williams., E. Butler and M.A. Litchman (Ed.), *McGraw Hill, New York, USA*, pp. 103–101 (1991).

d. Reports

9. M.D. Sobsey, and F.K. Pfaender. Evaluation of the H2S method for Detection of Fecal Contamination of Drinking Water, Report WHO/SDE/WSH/02.08, *Water Sanitation and Health Programme, WHO, Geneva, Switzerland* (2002).

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