

Concerted Technological efforts to contain and mitigate COVID-19

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Manifest pedagogy: As the pandemic has taken the whole world to halt, many dimensions of COVID 19 have to be explored. We will be covering those dimensions in our articles. Hence, the attention has to be paid all those dimensions.

Updated on 9th June 2020

In news: There are technological efforts going on worldwide to beat coronavirus.

Placing it in syllabus: Epidemics and human health

Dimensions:

- High Pressure Ventilator
- Mobile virology research lab
- CRISPR technology
- Sequencing of novel coronavirus
- Portable coronavirus detection kit
- Crystal structure of the main protease of the virus
- mRNA vaccine

Content:

High Pressure Ventilator:

- **NASA** engineers have developed high-pressure ventilators tailored **specifically to treat COVID-19 patients.**
- The device is **called VITAL (Ventilator Intervention**

Technology Accessible Locally).

- It is designed to treat patients with milder symptoms.
- It can be built faster and maintained more easily than a traditional ventilator and is composed of far fewer parts.
- It can be modified for use in field hospitals being set up in convention centres, hotels, and other high-capacity facilities across the globe.
- Like all ventilators, VITAL requires patients to be sedated and an oxygen tube inserted into their airway to breathe.
- However, **it wouldn't replace current hospital ventilators, which can last years** and are built to address a broader range of medical issues.

Mobile virology research lab:

- Defence Minister Rajnath Singh recently through a video conference inaugurated **mobile virology research and diagnostics laboratory (MVRDL)**.
- It has been **developed by the Defence Research and Development Organisation (DRDO)**, together with ESIC Hospital, Hyderabad and the private industry.
- The mobile lab will be **helpful in carrying out diagnosis of COVID-19** and in virus-culturing for drug screening, convalescent plasma-derived therapy, comprehensive immune profiling of patients towards vaccine development and early clinical trials specific to Indian population.
- It is a **combination of a biosafety level (BSL)-3 lab and a BSL-2 lab** and can process 1,000-2,000 samples a day.
- The first such MVRDL was developed by the Research Centre Imarat (RCI), Hyderabad, in consultation with ESIC Hospital.

Sequencing of novel coronavirus:

- As on April 7, India has shared nine whole genome sequences of the novel coronavirus with the **Global**

Initiative on Sharing All Influenza Data (GISAID), a public platform started by the WHO in 2008 for countries to share genome sequences.

- **All the sequences have been shared by the Pune-based National Institute of Virology.**
- So far, 3,086 sequences of the virus isolated from humans have been shared by 57 countries.
- **With 621, the U.S. has shared the most number of sequences, followed by the U.K., Belgium and China.**
- Sequencing the genome of SARS-CoV-2 will **help understand where the virus came from, if there are different strains circulating in India and how the virus has spread.**

CRISPR technology:

- A new **kit based on clustered regularly interspaced short palindromic repeats (CRISPR) technology** that tests for the novel coronavirus in an hour's time is available.
- The testing kit is developed by biotechnology firm **Sherlock Biosciences.**
- The kit is based on the **CRISPR-based SHERLOCK** (*Specific High Sensitivity Enzymatic Reporter UnLOCKing*) **technique.**
- It has **received Emergency Use Authorisation** by the United States' Food and Drug Administration (FDA) on May 7, 2020.
- It **does not give false negative or false positive results** and has high sensitivity and specificity.
- The **genetic material from the RNA of the virus does not need to be converted to DNA** unlike RT-PCR based tests.
- This is the **first time a CRISPR-based tool has been used as a diagnostic.**
- The test only needs basic equipment found in most labs.
- The test has **three steps:**
 1. Genetic material is extracted from the patients' sample and is amplified using a commercially

available **polymerase amplification kit**, which takes 25 minutes.

2. The amplified viral sample is then incubated with and detected with **Cas13** (an RNA editing technique), which takes 30 minutes.
3. A commercially available **paper dipstick is then used to confirm the presence of the virus**. This confirmation can be done through the naked eye and takes around two minutes.

