World Science Day for Peace and Development 2022

#ScienceDay

Basic Science for Sustainable Development

16 November 2022

Introduction

United Nations Educational, Scientific and Cultural Organization (UNESCO) in collaboration with the Commission on Science and Technology for Sustainable Development in the South (COMSATS), the Organization of Islamic Cooperation Standing Committee on Scientific and Technological Cooperation (COMSTECH), the Economic Cooperation Organization Science Foundation (ECOSF), the Pakistan Science Foundation (PSF) and the Pakistan Academy of Sciences (PAS), is planning to organize an event in celebration of World Science Day for Peace and Development on Wednesday, 16 November 2022, in Islamabad, Pakistan.

Background

The World Science Day for Peace and Development, celebrated every year on 10 November, was established by UNESCO in 2001 to highlight the important role of science in society and the need to engage the wider public in debates on emerging and important contemporary issues relevant to science. The theme of World Science Day for Peace and Development on 10 November 2022 is **Basic Sciences for Sustainable Development**. It is being celebrated within the International Year of Basic Sciences for Sustainable Development, which has been kicked off on 8 July 2022.

'The applications of basic sciences are vital for advances in medicine, industry, agriculture, water resources, energy planning, environment, communications and culture', affirmed the United Nations General Assembly on 2 December 2021, when it endorsed the proposal for an International Year of Basic Sciences for Sustainable Development. World Science Day is contributing to the Year in 2022 by celebrating this theme.

'We need more basic science to achieve *The 2030 Agenda* and its 17 Sustainable Development Goals', the United Nations General Assembly noted in December 2021. It is true that the share of domestic research expenditure devoted to basic sciences varies widely from one country to another. According to data from the UNESCO Science Report 2021 for 86 countries, some devote less than 10% of their research expenditure to basic sciences and others more than 30%.

Having a capacity in basic sciences is in the interests of both developed and developing countries, given the potential for applications to foster sustainable development and raise standards of living. For example, a growing number of people around the world suffer from diabetes. Thanks to laboratory studies of the ways in which genes can be manipulated to make

specific protein molecules, scientists are able to engineer genetically a common bacterium, *Escherichia coli*, to produce synthetic human insulin.

The ties between basic research and societal change

Also referred to as discovery research, or blue skies research, owing to its emphasis on the quest for knowledge as opposed to commercial applications, basic research has led to breakthroughs that have spawned not only new technologies but even entirely new fields of science. Here are some examples.

One of the most prominent examples of the ties between basic research and societal change is the transistor. When the first transistor radio came on the market in the early 1950s, it was the fruit of almost 50 years of basic research in public laboratories. The computer chip followed, the first integrated circuit. Since then, the miniaturization of integrated circuits has made it possible to manufacture ever-smaller mechanical, electronic and optical devices: today's smartphones use millions of miniscule transistors to perform complex processes.

The discovery of the double helical structure of DNA in 1953 laid the foundations for modern genetics and genomics. This discovery was followed, in 2003, by another breakthrough – the sequencing of the human genome – which provided insights into the mysteries of genetic variation, or why an individual's unique molecular and genetic profile makes them susceptible to a particular disease. This discovery helped to improve the treatment of genetic diseases and spawned the field of precision medicine, which tailors a medical treatment to the patient's individual characteristics.

Invented in 1983 by American biochemist Kary Banks Mullis, the polymerase chain reaction (PCR) is a technique used to copy tiny segments of DNA. PCR acts like a magnifying glass, making it easier to analyse these DNA segments. PCR has a wide range of applications. It can be used to detect the presence of bacteria and viruses, such as in food, water or patients. Over the past two years, PCR has been used countless times to test individuals for infection with Covid-19. PCR can also be used to detect a genetic disorder or to further our understanding of evolutionary relationships between different organisms. In forensics, PCR can be used to identify a criminal on the basis of a sample left behind at a crime scene, such as a hair follicle. Kary Banks Mullis was awarded the Nobel Prize for Chemistry in 1993 for his revolutionary discovery.

UNESCO's toolkit *Mathematics for Action: Supporting Science-Based Decision-Making* (2021) recalls that mathematical methods have been used during the Covid-19 pandemic to design vaccines more efficiently and to model vaccine hesitancy as a social phenomenon.

In chemistry, basic research is laying the foundations for 'green' applications such as innocuous alternatives to toxic chemicals and solvents, more energy-efficient chemical processes, biodegradable chemicals and waste and so on. One example of a new material to have emerged from basic science research is graphene; it has countless potential applications in industry. Isolated in 2004, graphene is ultra-light and much stronger than steel, yet extremely flexible. Graphene could be incorporated in rubber soles, for instance, to make shoes more durable.

Did you know that the flat screen on your television or cell phone is the fruit of basic research? The discovery of liquid crystals in 1888 would make it possible, more than a century later, to flatten the screens of televisions, computers and cell phones, once it was realized that liquid crystals could be used in display devices. Liquid crystals were first used in the 1960s in optical imaging devices. The liquid crystal does not produce light itself but rather draws on an external

source – such as the back light on a television – to form images, making for low-energy consumption. As so often happens in basic research, liquid crystals were discovered by accident.
One key challenge today is to transition to clean forms of energy. Hydrogen is already being used on an industrial scale but hydrogen energy is almost entirely supplied from coal and gas.[1] Converting water into hydrogen using artificial photosynthesis – by splitting water (H_20) into hydrogen and oxygen molecules – could offer a 'green' method of producing hydrogen energy.

