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Using science, technology and innovation to close the gap on Sustainable Development Goal 3, good health and well-being*

Report of the Secretary-General

Summary

The report highlights that the whole spectrum of science, technology and innovation can make a significant contribution to the achievement of Sustainable Development Goal 3, on ensuring healthy lives and promoting well-being for all at all ages. This report focuses on three areas: primary health care, poverty-related diseases and infectious disease outbreaks. Science, technology and innovation are conceived broadly to include not only scientific and technical innovations, but also well-established low-technology solutions and organizational and social innovations applied in health care. New technological developments in artificial intelligence, digital health, gene-editing and other areas can advance efforts in achieving Goal 3. However, these new technologies also raise critical concerns about privacy, security, accuracy of artificial intelligence in health care and the digital divide. The effective application of frontier or well-established science, technology and innovation tools in health care requires national capacities for health care innovation. Key areas of policy consideration include investments in research, human capital and infrastructure, support for research and development commercialization and a whole-of-government and multisectoral approach. Science, technology and innovation for global health require global partnerships to support national actions and international efforts in combating disease. Priority areas for consideration include supporting national innovation ecosystems, improving the accessibility of health innovations, and building and strengthening multilateral and multi-stakeholder platforms for cooperation, knowledge sharing and standards-setting.

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Introduction

1. At its twenty-third session in June 2020, the Commission on Science and Technology for Development selected "Using science, technology and innovation to close the gap on Sustainable Development Goal 3, good health and well-being" as one of its priority themes for the 2020-2021 intersessional period.

2. The secretariat of the Commission convened a virtual intersessional panel from 18 to 22 January 2021 to contribute to a better understanding of this theme and to assist the Commission in its deliberations at its twenty-fourth session. This report is based on the issues paper prepared by the Commission secretariat,[1] the findings and recommendations of the panel, country case studies contributed by Commission members, relevant literature and other sources.[2]

3. The report comprises five main chapters that are structured as follows. Chapter I investigates general applications of science, technology and innovation in health care, including in primary health care, poverty-related diseases and infectious diseases. Chapter II focuses on digital health care and looks at some policy considerations regarding digital health care. Chapter III analyses the key constraints and policy options at the national level to harness innovation for Sustainable Development Goal 3. Chapter IV discusses global cooperation to strengthen national health innovation ecosystems, more equitably share the benefits of health technologies and strengthen multilateral cooperation. Finally, chapter V presents findings and suggestions for consideration by the Commission.

I. Applications of science, technology and innovation in health care

4. Health care, as framed by Goal 3, is a key component of the global development agenda. Although there are many elements needed to ensure healthy lives for all, science, technology and innovation are critical contributors to the development of improvements in the quality and inclusiveness of healthcare. Science, technology and innovation accelerate progress along seven accelerator themes identified by the World Health Organization's (WHO) Global Action Plan for Healthy Lives and Well-being for All, especially in primary health care, poverty-related diseases, and disease outbreak early warning and response.[3]

5. Research and development, innovation, data and digital health can help deliver effective primary health care. Every year, more than 5 million children die before the age of 5 due to preventable or treatable causes.[4] Prenatal detection and newborn screening contribute to the early detection and diagnosis of conditions that can affect a child's long-term health. Early access to prenatal care and testing can also eliminate mother-to-child transmission of diseases such as HIV, syphilis and hepatitis. Cuba was the first

[1] The issues paper and all presentations and contributions to the intersessional panel cited in this report are available at https://unctad.org/meeting/cstd-2020-2021-inter-sessional-panel.

[2] Contributions from the Governments of Austria, Belgium, Cuba, Ecuador, Finland, the Islamic Republic of Iran, Kenya, Latvia, Portugal, Romania, the Russian Federation, Switzerland, Thailand and Turkey, as well as from the 10-member group to support the Technology Facilitation Mechanism, the Gender Advisory Board of the Commission on Science and Technology for Development, Economic Commission for Latin America and the Caribbean (ECLAC), Economic Commission for Europe (ECE), Economic and Social Commission for Asia and the Pacific (ESCAP), Economic and Social Commission for Western Asia (ESCWA), International Trade Centre (ITC), International Telecommunication Union (ITU), United Nations Industrial Development Organization (UNIDO), Office for Outer Space Affairs, United Nations Entity for Gender Equality and the Empowerment of Women (UN-Women), World Intellectual Property Organization (WIPO) and International Vaccine Institute, are gratefully acknowledged.

[3] https://www.who.int/initiatives/sdg3-global-action-plan.

[4] https://www.who.int/news-room/fact-sheets/detail/children-reducing-mortality.

country to completely eliminate such transmissions through its National Maternal and Child Care Programme and the National Health System.[5]

6. Remote sensing has and will continue to play a role in eradicating infectious diseases that disproportionately affect low- and middle-income countries, such as wild polio[6] and the meningococcal meningitis epidemic in Africa. International research efforts, such as the European and Developing Countries Clinical Trials Partnership, can promote an integrated approach to clinical research towards prevention and treatment of poverty-related diseases, particularly in sub-Saharan Africa.[7] In addition to research institutions, the private sector can also contribute to the fight against poverty-related diseases by making intellectual property available to scientists to accelerate discovery and development of technologies and fostering global health collaborations.[8]

7. It is important to ensure that all countries have equal access to the benefits of life-saving treatments, not only for the coronavirus disease of 2019 (COVID-19) pandemic but also for future health emergencies and infectious disease outbreaks. The COVID-19 pandemic has revealed ethically and politically unacceptable inequalities in access to treatments, vaccines, and health-related technologies. According to the International Vaccine Institute, COVID-19 vaccine doses have mainly been reserved for high-income countries, and modelling suggests that the exclusive use of the first 2 billion doses by high-income countries without some equity could double global deaths.[9] Strengthening international cooperation and a commitment to global solidarity are critical enablers for ensuring that all countries have the requisite technological capabilities and productive capacities (see chapter III) to produce the requisite health supplies for current and future health emergencies. A good example in this regard is the COVID-19 Vaccine Global Access (COVAX) Facility, the vaccines pillar of the Access to COVID-19 Tools Accelerator, convened by WHO and global partners, which aims at speeding up the search for an effective vaccine for all countries and ensuring equitable access to COVID-19 tools.