Portable coronavirus detection kit:

- Researchers from the **National Institute of Animal Biotechnology (NIAB), Hyderabad**, have developed a **biosensor** that can detect the novel coronavirus in saliva samples.
- The **new portable device named eCovSens, can be used to detect the presence of novel coronavirus antigens in human saliva within 30 seconds** using just 20 microlitres of the sample.
- The biosensor **consists of a carbon electrode and the coronavirus antibody**.
- The antibody is capable of binding with the spike protein found on the outer layer of the virus.
- An **electrical signal is generated when the antigen and antibody binds**.
- Electrical components in the device further amplify this signal, process it, convert it to digital readings on an LCD display.
- The device can also be connected to a computer or cellphone via Bluetooth and studied.
- The **device can also be battery-operated**.

Crystal structure of the main protease of the virus:

- A **team led by Rolf Hilgenfeld from the University of Lubeck, Germany** has developed the crystal structure of the main protease of the coronavirus.

- **Main virus protease is an enzyme that processes proteins critical to virus development.**
- An antiviral that blocks this enzyme effectively prevents the virus from replicating.
- The inhibitor against the main protease targets a specific region of the enzyme.
- And any antiviral that targets this region of the enzyme will be specific to the virus and will not be toxic to human cells.

Messenger-RNA (mRNA) vaccine:

- A messenger-RNA (mRNA) vaccine is **being tested at Seattle, US in a Phase-1 clinical trial on 45 healthy volunteers between the ages of 18 to 55 years over a period of approximately six weeks.**
- The study is evaluating different doses of the experimental vaccine for safety and its ability to induce an immune response in participants.
- The **first vaccine to enter human trials is mRNA-1273**, was developed by **National Institute of Allergy and Infectious Diseases (NIAID)**, U.S scientists and their collaborators at the biotechnology company Moderna, Inc.
- Unlike a usual vaccine, **RNA vaccines work by the introduction of an mRNA sequence into the host's cells.**
- This mRNA codes for a **disease-specific antigen.**
- Once inside a cell, the mRNA instructs the cell to produce the antigen, which is recognised by the immune system which makes an antibody or cellular response.
- Currently, **two forms of mRNA vaccines are being developed** against multiple pathogens: *conventional mRNA vaccines and self-amplifying mRNA vaccines, which are derived from positive strand RNA viruses.*
- The mRNA can be made synthetically by in vitro transcription or reading of a plasmid DNA template, with a recombinant RNA polymerase.
- **Though the virus is not required, the genome sequence of**

the virus is needed.

- The messenger RNAs are produced synthetically and this is what makes the technology rapid and reproducible.

Mould your thought: Discuss the recent technological developments to contain and mitigate COVID-19.

Previous article

In news: COVID 19 is declared pandemic by WHO.

Placing it in syllabus: Health and diseases

Dimensions:

- What are coronaviruses?
- Symptoms
- Basic protective measures to be taken
- Stages of transmission
- Number of cases detected
- Treatment options available now

Content: A novel strain of coronavirus, **SARS-CoV-2** was **first detected in December 2019 in Wuhan**, a city in China's Hubei province. The virus has now spread to over 200 countries and territories across the globe and was **characterised as a pandemic by the WHO on 11 March 2020.**

As of 2nd April 2020, there were 896,450 laboratory-confirmed cases of coronavirus disease 2019 (COVID-19) infection, with 45,525 reported deaths.

What are coronaviruses?

- SARS-CoV-2 belongs to a **family of single-stranded RNA viruses known as coronaviridae**, a common type of virus which affects mammals, birds and reptiles.
- Coronaviruses can cause enteric and neurological

diseases.

- **Previous coronavirus outbreaks** include Middle East respiratory syndrome (**MERS**), first reported in Saudi Arabia in September 2012 and severe acute respiratory syndrome (**SARS**), identified in southern China in 2003.
- The case fatality rates for these conditions were 35% and 10%, respectively.

- **SARS-CoV-2 is a new strain of coronavirus that has not been previously identified in humans.**

- The United States Centers for Disease Control and Prevention indicate that **symptoms may appear in as few as 2 days or as long as 14 days after exposure (incubation period).**
- Chinese researchers have indicated that SARS-CoV-2 may be **infectious during its incubation period.**
- Originally, the virus was understood to have originated in a food market in Wuhan and subsequently spread from animals to humans.
- However the **exact animal origin is not clear.**

Symptoms: The COVID-19 virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes.

