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GIST OF DOWN TO EARTH MAGAZINE

MARCH 2022 EDITION

PART-I

Important Articles Simplified!

How Green is Blue Hydrogen?

Our Cosmic Roots

Covid-19 Becoming Endemic!

Russia-Ukraine Conflict and Climate Change

mRNA Vaccine Breakthrough

Nuclear Race

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1. "How Green is Blue Hydrogen?"

Relevance

"GS 2: Government Policies & Interventions"

"GS 3: Environmental Pollution & Degradation, Growth & Development, Conservation"

Context

- **Reliance Industries** on **February 12, 2022,** announced an intent to become **"the world's top blue hydrogen producer"** by repurposing a **R30,000** crore synthetic gas plant to manufacture the fuel.
- Globally, there is an increased interest in blue hydrogen. Earlier this year, the EU included it under clean fuels, while the US state of New Mexico introduced a Bill to encourage its production.
- The **International Energy Agency** says at least 50 blue hydrogen projects are under development.

Why Hydrogen is preferred?

- Hydrogen is in focus because it is a clean source of energy and the most abundant element.
- Hydrogen is the most abundant element on the planet, but rarely in its pure form which is how we need it.
- But hydrogen does not exist on its own. It is mostly present in water in the oceans and needs to be extracted to be used as a fuel.
- On combustion it generates energy in the form of heat, releasing only water as a by-product.
- It has an energy density almost three times that of diesel.

What Decide Green, Blue, Pink etc.?

- Most commonly, hydrogen is extracted from water by **electrolysis** wherein current is passed through water to split hydrogen and oxygen.
- The source of power used for extraction decides how clean the hydrogen is, and prefixes such as **green, blue, grey, pink** indicate this.
- While green hydrogen means the fuel was extracted using **renewables,** blue hydrogen is extracted from **natural gas.**
- This is not considered to be clean since extraction of natural gas invariably results in atmospheric leakage of methane, a gas with 25 times the warming potential of carbon dioxide.
- Electric current from fossil fuel gets yellow hydrogen and from nuclear power gets pink hydrogen.

What is wrong with Blue Hydrogen?

- **Blue hydrogen** is hydrogen produced from natural gas with a process of steam methane reforming, where natural gas is mixed with very hot steam and a catalyst.
- A chemical reaction occurs creating hydrogen and carbon monoxide. Water is added to that mixture, turning the carbon monoxide into carbon dioxide and more hydrogen. If the carbon dioxide emissions are then captured and stored underground, the process is considered **carbon-neutral,** and the resulting hydrogen is called **"blue hydrogen."**
- But there's some controversy over blue hydrogen because natural gas production inevitably results in methane emissions from so-called **fugitive leaks,** which are leaks of methane from the drilling, extraction and transportation process.
- Methane does not last in the atmosphere as long as carbon dioxide, but it is much more potent as a greenhouse gas. Over 100 years, one ton of methane can be considered to be equivalent to **28 to 36 tons of carbon dioxide**, according to the **International Energy Agency.**

2. "Our Cosmic Roots"

Relevance

"GS 3: Space Technology"

Context

Recently, the **James Webb Space Telescope (JWST) or Webb** opened its 18 golden mirrors to the universe and captured its first image—of a sun-like star called **HD-84406**, some **260 light-years** from the Earth.

When the telescope was launched?

- The telescope was launched on **December 25, 2021.**
- It took **30 days to travel 1.5 million km from Earth** in a direction opposite to the Sun to reach its destination—a gravitationally stable point named **L2**—from where it will orbit the Sun, slightly changing its position every three weeks to stay in a halo orbit.
- **NASA** states the aim of the telescope is to **examine the formation of galaxies and the evolution of our own solar system.**

About James Webb Space Telescope (JWST) or Webb

- US space agency NASA took 30 years to build the telescope.
- The telescope was named after NASA's second administrator James E Webb.
- JWST in its formative stages in the 1990s was called the Next Generation Space Telescope.
- It is based on infrared light and can see events from 13.5 billion years back in time.
- This is right after the Big Bang, when a single, unimaginably hot and dense point called the singularity exploded to form the Universe.
- Its observations of the earliest galaxies could be instrumental in understanding life today.