8. Science, technology and innovation are key enablers in the response to the health, economic, and social disruptions caused by infectious diseases such as the COVID-19 pandemic. Science, technology and innovation and information and communications technology (ICT) tools are supporting the development and deployment of diagnostics,[10] community- and self-testing through automated tools and artificial intelligence-powered interpretation analysis of computer tomography imaging.[11] In addition, the COVID-19 pandemic has led to the emergence of digital contact tracing applications that enable contact tracing on an unprecedented scale and speed.[12]

9. Science, technology and innovation are essential for early warning and disease surveillance. In addition to case identification by online symptom reporting, data aggregation systems provide epidemiological insight and played an important role in

[5] https://www.who.int/mediacentre/news/releases/2015/mtct-hiv-cuba/en/; contribution of Cuba, available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c04_HB_Cuba_es.pdf.

[6] https://www.geospatialworld.net/article/digitalglobes-satellite-imagery-polio/.

[7] Contribution of Portugal, available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c22_H_Portugal_en.pdf.

[8] https://hbr-org.cdn.ampproject.org/c/s/hbr.org/amp/2019/12/how-one-person-can-change-the-conscience-of-an-organization and contribution of WIPO, available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c42_H_WIPO_en.pdf.

[9] Kim J, 2021, COVID-19 vaccines: The daze beyond efficacy, presented at a panel of the Commission on Science and Technology for Development, 11 January, available at https://unctad.org/system/files/non-official-document/CSTD2020-21_ISP_T1_p02_JKim_en.pdf.

[10] Contribution of Austria, available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c01_HB_Austria_en.pdf.

[11] https://www.nature.com/articles/s41591-020-1011-4; https://www.who.int/china/news/feature-stories/detail/covid-19-and-digital-health-what-can-digital-health-offer-for-covid-19.

[12] https://www.nature.com/articles/s41591-020-1011-4; contribution of ECLAC, available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c05_H_ECLAC_en.pdf; and contribution of Turkey, available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c32_H_Turkey_en.pdf.

COVID-19 surveillance.[13] Since July 2006, outbreaks of major animal diseases have been monitored worldwide by the Global Early Warning and Response System for Major Animal Diseases, including zoonoses, WHO and the World Organization for Animal Health. Data dashboards are increasingly being used to keep the public informed and support policymakers in finetuning their policies.[14] Several countries, such as the Russian Federation,[15] have created online COVID-19 information resources to monitor the dynamics of morbidity and mortality, and the provision of medical personnel and specialized beds, and the identification of the need for them.

10. Emerging research using simulation models show that contact tracing paired with case isolation has the potential to control a new COVID-19 outbreak within three months.[16] A model developed in the United Kingdom of Great Britain and Northern Ireland predicts that effective contact tracing could reduce the number of untraced infections to less than one in six cases.[17] However, most studies on contact tracing for COVID-19 are modelling or observational studies, and the evidence at this point is low to assess its effectiveness in the future of the pandemic.[18] Furthermore, reticence by some populations to not adopt contact tracing tools and the community spread of infectious diseases can inhibit its potential effectiveness.

11. Science, technology and innovation can also contribute to well-established low-technology solutions, such as educating patients about their health care, text message reminders for check-ups and taking medication, and community-based peer support groups. Another example is the development of affordable traditional and herbal medicines that can help to ensure more inclusive health coverage and create new export products. The United Nations Conference on Trade and Development (UNCTAD) science, technology and innovation policy review of Ghana found that 60 per cent of the population used traditional and herbal medicines. Although the science, technology and innovation policy review on traditional and herbal medicines was published in 2011, the issues outlined in this section are still relevant for the health-care system of Ghana and possibly applicable to the situation in other countries.[19] The challenges in developing traditional and herbal medicines into an industry included a low level of research and development, a low level of testing of traditional and herbal medicines products, limited infrastructure, difficulty in investing in upgrading of production processes and limited policy support and protection for traditional and herbal medicines.

II. Digital health care

12. Data and digital technologies for health (or digital health) are catalysts for accelerating achievement and monitoring progress on Goal 3. E-health is a generic term used to refer to all digital health-related information and online care delivery. Telemedicine and teleconsultations, electronic health records and hospital and health information systems, e-prescriptions and computer-assisted imaging are examples of modalities in e-health. In its resolution 58.28 on e-health, the World Health Assembly stressed that e-health was "the cost-effective and secure use of information and communications technologies in support of health and health-related fields, including health-care services, health surveillance, health literature, and health education, knowledge and research".

[13] https://www.nature.com/articles/s41591-020-1011-4.

[14] https://www.nature.com/articles/s41591-020-1011-4.

[15] Contribution from the Russian Federation (available at: https://unctad.org/system/files/non-official-document/CSTD_2020-21_c26_H_Russia_ru.pdf).

[16] https://www.sciencedirect.com/science/article/pii/S2214109X20300747.

[17] https://jech.bmj.com/content/74/10/861.

[18] https://www.medrxiv.org/content/10.1101/2020.07.23.20160234v2

[19] For an updated study on traditional and herbal medicines in Ghana, see Essegbey GO and Awuni S, 2016, chapter 5, Herbal Medicine in the Informal Sector of Ghana, in Kraemer-Mbula E and Wunsch-Vincent S (eds.), *The Informal Economy in Developing Nations – The Hidden Engine of Innovation?* Cambridge University Press, 194–227.

13. From managing a population's health more effectively to improving the diagnosis of diseases and monitoring the impact of health-related policies and interventions, data and digital technologies for health, or digital health, are bringing profound changes to how health services are delivered and how health systems are managed.[20] Because of the increasing convergence of new technologies,[21] digital health will likely implicate other advanced technologies, such as the Internet of things, space technologies, blockchain, remote control and autonomous vehicles, 3-D printing and geolocation services.

14. It is predicted that the healthcare landscape will completely shift in the next 10 years, driven by artificial intelligence and machine learning. By aggregating and analysing data from connected-home devices and medical records, healthcare systems will be able to deliver proactive and predictive medical care, provided issues about privacy, regulatory compliance and connectivity are addressed. As technology becomes more integrated in health services, there is and will continue to be, a huge increase in both the generation and usage of health data. Telemedicine, health chatbots and applications, and smart watches coupled with monitoring of social media and web data is bringing an opportunity to leverage data to better understand and yield insights about health. Fifth generation (5G) technologies, the next generation of mobile Internet connectivity that offer higher speed, lower latency and higher capacity for communication, could support many of these applications of digital technologies to health care by quickly transmitting large amount of data, expanding telemedicine and reliable, real-time remote monitoring.[22] [23]

A. Digital solutions for primary health care

15. WHO considers that an educated, aware and engaged public is a goal of primary health care and, in this regard, digital health can support active engagement of the population for their health and well-being, by connecting to high-quality health information and patient communities online.