A growing number of households are turning away from oil or gas heating towards solar, geothermal and wood pellet options. Biomass produced using the floating mangrove technology could provide an alternative to cutting down existing mangrove trees illegally to make wood pellets for charcoal production. UNESCO has developed a system of floating mangroves, in cooperation with Mourjan Marinas and Lusail City in Qatar. The system has been tested since 2012. The mangrove seeds have germinated, produced roots, stems, pneumatophores, leaves, bark, flower buds, flowers and even new seeds, in a floating system. The value of this new type of biomass is that it can be produced in coastal systems without the need for agricultural land. Moreover, no freshwater is required for irrigation, since mangroves are salt-tolerant. The market for wood pellets was worth an estimated US$10 billion in 2020, with pellets costing about US$250 per ton, depending on the wood quality. Mangrove wood pellets would, thus, have great market potential.

There is so much we can learn from observing nature. By studying the ways in which animals and plants have adapted to their environment, we can learn how to mimic these coping mechanisms in industry. For instance, the structure of lotus leaves is designed to keep the surface of the leaf clean and dry in damp conditions. Unable to penetrate the leaf, rainwater simply runs off the surface, taking any dirt with it. These properties have inspired coatings for aircraft cabins which reduce the amount of cleaning fluid required to wash away fingerprints and spillages left by hundreds of passengers.

Have you ever wondered how migrating birds are able to fly hundreds or even thousands of kilometres without ever touching land? These birds exploit warm, rising air currents – or 'thermals' – to fly and gain height without needing to flap their wings, thereby conserving energy. Since the landscape of these currents is complex and continuously changing, we do not yet have a good understanding of exactly how birds find and navigate thermals. Scientists at UNESCO's Abdus Salam International Centre for Theoretical Physics have used machine learning to identify navigation strategies that could cope with, and even exploit, turbulent fluctuations, using a learning strategy based on trial and error which combined numerical simulations of atmospheric flow with reinforcement learning methods. This type of basic research could aid in the development of energy-efficient long-distance autonomous gliders.

As *Mathematics for Action* recalls, mathematical models can also help to tackle the interrelated crises of climate change, biodiversity loss and water insecurity. They can quantify the value of ecosystem services and biodiversity of large estuaries, for example, and enable us to explore multiple "what-if" scenarios to inform the decision-making process. Scientists use climate models in combination with storylines to produce scenarios of plausible alternative futures. This approach is used, for example, in the reports produced by the Intergovernmental Panel on Climate Change to inform policy-makers of the science behind climate change and their options through plausible scenarii for the future.

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[1] SEE: INTERNATIONAL ENERGY AGENCY (2019) INTERNATIONAL ACTION CAN SCALE UP HYDROGEN TO MAKE IT A KEY PART OF A CLEAN AND SECURE ENERGY FUTURE, ACCORDING TO NEW IEA REPORT. WEB NEWS, 14 JUNE

Atmospheric sciences can make a vital contribution to sustainable development. Scientists in UNESCO's Intergovernmental Hydrological Programme have worked with the University of California, Irvine, in the USA, to develop an algorithm that can estimate real-time precipitation worldwide. This algorithm has enabled them to extract local and regional cloud features, such as coldness and texture, from an international constellation of satellites, in order to inform hydrological services on the ground about the risk of flooding, drought or storms and, thereby, improve emergency planning and management. This system is now available as the iRain application for mobile phones.

The University of Ghent in Belgium has an antenna in the Yangambi Biosphere Reserve in the Democratic Republic of Congo, which is part of UNESCO's World Network of 731 Biosphere Reserves. In March 2020, the university installed the Congoflux Tower, the first of its kind in the Congo BasinSome 55 m tall, the Congoflux Tower rises 15 m above the forest canopy as it collects data over a 1 km^2 radius on exchanges of water vapour and greenhouse gases such as carbon dioxide, nitrous oxide and methane between the atmosphere and the forest. These data will fill yawning gaps in our knowledge of the role that the forest plays in carbon sequestration and, thereby, in limiting climate change.

A number of UNESCO prizes reward giant leaps in basic research. These prizes include the Carlos J. Finlay Prize for Microbiology, the UNESCO-Equatorial Guinea Prize for Life Sciences and the L'Oréal-UNESCO Awards for Women in Science.

Activity

UNESCO in collaboration with COMSATS, COMSTECH, ECOSF, PSF and PAS is organizing an event on Wednesday, 16 November 2022.

Distinguished experts will cover the following areas of basic sciences:

- Physics
- Chemistry
- Biology
- Mathematics

Method and Timing

The celebration will be organized at the COMSTECH Auditorium on Wednesday 16 November 2022, and live streamed as well at 0900am (Pakistan time).

Participants

Scientists, students, teachers, researchers, science communicators who work in science centres and science museums, independent science communicators and science journalists.