James Webb Space Telescope (JWST) vs Hubble Telescope

- Webb often gets called the replacement for Hubble but actually it's a **successor.**
- Webb's science goals were motivated by results from Hubble.
- Hubble's science pushed us to look to longer wavelengths to **"go beyond"** what Hubble has already done.
- In particular, more distant objects are more highly redshifted, and their light is pushed from the UV and optical into the near-infrared.
- Thus observations of these distant objects (like the first galaxies formed in the Universe, for example) requires an infrared telescope.
- This is the other reason that Webb is not a replacement for Hubble; its capabilities are not identical.
- Webb primarily looks at the Universe in the infrared, while Hubble studies it primarily at optical and ultraviolet wavelengths (though it has some infrared capability).
- Webb also has a much bigger mirror than Hubble.
- This larger light-collecting area means that Webb can peer farther back into time than Hubble is capable of doing.
- Hubble is in a very close orbit around the earth, while Webb will be 1.5 million kilometres (km) away at the second Lagrange (L2) point.

Why should we know about the early universe?

- learning about the very early universe is still an important goal because it traces our cosmic roots.
- One of the biggest mysteries in the study of the cosmos is: **What happened before the Big Bang?** Einstein's theory of gravity breaks down at the **singularity of the Big Bang.** We currently do not have a working theory that unifies quantum mechanics and gravity that could take us through that singularity.
- Some people are also searching for clues about the very beginning in the cosmic microwave background (residual electromagnetic radiation from an early stage of the universe) and in the distribution of galaxies.
- Of course, there is also the question of how and when the stars and galaxies formed.
- We, humans, are possible thanks to heavy elements like carbon or oxygen that were produced in stars, not the Big Bang. So tracing our cosmic roots will bring us to the period when the first stars formed and enriched the environment with heavy elements. In a way, it's the scientific version of the **story of Genesis.**

Conclusion

JWST could be helpful in measuring the expansion rate of the universe versus cosmic time, by looking at very distant supernovae. This would allow us to set limits to detect dark energy evolution over time, and in much the same spirit also set limits on dark matter. The more data we get, the better our limits on nature can be.

3. "Covid-19 Becoming Endemic!"

Relevance

"GS 2: Health, Issues Arising Out of Design & Implementation of Policies, Government Policies & Interventions"