16. Data and digital health are used across the world in several contexts. First, electronic health records allow the sharing of information about a person's health for referrals and timely clinical decision-making. Second, telemedicine, remote care and mobile health, including the home monitoring of vital signs and medication adjustments, reduce paperwork and cost for health-care providers and improve safety in the management of medication for the elderly or other vulnerable groups. Third, the application of big data and artificial intelligence enable complex clinical decision-making and the identification and reporting of adverse events. Finally, developing medical and assistive devices and services, such as 3-D printing, have revolutionized the manufacture of devices and equipment.

17. There are more than 120 countries that have national policies for digital health, a recognition of the fact that digital health provides opportunities to accelerate the progress towards Goal 3.[24] Several Member States of the Commission on Science and Technology for Development have shared their experience in developing policies on digital health. Kenya, for example, is aiming to attain universal health coverage by 2022. To ensure universal health coverage is attained, the country is looking at several electronic services to

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[20] https://www.who.int/docs/default-source/primary-health-care-conference/digital-technologies.pdf?sfvrsn=3efc47e0_2.

[21] UNCTAD, 2018, *Technology and Innovation Report 2018: Harnessing Frontier Technologies for Sustainable Development* (United Nations publication, Sales No. E.18.II.D.3, New York and Geneva).

[22] UNCTAD, 2021, *Technology and Innovation Report 2021: Catching Technological Waves – Innovation with Equity* (United Nations publication, Sales No. E.21.II.D.8, Geneva).

[23] https://www.business.att.com/learn/updates/how-5g-will-transform-the-healthcareindustry.html#:~:text=With%205G%20technology%2C%20which%20has,their%20patients%20need%20and% 20expect.

[24] https://www.who.int/health-topics/digital-health#tab=tab_1.

meet the needs of the population with limited spending power and poor access to formal health-care facilities, given the large penetration of mobile in the country.[25]

B. Critical policy considerations in digital health

18. There are unique challenges in the use of data and digital health to accelerate progress on Sustainable Development Goal 3. Developing the digital skills of the workforce in the health sector is critical, while the digital literacy of users (patients) should be also improved. Despite the potential of telemedicine, most countries do not have a regulatory framework for telemedicine that enables its authorization, integration and reimbursement. The COVID-19 pandemic could be a catalysing factor for countries to develop the regulatory frameworks that could scale up the adoption of telemedicine.[26]

19. Digital divides between and within countries persist, hindering the potential adoption of digital health. Although mobile networks reach 95 per cent of the global population, global Internet access only stood at 53 per cent in 2019.[27] Even when broadband connectivity is available in developing countries, the productivity benefits for business are limited as broadband connectivity tends to be relatively slow and expensive. Digital infrastructure investment is critical to addressing the inequalities in Internet access and leveraging the benefits of digital health, particularly in the least developed countries, landlocked countries and small island developing States, where low population densities, geographical constraints and limited resources make it more difficult for private investors to secure rapid returns on capital investments on extensive Internet infrastructure to remote regions. In this regard, international financial institutions and development partners have an important role to play in extending access to digital infrastructure.[28]

20. The digital gap in smartphone use for women and marginalized groups may affect the public dissemination of health and early warning information. In low- and middle-income countries, women are 8 per cent less likely to own smartphones and 20 per cent less likely to use the Internet compared with men.[29] Gender digital divides prevent women from equal access to health-related information and services, but this also has implications for the generation of health data. Uneven datasets can result in the misrepresentation of digital biomarkers for prevention and diagnosis of disease, as well as more effective treatment monitoring.[30] For instance, smoking behaviour varies according to sex-associated genetic differences.[31]

21. Effectively harnessing ICTs for health requires the building of digital competencies and an enabling environment. Digital competencies can be strengthened by education policy that accommodates digital skills' training schemes in formal education curricula, as part of the on-the-job training, and in the context of lifelong learning. The creation of an enabling environment can make access to ICT-enabled health innovations possible through the following: policies and institutional development, including investments in ICT

[25] Contribution of Kenya, available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c19_H_Kenya_en.pdf. Example of digital health initiatives are: (a) mobile money transport vouchers for mothers to get free transport to give birth to their child in health centres; and (b) Changamka Micro Health, which through its product Linda Jamii allows Kenyans to access health insurance by using savings from their mobile money (M-Pesa) accounts.

[26] https://publichealth.jmir.org/2020/2/e18810/?utm_source=TrendMD&utm_medium=cpc&utm_campaign=JMIR_TrendMD_0.

[27] UNCTAD, 2020, *Fifteen Years since the World Summit on the Information Society* (United Nations publication, Sales No. E.20.II.D.1, Geneva).

[28] UNCTAD, 2019, *Building Digital Competencies to Benefit from Frontier Technologies* (United Nations, Sales No. E.19.II.D.6, Geneva).

[29] Rowntree O et al., 2020, *The Mobile Gender Gap Report 2020*, GSM Association, available at https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2020/05/GSMA-The-Mobile-Gender-Gap-Report-2020.pdf.

[30] Cirillo D et al., 2020, Sex and gender differences and biases in artificial intelligence for biomedicine and health care. *npj Digital Medicine*, 3:81.

[31] Bourne PE et al., 2015, The NIH big data to knowledge (BD2K) initiative, *Journal of American Medical Informatics Association*, 22:1114–1114.

infrastructure; big data analysis and decision-making capabilities; open government data tools; incentives encouraging investment and labour market participation in the digital economy; and ICT foresight capacities.[32]

22. Highly granular or personal data for public-health purposes raises security and privacy concerns. The proliferation of contact tracing technology for the COVID-19 pandemic specifically presents challenges for privacy and data protection, as technology companies may misuse data and violate users' privacy.[33] Applications use either Global Positioning System or Bluetooth data from mobile phones to record users' proximity of each other and send alerts if a user has been exposed to someone with COVID-19. Also, the security and privacy of freely available communication platforms used for digital health purposes remains a concern, particularly for the flow of confidential, highly private health-care information.[34]

23. Some COVID-19 tracing applications, such as Trace Together (Singapore) and Pan-European Privacy-Preserving Proximity Tracing, address these concerns through a "privacy by design" approach that allows notification of potentially exposed persons while preserving privacy. The voluntary contact tracing application Apturi COVID (Latvia) is decentralized and uses encrypted data in line with European Union regulations on data protection.[35] To address the issue of privacy in contact tracing during pandemics, for example, several international frameworks with different degrees of privacy preservation are emerging, including Decentralized Privacy-Preserving Proximity Tracing, the Pan-European Privacy-Preserving Proximity Tracing initiative and the joint Google–Apple framework. However, the issue of privacy and security remains a large concern in harnessing data and digital health.[36] Safety is also one of the biggest challenges for artificial intelligence in health care.