Common symptoms include:

- Fever
- Tiredness
- Dry cough

Other symptoms include:

- Shortness of breath
- Aches and pains

- Sore throat
- Diarrhoea, nausea or a runny nose.

Older people and those with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are **more likely to develop serious illness.**

Basic protective measures to be taken:

- Washing hands frequently with an alcohol-based hand rub or with soap and water.
- Maintain social distancing of at least 1 metre (3 feet) between oneself and anyone who is coughing or sneezing.
- Avoid touching eyes, nose and mouth as the virus can enter the body and can make one sick.
- Practicing respiratory hygiene i.e. covering mouth and nose when one cough or sneeze as droplets spread virus.
- If one experiences fever, cough and difficulty in breathing, seek medical care early.
- Stay informed and follow advice given by one's healthcare provider.



Stages of transmission: As per the WHO, there are **four stages** of the pandemic novel coronavirus outbreak around the globe.

- **Stage 1 is when cases are imported from affected countries.** In this stage, the virus doesn't spread locally – cases reported are usually due to the people who have a travel history to an affected country. Stage one sees only these test positive.
- **When it comes to stage two, people who have brought the virus into the country transmit it to people they come in contact with,** usually friends and family. The source of the virus in the second stage is known and it is easier to trace the chain and quarantine people.
- The **third stage, community transmission,** is when the source of the virus is untraceable. This stage is

identified when people who haven't had travel history to the affected place, get diagnosed with the virus. Once we reach this stage, spread is extremely contagious and difficult to control.

- **Stage four occurs when the spread of the virus goes out of control** and there are many major clusters of infection all over the country.

Number of cases detected: As of 4th April, 2020 the number of cases of the novel coronavirus across the globe crossed 1,118,059 and the global death toll surpassed 59,206. The **highest number of cases have been reported from the US** at 277,161 (7,392 deaths) and more than half of all the cases have been in Europe, with Italy and Spain worst affected.

India crossed 3000 Covid-19 cases with 75 deaths. At least 42 per cent cases are among people between 21-40 years of age and 32 per cent in the 41-60 year category.

At this time, there are no specific vaccines or treatments for COVID-19. However, there are many ongoing clinical trials evaluating potential treatments.

Treatment options available now:

- Those who get admitted to hospital are given treatment for their symptoms while their immune systems try to fight the virus off.
- Patients are isolated to stop the virus spreading.
- Patients are given oxygen and in the worst cases may be put on a ventilator.

Some treatment options that are currently being investigated are:

Remdesivir

- Remdesivir is an experimental broad-spectrum antiviral drug originally designed to target Ebola.

- Researchers have found that remdesivir is highly effective at fighting the novel coronavirus in isolated cells.
- This treatment is not yet approved in humans, but two clinical trials for this drug have been implemented in China.
- One clinical trial was recently also approved by the FDA in the United States.

Chloroquine

- Chloroquine is a drug that's used to fight malaria and autoimmune diseases.
- At least 10 clinical trials are currently looking at the potential use of chloroquine as an option for combating the novel coronavirus.

Lopinavir and ritonavir

- Lopinavir and ritonavir are sold under the name Kaletra and are designed to treat HIV.
- In South Korea a combination of these two drugs had a significant reduction in a patient's levels of the coronavirus.
- According to WHO, there could be benefits to using Kaletra in combination with other drugs.

APN01

- The scientists who first developed APN01 in the early 2000s discovered that a certain **protein called ACE2 is involved in SARS infections.**
- This protein also helped protect the lungs from injury due to respiratory distress.
- From recent research, it turns out that **COVID 19 also uses the ACE2 protein to infect cells in humans.**

Favilavir

- **China has approved the use of the antiviral drug**

Favilavir to treat symptoms of COVID-19.

- The drug was initially developed to treat inflammation in the nose and throat.
- The drug has supposedly shown to be effective in treating COVID-19 symptoms in a clinical trial of 70 people.