Introduction

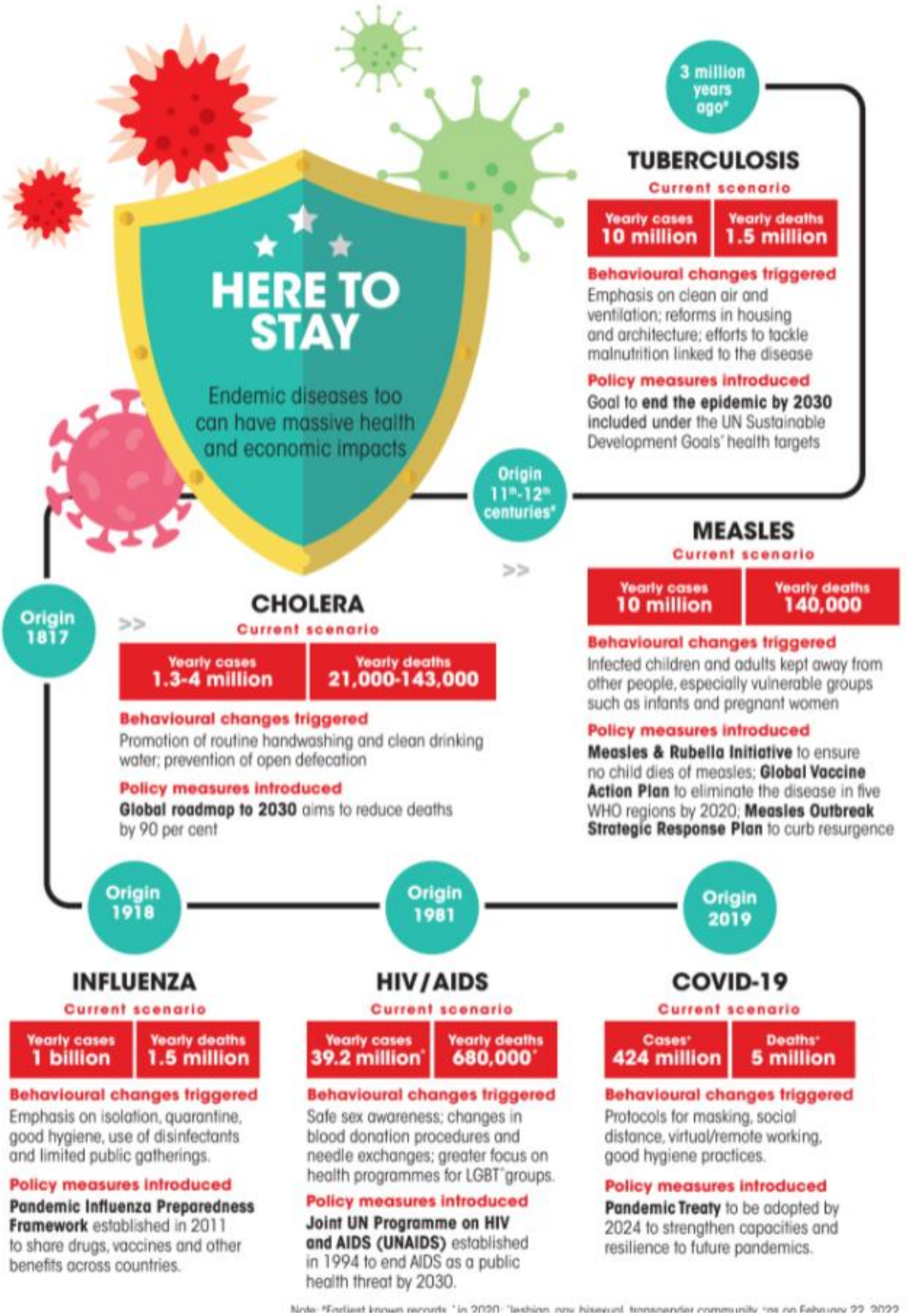
- It's been **two years** since the **World Health Organization,** on **March 11, 2020,** officially declared a global pandemic.
- All pandemics end eventually, but the virus does not necessarily die out—so far, **smallpox** is the only infectious disease afflicting humans that the world has completely eradicated.
- At present, India appears to have reached the endemic stage as far as its daily COVID-19 cases are concerned.
- In this stage, the population essentially learns to live with the disease.
- Most others become endemic and either remain dormant or keep circulating at very low levels— ready to re-emerge at a moment's notice.
- Many diseases, including **influenza, measles, hiv/aids, cholera, malaria, chikungunya and dengue** are considered endemic but continue to kill hundreds of thousands of people every year.
- **Malaria,** for example, is endemic in many parts of sub-Saharan Africa and causes an estimated 200 million cases every year, with about 600,000 deaths. Similarly, an estimated 2.6 million deaths occur each year because of **measles.**

What does endemic mean?

- The word **"endemic"** comes from the Greek word **endēmos, which means "in the population."**
- In epidemiology, it means that the disease is always present at a baseline level. So it's not down to zero. There are observable cases.
- But unlike a pandemic or epidemic, in which a disease's behaviour is often surprising or unexpected, an illness that has become endemic has become more predictable.
- **Epidemiologically,** Covid-19 can also be defined as endemic when it exists at a predictable level that does not require society-defining interventions.

What's next for COVID-19?

- Similar to the previous viruses that have caused pandemics, the COVID-19-causing **SARS-CoV-2** will also keep on developing **mutations.**
- Some of these mutations may possibly cause some antigenic drift and lead to minor or major outbreaks.
- So watchfulness, disease surveillance and gene sequencing of a sample of viruses must continue so that we will not be taken by surprise by a mutant variant.



Possibility of 4th Wave in India

- Some statistical models have already begun making predictions on when the fourth wave will hit India, albeit in the midst of debates over whether a fourth wave will occur at all.
- The wave will depend on factors such as the emergence of new coronavirus variants, the population's vaccination status, and the administration of booster doses.

Way Forward

- Covid-19 pandemic has made it explicitly clear that gains made in disease control are fragile. Unless health systems are strong. So we need to strengthen our **health infrastructure.**
- **Testing and treatment** must be made available to the most vulnerable—those with diabetes and other non-communicable diseases and with existing conditions of the lung, kidney and liver, whose immune response is not strong despite vaccination.
- Covid appropriate behaviour should always be followed in crowded places.
- In open markets, COVID-19 vaccines are more expensive. Prices can be reduced by allowing competition.
- The experience of conducting adult and adolescent vaccination drives must be used in initiatives for diseases like **hepatitis B, cervical cancer and pneumococcal pneumonia.**

Conclusion

It's important to remember that endemic is **not synonymous with harmless.** Malaria, for example, is considered endemic in a number of countries. In 2020, the World Health Organization tallied 627,000 deaths from this mosquito-borne disease. So, we can't lower our guards.