24. Artificial intelligence can improve health care, not only in high-income settings, but also to democratize expertise and deploy it to remote areas. However, any machine learning system or human-trained algorithm will only be as trustworthy, effective and fair as the data that it is trained with. Artificial intelligence also bears a risk of biases and thus discrimination. For example, artificial intelligence can magnify gender inequalities if it is developed without removing biases and confounding factors. As recognized in other sectors where artificial intelligence is applied, most currently used biomedical artificial intelligence technologies do not account for bias detection. The design of the majority of algorithms ignores the gender dimensions and their contribution to health and disease differences.

25. It is therefore vital that artificial intelligence developers are aware of these risks and minimize potential biases at every stage in the process of product development. They should consider the risk for biases when deciding which machine learning technologies and procedures they want to use to "train" the algorithms and which data sets (including consideration of their quality and diversity) they want to use for the programming.

26. Public-health organizations and technology companies have been trying to mitigate the spread of misinformation and disinformation, and to prioritize trusted news sites. For example, Google's SOS alert intervention prioritizes the WHO and other trusted sources at the top of search results.[37] Equally, Governments should ensure transparency in their data sets, including epidemiological data and risk factors, making them easily accessible to researchers.[38] Also, the evidence of the effectiveness of digital health solutions, although particularly difficult during pandemics due to the time constraints, needs to be

[32] https://unctad.org/en/PublicationsLibrary/dtlstict2019d3_en.pdf.
[33] https://www.healthaffairs.org/do/10.1377/hblog20200515.190582/full/.
[34] https://www.nature.com/articles/s41591-020-1011-4.
[35] Contribution of Latvia, available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c20_H_Latvia_en.pdf.
[36] https://www.nature.com/articles/s41591-020-1011-4.
[37] https://www.nature.com/articles/s41591-020-1011-4.
[38] https://www.nature.com/articles/s41591-020-1011-4.

peer-reviewed and undergo thorough clinical evaluation for further improvement and to obtain lessons learned.[39]

III. Strengthening national capacities for health innovation

27. The role of science, technology and innovation in extending health and well-being to all is shaped by health innovation systems, inclusive policy frameworks and multisectoral partnerships across and outside of Government. The longer-term process of building effective innovation systems can help developing countries effectively utilize existing, new and frontier technologies in their pandemic recovery and accelerate actions to achieve Sustainable Development Goal 3 on health and well-being.

28. National capacities for health innovation are critically important for ensuring that all countries, including developing and least developed countries, can produce life-saving vaccines and treatments not only for common diseases but also for infectious disease outbreaks that require a swift response.

A. General challenges in health-care innovation ecosystems in developing countries

29. UNCTAD science, technology and innovation policy reviews in Ethiopia, Ghana and the Islamic Republic of Iran have looked at issues highly relevant to the health system in developing countries, providing results that can inform the issue of improving health through science, technology and innovation. Common challenges relate to deficiencies in research and development skills; science, technology, engineering and mathematics skills more broadly; research and development infrastructure; research and development investment by both the public sector and the private sector; and testing and quality assurance systems. Technology development is a common problem, especially with the commercialization of the research that is undertaken. Accessing technology is also frequently a challenge, with relatively low rates of access to the modern machinery and equipment that have embedded technologies.

30. Many hurdles concern converting knowledge and skills into local innovations that are useful for health. The issue of leveraging health benefits from knowledge systems is further exacerbated by deficiencies in funding, physical infrastructure, power, transport, clean water and ICTs, along with weak policy implementation capacities. Internet access is a key infrastructure for digital health, but it requires reliable electricity access. Affordable, accessible and reliable electricity plays an important role in the economic structural transformation of developing countries[40] and the potential adoption of health-related technologies. The number of people without access to electricity was 770 million in 2019, with 75 per cent of the unconnected population living in sub-Saharan Africa, a share that has risen over recent years.[41]

[39] https://www.nature.com/articles/s41591-020-1011-4.

[40] UNCTAD, 2017, *The Least Developed Countries Report 2017: Transformational Energy Access* (United Nations publication, Sales No. E.17.II.D.6, New York and Geneva).

[41] International Energy Agency, 2020, *[Sustainable Development Goal] SDG7: Data and Projections. Access to Affordable, Reliable, Sustainable and Modern Energy for All*, available at https://www.iea.org/reports/sdg7-data-and-projections.

31. In addition to the infrastructural constraints, technological capacity gaps between developed and developing countries limit the potential adoption of health technologies. Average research and development intensity in 2017[42] in North America and Western Europe (2.5 per cent) and East Asia and the Pacific (2.1 per cent) exceed the world average of 1.7 per cent. The number of researchers per 1 million inhabitants sits at a global average of 1,198 (in 2017), with Europe and North America (3,707) and Eastern and South-Eastern Asia (1,468) exceeding the world average.[43]

32. Challenges originate from diverse parts of innovation systems. In addition, there are weak linkages between research and industry, and weak private sectors with mostly small firms that face constraints that larger firms can overcome. The intellectual property system provides a potential avenue to strengthen national capacities for health care by commercializing knowledge. However, in most developing countries, most patent applications are filed by non-residents, potentially limiting the scope for local innovation in the areas concerned. Furthermore, lack of awareness of intellectual property protection options by creators adds further barriers to the commercialization of health innovations. More issues arise when considering how regulatory frameworks for health innovation are defined and enforced, as there are important considerations to be made about standards, testing and quality systems and their implications for assessing and accessing markets.

B. Building the science and talent base for health-care innovation

33. Substantial investments in science, technology and innovation infrastructure, institutions and human capital – all the underpinnings of sound innovation systems – must be an integral part not only of the immediate response to the COVID-19 crisis and persistent health challenges, but also of the long-term effort to ensure that all countries can quickly rebuild better and prepare for similar future challenges.[44] Despite the accentuated motivation to foster stronger innovation systems in developing countries, it is important to prioritize a long-term approach with continuous commitment to investments and policy support for science, technology and innovation.

34. There is evidence that government expenditures to encourage research and development are far more effective when they are stable over time.[45, 46] Firms may hesitate to invest in additional research and development if they are uncertain of the durability of government support. Predictability and long-term perspectives in funding are also critical for academic research. Investment in human capital can suffer from stop-and-go policies. Faced with unstable academic research systems and uncertain career prospects, promising researchers are likely to switch to other career paths or migrate to countries where science, technology and innovation investments are stable or continue to grow.