4. "Russia-Ukraine Conflict and Climate Change"

Relevance

"GS 3: Disaster Management, Environmental Pollution & Degradation, Environmental Impact Assessment (EIA)"

Context

- Recently, more than **1,000 people** and organizations from **75 countries** issued an open letter through the **Environmental Peacebuilding Association** to express their solidarity with Ukraine as it faces attacks from Russia — and their **concern over the environmental and humanitarian** toll of the war.
- Recently, the **United Nations Intergovernmental Panel on Climate Change** released a report saying that climate breakdown is occurring faster than previously thought and parts of the world will become unlivable in the next few decades if action isn't taken now.

Key Concerns

- Russia's invasion of Ukraine is causing **air, ground, and water pollution** that will be long-lasting.
- In addition, **risks for contamination and health problems** arise when nuclear sites are disturbed.
- The current crisis could also affect **future climate policy** by diverting resources and attention.
- In the **short term**, environmental emergencies could result from damage or disruption to energy or industrial facilities.
- But in the **long term**, the region could see weakened environmental governance, and the conflict's environmental issues could go unaddressed as the government faces multiple problems.
- **"Transboundary disputes"** over control of resources like **water or risk management** of hazardous facilities could happen if Russia permanently occupies more areas of Ukraine.

Research Work Halted in the Russian Arctic

- One of the most significant impacts of the Russia-Ukraine Crisis for the future of global warming is unfolding thousands of miles away in the Arctic, where vital research on carbon emissions just came to a screeching halt.

Importance Of Research in Arctic Region

- After the **Amazon rainforest,** the **Arctic is the second-largest carbon sink** in the world, locking approximately **1.5 trillion** metric tons of organic carbon—twice as much as Earth's atmosphere currently holds—under thick layers of frozen soil and ancient plant matter called permafrost.
- The region is warming four times faster than the rest of the planet.
- This is one of the largest and most vulnerable carbon pools on the planet.
- As the ***Arctic heats up, the permafrost thaws, releasing stores of planet-warming carbon and methane gasses in a continuous feedback loop that threatens to turn the Arctic into a net carbon emitter, instead of a carbon sink, locking the planet on a cataclysmic climate trajectory.***
- We cannot just ignore what is happening with permafrost in Russia. It's a massive blind spot.
- An intensifying conflict in Ukraine, however, could have repercussions in the Arctic that go way beyond the permafrost study.

War displaced climate change from the political agenda

- The war and need for Russia's resources seem to have displaced climate change from the political agenda.
- War and politics are complicating the efforts of the two biggest polluters in history — the United States and Europe — **to slow down global warming.**

Targeting nuclear sites poses health and environmental risks

- On **February 24,** Russia took control of **Chernobyl,** the site of a nuclear power plant where an explosion in **1986** sent radioactive material into areas nearby.
- Taking of Chernobyl **"incredibly alarming,"** as it stirred up radioactive dust and increased the detectable levels of radiation at the site recently.

Conclusion

Although the **physical, biological, and chemical damage** due to the current conflict, in short term, remains confined to Ukraine, the long term effect will reverberate far beyond. While presently Europe scramble for energy supplies to replace Russia's fossil fuels, the long-term impact of this war could and should be increased demand for **renewable energy.**

5. "mRNA Vaccine Breakthrough"

Relevance

"GS 3: Health"

Introduction

- Recently, **South African scientists** established their **first COVID mRNA vaccine technology transfer hub.**
- South Africa has proved that with a little bit of financial help from the rich nations and technological aid from the **World Health Organization (who),** it can do what the developed nations have done.
- This is a huge morale-booster for Africa, which exemplifies the glaring inequity in access to vaccines, with close to 90 per cent of the population yet to get even a single dose.
- The first African countries selected to receive the technology necessary to produce mRNA vaccines against COVID-19 are **Egypt, Kenya, Nigeria, Senegal, South Africa and Tunisia.**

Key Facts About COVID-19 mRNA Vaccines

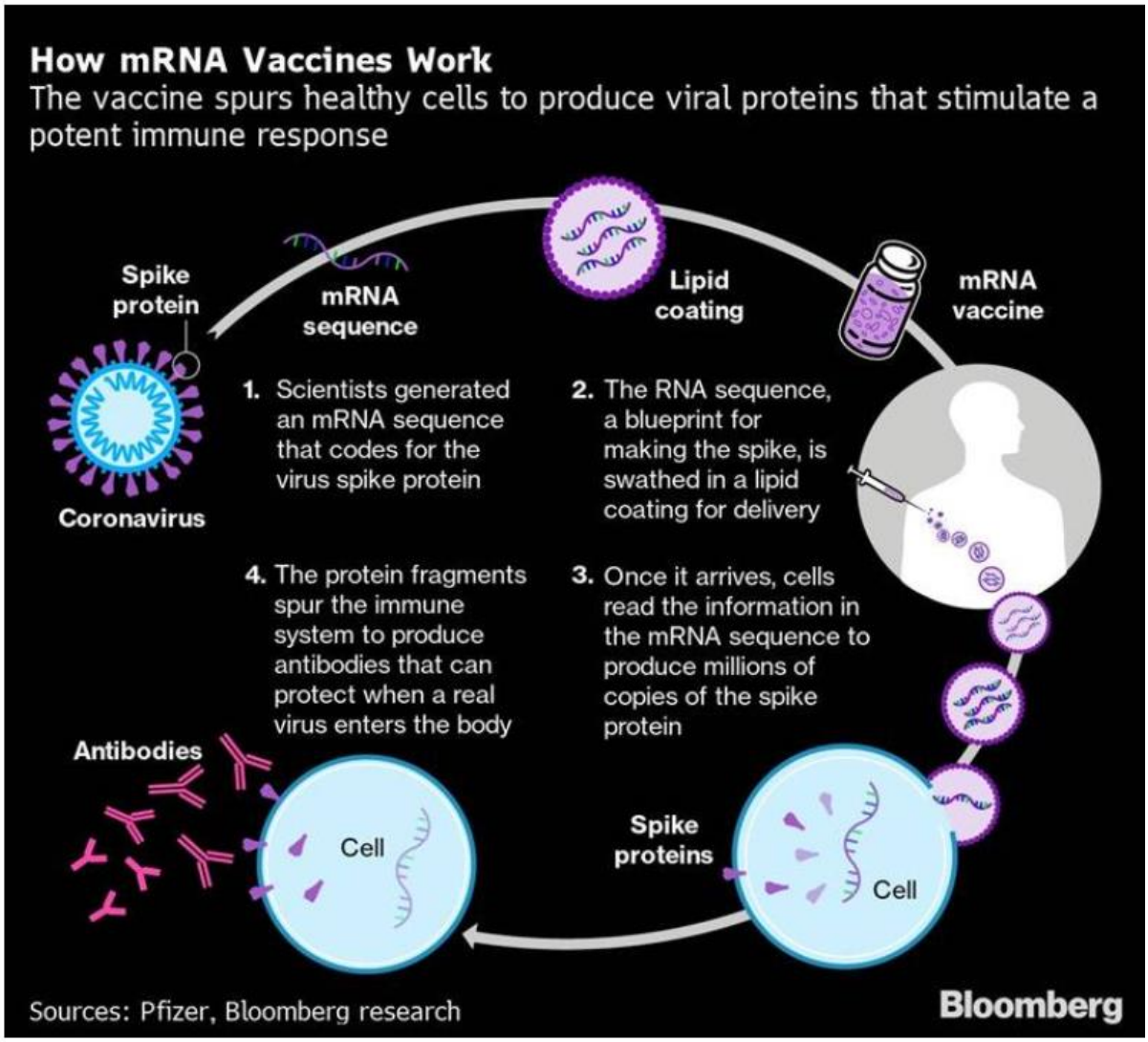
- mRNA vaccines **do not use the live virus** that causes COVID-19 and cannot cause infection with the virus that causes COVID-19 or other viruses.
- mRNA **never enters the nucleus of the cell where our DNA (genetic material) is located,** so it cannot change or influence our genes.
- Our cells break down mRNA and get rid of it within a few days after vaccination. Scientists estimate that the spike protein, like other proteins our bodies create, may stay in the body up to a few weeks.

What is the global mRNA technology transfer hub?