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[42] Expenditure on research and development as a proportion of gross domestic product (GDP), also known as research and development intensity, is the most widely used indicator of countries' efforts on science, technology and innovation. Research and development comprise creative and systematic work undertaken to increase the stock of knowledge, including the knowledge of humankind, culture and society, and to devise new applications of available knowledge Research and development cover three types of activity: basic research, applied research and experimental development. Organization for Economic Cooperation and Development (OECD), 2015, *The Measurement of Scientific, Technological and Innovation Activities-Guidelines for Collecting and Reporting Data on Research and Experimental Development*, Paris, OECD Publishing.

[43] United Nations Educational, Scientific and Cultural Organization, New UNESCO Institute for Statistics data for Sustainable Development Goal 9.5 on research and development, available at http://uis.unesco.org/en/news/new-uis-data-sdg-9-5-research-and-development-rd (accessed 2 March 2021).

[44] UNCTAD, 2020, The need to protect science, technology and innovation funding during and after the COVID-19 crisis, Policy Brief No. 80.

[45] Guellec D and Pottelsberghe B van, 2000, The impact of public [research and development] R&D expenditure on business [research and development] R&D, STI Working Papers 2000/4, OECD.

[46] Mitchell J et al., 2019, Tax incentives for [research and development] R&D: supporting innovative scale-ups? *Research Evaluation*, 29(2):121–134.

35. In several Member States of the Commission on Science and Technology for Development, such as Cuba[47] and Ecuador,[48] health accounts for a significant proportion of the budgets of research and development and of science and technology. However, as the case of Ethiopia illustrates, it is often difficult to prioritize health due to misalignments in science, technology and innovation policy with the local health and industrial sectors, along with barriers to research and development outputs and deficiencies in electricity, Internet, transport and research funding.[49]

36. Efforts to strengthen science, technology and innovation resources of developing countries could distinguish between the needs of the immediate response and the longer-term strategies. During crisis, support to research and development should be included in emergency measures such as smart recovery packages[50] as well as recovery fiscal packages in the form of research and development grants for disease preventive and containment measures. In the longer term, a "forward guidance" approach (committing to a growth path of future government research and development expenditures) can be an effective tool.

37. Some regional organizations have already set targets for research and development expenditure as percentage of GDP such as the European Union's 3 per cent target and the African Union's 1 per cent target. Likewise, developing countries could revisit and set their targets and, importantly, establish their spending trajectory towards them. This way, governments can not only treat research and development expenditures as "protected funding lines" but also ensure and signal the continuity and predictability of government research and development support to other stakeholders.[51]

C. Commercializing research and development as health care products and services

38. For many countries, challenges in translating innovative capacity into health products and services for patients in international markets arise despite having a well-established science and talent base for health care innovation. In the UNCTAD science, technology and innovation policy review of the Islamic Republic of Iran, the country was found to have strong research capabilities and highly skilled human capital owing to decades of investment into enhancing science, technology, engineering and mathematics education nationwide. However, the Islamic Republic of Iran has struggled to translate this into tangible innovations in biotechnology. [52]

39. According to research and development surveys conducted in Turkey, the health sector has the lowest likelihood of commercialization with a ratio of 3 per cent. Research and development and innovation in the health sector tend to comprise longer terms and periods, such as for clinical stages, than any other research and development intensive sector.[53] Research and development and innovation processes, especially in the sub-fields of pharmaceuticals, vaccines, biomaterials and treatment development, take at least a period of 10–15 years, in addition to higher costs.[54]

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[47] Contribution of Cuba, available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c04_HB_Cuba_es.pdf.

[48] Contribution of Ecuador, available at https://unctad.org/meeting/commission-science-and-technology-development-twenty-fourth-session.

[49] UNCTAD, 2020, Science, Technology and Innovation Policy Review: Ethiopia (United Nations publication, Geneva).

[50] UNCTAD, 2020, The need to protect science, technology and innovation funding during and after the COVID-19 crisis, Policy Brief No. 80.

[51] Ibid.

[52] UNCTAD, 2016, Science, Technology and Innovation Policy Review: Islamic Republic of Iran (United Nations publication, New York and Geneva).

[53] For more information on the surveys, see https://stip.oecd.org/stip/policy-initiatives/2019%2Fdata%2FpolicyInitiatives%2F25692.

[54] Contribution of Turkey, available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c32_H_Turkey_en.pdf.

40. Some countries[55] have support programmes that target productive and collaborative interactions between research and development and innovation actors in the local ecosystem. In this respect, the focus of some policy efforts is to proactively enable a “closing of the innovation gap” between research and development and innovation actors as areas of important opportunities.

41. Another area of interest for some countries is the local production of essential medicines. The issue of local pharmaceutical production, particularly in Africa, has attracted significant interest during the COVID-19 crisis due to the potential to address the security of supply challenges given the reliance on imports from distant geographies. Enhancing local production of essential medicines to improve access to high-quality products requires a multifaceted approach that enables improved quality and commercial viability of existing manufacturers and new entrants to the market. It requires initiatives covering access to investment and technology, capacity-building for industry stakeholders, market transparency and opportunities for international standard products.[56]

D. Promoting a whole-of-government and multisectoral approach

42. To be effective, science, technology and innovation policies need to be internally consistent and aligned with national health priorities and development plans. The former can be promoted through the design and deployment of strategies and policy instruments at the most appropriate level, while the latter requires a whole-of-government perspective, facilitating cooperation across ministries and other public bodies in different fields of policy. Coherence is needed between science, technology and innovation policies and policy areas such as industrial policies, trade, foreign direct investment (as knowledge and technology are often being transferred through trade and foreign direct investment), education and competition.[57]

43. In some developing countries, such as Thailand,[58] responses to the COVID-19 pandemic involve multisectoral and multidisciplinary actors within and across Government. Such collaborative efforts across Government can build a foundation for science, technology and innovation policies that move beyond a focus on economic competitiveness or science funding, towards sustainable development and integrating health and societal challenges to their cores.[59] Some countries have established effective cross-ministerial collaboration on health care-related sectors – as is the case with pharmaceutical companies in Ethiopia[60] and clinical research in Portugal.[61] Each of these sectors collaborates with various government sectors in science, technology and innovation, health, trade and industry.