- The WHO's global mRNA technology transfer hub was established in 2021 to support manufacturers in low- and middle-income countries to produce their own vaccines, ensuring that they have all the necessary operating procedures and know-how to manufacture mRNA vaccines at scale and according to international standards.
- Primarily set up to address the COVID-19 emergency, the hub has the potential to expand manufacturing capacity for other products as well, putting countries in the driver's seat when it comes to the kinds of vaccines and other products they need to address their health priorities.
- The **WHO mRNA technology transfer hub** is part of a larger effort aimed at empowering **low- and middle-income countries** to produce their own vaccines, medicines and diagnostics to address health emergencies and reach universal health coverage.

What is mRNA?

- Messenger ribonucleic acid, or mRNA for short, is a single-stranded molecule that carries genetic code from DNA to a **cell's protein-making machinery.**
- Without mRNA, our genetic code wouldn't be used, proteins wouldn't be made, and your body wouldn't work.
- If **DNA is the bank card, then mRNA is the card reader.**
- The mRNA, in this case, is coded to tell the cells to recreate the spike protein of the coronavirus **SARS-CoV-2,** which causes Covid-19.
- The genius of mRNA vaccines is there's no need to inject the antigen itself. Instead, these vaccines use the genetic sequence or "code" of the antigen translated into mRNA.



- It is the spike protein — which appears as spikes on the surface of the coronavirus — that initiates the process of infection; it allows the virus to penetrate cells, after which it goes on to replicate.
- A coronavirus vaccine based on mRNA, once injected into the body, will instruct the body's cells to create copies of the spike protein. In turn, this is expected to prompt the immune cells to create antibodies to fight it.
- These antibodies will remain in the blood and fight the real virus if and when it infects the human body.

Why mRNA based treatment is important?

- mRNA based treatment started in mid-90's and it has additional benefits over traditional vaccines.
- mRNA vaccines can be made and developed rapidly which is why vaccines of Moderna Inc and BioNTech/Pfizer were among the earliest to reach the highly regulated markets in the West.
- mRNA vaccines allow for a high degree of modulation including addressing cancer treatments.
- They are non-infectious causing lower side effects.

Conclusion

Future mRNA vaccine technology may allow for one vaccine to provide protection against multiple diseases, thus decreasing the number of shots needed for protection against common vaccine-preventable diseases.

6. 'Nuclear Race'

"GS 1: Mineral & Energy Resources"
"GS 3: Nuclear Technology"

Introduction

- The **space race** has nations on their toes as they chart ambitious plans to go **beyond the moon and Mars.**
- They are all betting big on **nuclear energy,** touted to be the **fastest and most efficient** means of venturing into deep space.
- **Nuclear batteries, Dubbed Radioisotope Thermoelectric Generators or RTGs**, have been powering spacecraft for more than six decades.

A tricky energy source

- While countries are betting on Nuclear Power to transition out of fossil fuels by **2030**, they are scared of it because of safety issues.
- Currently responsible for less than 10 per cent of the world's electricity generation, nuclear power plants have already reported three major disasters—**Three Mile Island, Chernobyl and Fukushima.**

Key Concerns

- Experts warn that the lack of a robust international regime governing space reactors is troubling as nations increasingly invest in nuclear energy in space.
- The **UN's Office for Outer Space Affairs** has provided a set of principles for deploying nuclear power sources in outer space. But it needs to establish guidelines for the safe use of **atomic energy.**
- Countries are also trying to develop spaceships that will use **nuclear energy as fuel.**

How Nuclear Batteries Works?

- They perform **two key functions:** providing power to keep the onboard instruments running and Supplying heat to protect the instruments from the cold environs of space.
- In **1961,** the **first RTG-**powered satellite, the **Transit 4A spacecraft**, took off from the US.
- Since then, several nuclear-powered missions have been launched, including 25 from the US. Russia has also invested in this technology.
- In 2013, China soft-landed its RTG-powered **Change 3** robot on the moon.
- **NASA's Perseverance rover,** which touched down on **Martian soil in 2021,** is also nuclear-powered.