44. Multi-stakeholder collaboration, in addition to a whole-of-government approach, is needed to ensure that health innovations involve the support of all key national stakeholders and are included in national action plans. Austria[62] and Kenya are examples of countries

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[55] For example, see the contributions of Thailand (available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c30_B_Thailand_en.pdf) and Turkey (available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c32_H_Turkey_en.pdf).

[56] Contribution of UNIDO, available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c38_H_UNIDO_en.pdf.

[57] UNCTAD, 2018, *Technology and Innovation Report 2018: Harnessing Frontier Technologies for Sustainable Development* (United Nations publication, Sales No. E.18.II.D.3, New York and Geneva).

[58] Contribution from the Government of Thailand (available at: https://unctad.org/system/files/non-official-document/CSTD_2020-21_c31_H_Thailand_en.pdf).

[59] UNCTAD, 2017, *New Innovation Approaches to Support the Implementation of the Sustainable Development Goals* (United Nations publication, New York and Geneva).

[60] UNCTAD secretariat, based on UNCTAD, 2020, *Science, Technology and Innovation Policy Review: Ethiopia* (United Nations publication, Geneva).

[61] Contribution of Portugal (available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c22_H_Portugal_en.pdf).

[62] Contribution of Austria (available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c01_HB_Austria_en.pdf).

that make use of national, international, scientific societies and non-governmental organizations to support their health research, funding and implementation efforts, also involving civil society and citizen scientists in addition to conventional research and development and science and technology institutions. Some project partners of public–private partnerships that have been involved with the Ministry of Health in Kenya include the United States Agency for International Development, WHO, the Kenya Red Cross Society, the Global Fund to Fight AIDS, Tuberculosis and Malaria and World Vision.[63]

IV. Mobilizing international action in science, technology and innovation for health

45. Addressing global challenges in vastly different local contexts requires the combination of cutting-edge scientific capabilities with local knowledge. Global collaboration can contribute to this process, providing opportunities both to create new knowledge and to increase the impact of research by diffusing existing knowledge, quickly and at all levels.[64] With fast movements of goods and people across borders in the increasing globalization context, countries have become interdependent in the health sector. Regional and global action is needed to deepen research cooperation, reimagine health innovations as global public goods and shape global norms and frameworks on emerging health and medical technologies.

A. Supporting national health innovation ecosystems

Extending access to digital health

46. Examples abound of international cooperation to build capacities for digital health at the national level. The United Nations Technology Innovation Lab has been working with the Government of Finland to develop guidance for digital public goods in the area of maternal, new-born and child health.[65] Belgium[66] also uses digital technologies in development programmes, creating a case for the transformative power of technology across different sectors. Switzerland helps Rwanda and the United Republic of Tanzania to use digital technology to guide and train health workers in the diagnosis and management of sick children.[67]

47. International support, including regional and international cooperation, engaging multi-stakeholders (i.e. national Governments, the private sector, research platforms for economic discovery and technical education and training institutes) will need to expand to enable the potential promise of digital health. The COVID-19 experience highlights the need to build, and truly invest in and scale up, a new digitalized infrastructure and efforts on supporting the provision of affordable Internet connection and necessary public services, such as health. Thus, there is scope for scaling up regional intergovernmental cooperation and implementing policies that promote the benefits of digital health care.[68] Such

[63] Contribution of Kenya (available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c19_H_Kenya_en.pdf); Minjire EK and Waiganjo E, 2015, Factors affecting the performance of public–private partnerships in health-care projects in Kenya: A case study of the ministry of health, *The Strategic Journal of Business and Change Management*, 2(36):717–746.

[64] UNCTAD (2020). Impact of the COVID-19 Pandemic on Trade and Development: Transitioning to a New Normal (United Nations publication, Sales No. E.20.II.D.35, Geneva).

[65] Contribution of Finland, available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c12_HB_Finland_en.pdf.

[66] Contribution of Belgium, available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c03_H_Belgium_en.pdf.

[67] Switzerland, statement at the 2020–2021 intersessional panel of the Commission on Science and Technology for Development.

[68] Contribution of ESCAP, available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c08_H_ESCAP_en.pdf.

cooperation should include ICT education and training to build digital capabilities, as well as entrepreneurship training.

Shaping scientific networks and research and development for health-care innovation

48. Governments and international agencies could improve their efforts to guide and shape scientific research and development networks for global health, including through the prioritization of health concerns for developed and least developed countries and supporting developing countries' participation in regional and global health research networks. If the international community strengthens global collaboration in scientific research and innovation, it could potentially provide new opportunities for the combination of the most advanced scientific capabilities, with detailed local knowledge in key areas of sustainable development.

49. An amalgamated approach to knowledge generation has been observed often in European research programmes that support national research infrastructures, such as the Horizon 2020 projects of the European Union support the strengthening of research infrastructure in universities in Turkey. Similarly, the International Consortium for Personalized Medicine facilitates the work of member organizations on fostering and coordinating research as a driver for personalized medicine implementation.[69]

50. The open science approach is one of the most favourable arrangements that has gathered momentum during the COVID-19 pandemic as it enables the free use of what would otherwise be proprietary information, which scientific collaboration is increasingly relying upon.[70] Open access is characterized by free access to information and unrestricted use of electronic resources for everyone. The International Vaccine Institute[71] and the open-source platform called Insurance Management Information System, funded by Switzerland, have both taken the approach of collaborative science innovation through open-source knowledge sharing.

Building health-care innovation capacities

51. Bilateral and multilateral cooperation and technical cooperation projects from international agencies can support the building of national capacities for health care innovation. Cooperation projects can take the form of financial and technical support to various health authorities in developing countries, e-learning projects, or fellowship programs to help developing countries increase their scientific and research capacity. In 2020, under the auspices of the Commission on Science and Technology for Development of the United Nations, UNCTAD and Okayama University in Japan launched the Young Female Scientist Programme with the aim of building human capital in science, technology and innovation-related fields in developing countries.[72]

Strengthening innovation in health-care industries

52. Bilateral, regional and international cooperation arrangements are potential mechanisms for the building and strengthening of innovation in health-care industries. UNIDO has been supporting efforts towards innovation and collaboration in the pharmaceutical sector through an ongoing project entitled "Fostering Slovenian–Cuban innovation cluster for biopharma, medical and nanotechnologies sectors".[73]

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[69] Contributions of Portugal (available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c22_H_Portugal_en.pdf), Romania (available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c24_HB_Romania_en.pdf) and Turkey (available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c32_H_Turkey_en.pdf).

[70] OECD, 2015, Making open science a reality, OECD Science, Technology and Industry Policy Papers No. 25, OECD Publishing, Paris, available at http://dx.doi.org/10.1787/5jrs2f963zs1-en.

[71] Contribution of the International Vaccine Institute, available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c16_H_IVI_en.pdf.

[72] For more information on this project, see https://unctad.org/news/partnering-nurture-scientific-talent-developing-countries.

[73] https://tii.unido.org/news/go-global-biopharma-business-forum-high-tech-companies.

53. Another example of international cooperation in the field of health-care innovation is the links established between the BioCubaFarma Group and various entities of China. These joint initiatives contributed to important outputs such as monoclonal antibodies and treatment for viral hepatitis. Joint laboratories have also been set up between the two countries, as well as research centres and projects aimed at ailments of the central nervous system, such as dementia and Alzheimer's disease.[74]

54. At the regional level, the Conference on Science, Innovation and Information and Communications Technologies (a subsidiary body of ECLAC) approved a regional cooperation proposal, which includes measures to develop the health care industry at the national and regional levels, as well as foster regional research and development networks.[75]

B. Making health care technologies accessible for all

55. To address the needs of health systems in developing countries, international collaboration in scientific research can play a critical role in improving health, equity and sustainable development. It can particularly make an important contribution in the context of diseases that are disproportionately prevalent in developing countries, but where research capacity may be limited. To enable their success, collaborative arrangements should ideally seek to foster equitable relations between the collaborating parties through partnerships towards a common goal, including the possibility of joint ownership of intellectual property rights.[76] On the other hand, collaborative arrangements may seek to issue licences (either paid or unpaid) for the equitable use of intellectual property rights. Alternatively, a waiver of intellectual property right barriers or enabling open access for scientific collaboration may be issued to achieve specific outcomes aimed at addressing health challenges such as COVID-19. A number of approaches may be used to ensure the equitable use of intellectual property rights for scientific collaboration.

Access to benefits and sharing

56. Access to benefits and sharing links access to genetic resources and traditional knowledge to the sharing of monetary and non-monetary benefits, which may include joint ownership of intellectual property rights. The international regime on access to benefits and sharing is defined and governed by the Convention on Biological Diversity[77] and the Nagoya Protocol[78] of the United Nations, with the objective of fostering mutually beneficial collaboration with those providing genetic resources and those seeking to produce and commercialize products essential to human welfare such as pharmaceuticals. For developing countries, this mechanism can be greatly beneficial in harnessing technology transfer and know-how to address neglected diseases and advance sustainable development.

57. Several intellectual property rights models have been adopted in access to benefits and sharing agreements, but what is more common is the existence of companies with sole ownership of intellectual property. For example, in the partnership between Diversa Corporation, the Kenya Wildlife Service and the International Centre of Insect Physiology and Ecology in Kenya, Diversa retains intellectual property rights over any products that it develops, provided that the International Centre of Insect Physiology and Ecology and

[74] Contribution of Cuba, available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c04_HB_Cuba_es.pdf.

[75] Contribution of ECLAC, available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c05_H_ECLAC_en.pdf.

[76] UNCTAD, 2014, The Convention on Biological Diversity and the Nagoya Protocol: Intellectual Property Implications, UNCTAD/DIAE/PCB/2014/3, Geneva.

[77] United Nations Environment Programme, 1992, *Convention on Biological Diversity*, article 15 – access to genetic resources, available at https://www.cbd.int/convention/articles/?a=cbd-15.

[78] Secretariat of the Convention on Biological Diversity, 2011, Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization to the Convention on Biological Diversity, available at https://www.cbd.int/abs/doc/protocol/nagoya-protocol-en.pdf.

Kenya Wildlife Service have the option of a royalty free licence that allows them to research, develop and otherwise make use of any products or inventions developed from the material supplied within the jurisdiction of Kenya.[79]

58. However, various challenges and shortcomings surrounding the access to benefits and sharing approach have become known in recent years, including the fact that both commercial and non-commercial research requires substantial investments of time, money and capacity to receive permits, as well as the reality of signing access to benefits and sharing agreements in countries where the legal and administrative practices are more challenging than what might otherwise be expected. Parties wishing to share in intellectual property from a successful development should be prepared to make a significant financial investment to share the risk of failure, but such investments are often beyond the reach of many providing institutions.[80] One possibility to offset this obstacle is through the provision of public funding from national and international agencies to be directed towards efforts in creating an enabling environment for scientific research in developing countries. This could provide a financial backstop through research grants and subsidies for international scientific partnerships. Some developing countries also face limitations in institutional capacity and intellectual property rights protection, which can present further challenges. This is particularly problematic, given that intellectual property rights generally tend to be given prominence as a mechanism for benefit-sharing in access to benefits and sharing agreements, over and above the frequently more concrete gains of building domestic scientific and technological capacity.[81]

59. Another issue is the fact that, while access to benefits and sharing has provided an international policy dialogue on ethics and equity in research, ownership and control of genetic resources and traditional knowledge, capacity-building, technology transfer and other issues, there is further scope to expand on issues relating to equity in broader science and technology. For example, only parties to the Convention on Biological Diversity make decisions about scientific research practices that can have impacts far afield from biodiversity.[82]

Patent pools

60. A patent pool is an agreement between two or more patent holders to aggregate or pool their respective technologies and license them as a single package, either by the group of owners or by a separate entity specifically created for that purpose.[83] Patent pools can create a freedom-to-operate environment for relevant technologies, consolidated in one package, giving pool members and licensees the opportunity to utilize the collection of technologies included in the pool, both to bring new products to market, thereby facilitating competition in the marketplace, and to carry out further research and development, in order to facilitate innovation. Patent pooling is much more likely to be of relevance when multiple overlapping (and often complementary) patents operate in the same space. In the instance where patent applications are filed in the same field by a number of organizations, as was the case with the genomic sequence of the severe acute respiratory syndrome coronavirus, this is likely to result in a fragmentation of intellectual property rights, which in turn may adversely affect the development of products such as vaccines to combat the

[79] Secretariat of the Convention on Biological Diversity, 2008, Access and Benefit-Sharing in Practice: Trends in Partnerships Across Sectors, Montreal, Technical Series No. 38.

[80] Weiss C and Eisner T, 1998, Partnerships for value added through bioprospecting, *Technology in Society*, 20:481–498.

[81] Secretariat of the Convention on Biological Diversity, 2008.

[82] Laird S, Wynberg R, Rourke M, Humphries F, Ruiz Muller M and Lawson C, 2020, Rethinking the expansion of access and benefits sharing, *Science*, 367(6483):1200–1202.