Beyond RTGS

- The global discourse is now moving beyond RTGs.
- The US and China plan to set up a nuclear power reactor on the moon to provide electricity for astronauts camping on the **lunar body.**
- In **2021,** NASA invited proposals from industries to design nuclear power systems for **lunar applications.**
- **By 2030**, NASA plans to set up a plant that will continuously provide **10 kilowatts (kW)** of power—the average annual power intake of a home on Earth.
- China is trying to build a reactor that can generate **1 megawatt (MW)** of electric power.
- In 2021, the **Indian Space Research Organization (ISRO)** took its first step by inviting companies to develop a **100-watt RTG.**

Small Modular Reactors

- In order to address the safety concerns, over 17 countries, including the **US, China, Russia, and Canada,** are trying to develop small modular reactors, or SMRs.
- There are over 70 commercial SMR designs that are at different stages of development.
- With a power capacity of up to **300 megawatt (MW)** per plant, they constitute about **one-third of the generating capacity o**f traditional nuclear power reactors.
- SMRs are being explored as an energy source in other sectors. For instance, they could potentially reduce the carbon footprint of the shipping industry, which emits more than one billion tons of greenhouse gas emissions per year.
- The naval force already uses nuclear energy for propulsion. **India's Arihant class of submarines** is one example.
- SMRs could also produce **hydrogen.** Over 95 per cent of hydrogen comes from fossil fuels.

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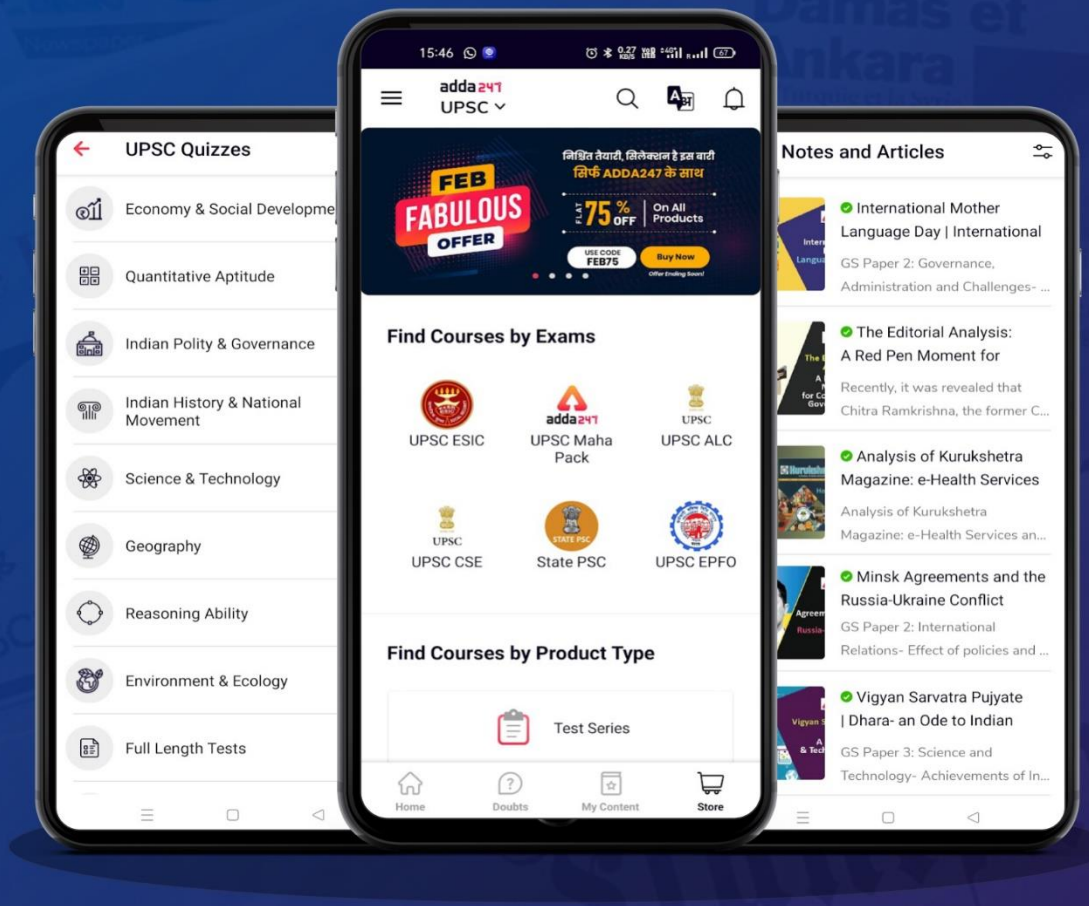

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