[83] Krattiger A and Kowalski S, 2007, Facilitating assembly of and access to intellectual property: focus on patent pools and a review of other mechanisms, in Anatole Krattiger et al. (eds.), *Intellectual Property Management in Health and Agricultural Innovation: A Handbook of Best Practice*, MIHR, Oxford, United Kingdom, and PIPRA, Davis, California, United States of America: 131–144.

disease.[84] Consolidating these patents into a patent pool to be licensed on a non-exclusive basis may circumvent these problems and thereby lead to public health benefits.

61. Various international organizations and non-profits, such as WHO and the Medicines Patent Pool, have recently established patent pooling mechanisms to facilitate access to COVID-19 intellectual property, knowledge and data. However, there is a risk that patent pools could be both anticompetitive (if they encourage collusion and shield weak patents), and anti-innovative (if they do not include all necessary patents or are poorly managed and inadequately resourced).[85] It is also important to highlight the structural and legal complexities surrounding patent pools, as became evident during the severe acute respiratory syndrome outbreak in the early 2000s. Researchers had initially agreed to pool their patents to help find vaccines and treatments against severe acute respiratory syndrome, but the negotiations over details took so long that the outbreak was contained before the patent pool was ever formalized.

Intellectual property rights pledges

62. Voluntary pledges to make intellectual property rights broadly available to address urgent public health crises can overcome administrative and legal hurdles faced by more elaborate legal arrangements, such as patent pools, and achieve greater acceptance than governmental compulsory licensing.[86] COVID-19 has prompted both Governments and intellectual property rights holders around the world to seek ways to increase the availability of intellectual property rights necessary to combat the pandemic. Two examples of single organizations that have pledged patents for specific products related to the fight against COVID-19 include Medtronic (ventilators) and AbbVie (therapeutics). These pledges and the licences that are associated with them are irrevocable once granted and legally enforceable under precedents that have been recognized in jurisdictions around the world.[87] It is, however, important to highlight that many pledges relating to patented technologies may include a limited product range, scope of use and duration. For example, they may be limited to the most basic ventilators only for the duration of the COVID-19 pandemic and a short period thereafter.

C. Strengthening multilateral cooperation

63. The United Nations and its specialized agencies have an important role in shaping global norms and frameworks on health innovations. The overabundance of possibly inaccurate health information online can make it difficult for societies to have access to trustworthy and reliable guidance on the pandemic.[88] In this context, it is important that the international community have a better understanding of the risk-reward trade-offs of artificial intelligence in medicine, gene editing and other new and emerging health innovations and continue discussions on appropriate normative frameworks to guide their development and use. Several entities are actively leveraging multilateral cooperation in the domain of science, technology and innovation and health, which is evidently a crucial domain of the global commons. Member States of ESCAP,[89] the Committee on the Peaceful Uses of Outer Space – an intergovernmental platform which has the Office for Outer Space Affairs as its secretariat – and the Member States of the Commission on Science and Technology for Development are all examples of this.

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84 Simon et al., 2005, Managing severe acute respiratory syndrome (SARS) intellectual property rights: the possible role of patent pooling, Bulletin of the World Health Organization, 83:701–710.

85 Nicol D and Nielson J, 2010, Opening the dam: patent pools, innovation and access to essential medicines, in Thomas Pogge et al. (eds.), *Incentives for Global Public Health: Patent Law and Access to Essential Medicines*, Cambridge University Press: 235–262.

86 Contreras JL, Eisen M, Ganz A, Lemley M, Molloy J, Peters DM and Tietze F, 2020, Pledging intellectual property for COVID-19, *Nature Biotechnology*, 38:1146–1150.

87 Contreras JL, Jacob M (eds.), 2017, *Patent Pledges: Global Perspectives on Patent Law's Private Ordering Frontier*, Edward Elgar Publishing, Cheltenham, United Kingdom.

88 https://iris.paho.org/bitstream/handle/10665.2/52052/Factsheet-infodemic_eng.pdf?sequence=14.

89 Contribution of ESCAP (available at https://unctad.org/system/files/non-official-document/CSTD_2020-21_c08_H_ESCAP_en.pdf).

V. Suggestions for consideration by Member States and the Commission on Science and Technology for Development at its twenty-fourth session

64. The effective application of frontier or well-established science, technology and innovation tools in health care requires national capacities for health-care innovation. Key areas of policy consideration include investments in research, human capital and infrastructure, support for research and development commercialization and a whole-of-government and multisectoral approach. Global health requires global partnerships to support national actions and international efforts in combating disease. Priority areas for consideration include supporting national innovation ecosystems, improving the accessibility of health innovations, and building and strengthening multilateral and multi-stakeholder platforms for cooperation, knowledge sharing and standards-setting.

65. Member States may wish to consider the following suggestions:

(a) Strengthen innovation systems for health by investing in infrastructure, institutions and human capital and make innovation systems an integral part of long-term building back better strategies;

(b) Provide support to firms and research and development institutions in turning research and development into health-care products and services and in commercializing these products and services;

(c) Encourage a whole-of-government and multisectoral approach to ensure that science, technology and innovation policies are consistent with national health priorities and development plans;

(d) Consider a broader approach to innovation policy for health that includes socio-economic characteristics, knowledge flows (e.g. among formal and informal institutions), linkages and capabilities;

(e) Support and strengthen health information systems for knowledge sharing within and across Government and other sectors;

(f) Develop national readiness frameworks that incorporate science, technology and innovation and ICT as part of efforts to address health emergencies as well as early warning systems to detect health emergencies.

66. The international community may wish to consider the following suggestions:

(a) Support countries' efforts in developing national health innovation ecosystem, including building national capacities for digital technologies for health care;

(b) Work towards more equitable access to scientific knowledge and technologies;

(c) Continue to shape scientific networks and research and development for health care innovation including through supporting developing countries' participation in regional and global health research networks;

(d) Promote North–South, South–South and triangular cooperation on science, technology and innovation for health through joint research programmes and creation of new knowledge and technologies for local needs;

(e) Establish a framework for collaborative research and development by diverse specialists in veterinary medicine, medicine, agriculture, natural science, information science, social science and education about animal diseases, to detect global health emergencies.

67. The Commission is encouraged to take the following steps:

(a) Support multi-stakeholder collaboration, including North–South, South–South and triangular cooperation, in policy learning and capacity-building in research and technology development;

(b) Share best practices and lessons learned on the formulation of science, technology and innovation policies and strategies for health-care innovation, and the utilization of science, technology and data for health-related applications.