SCIENCE AND TECHNOLOGY

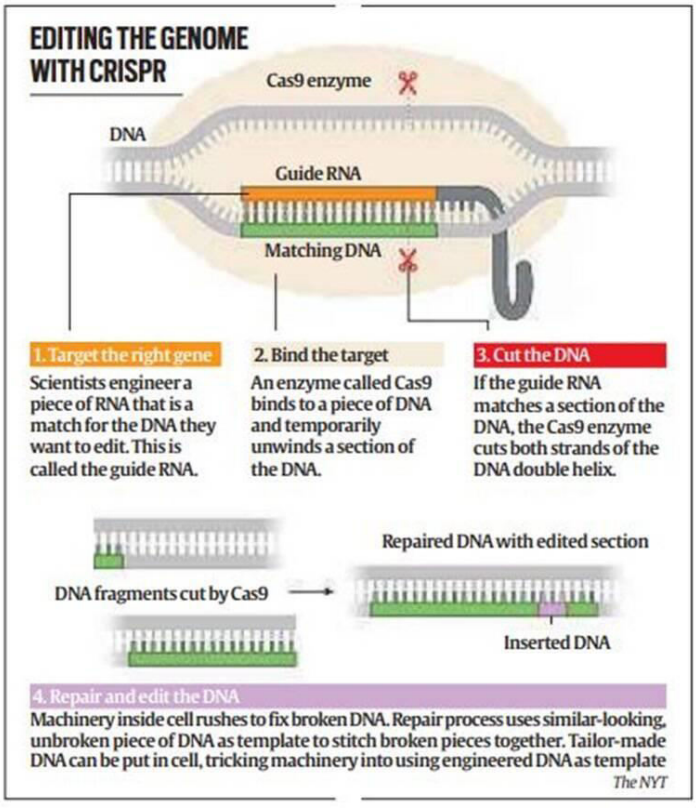
❖ **CRISPR: A technology beginning to deliver on the near unlimited potential to improve quality of human life**

❖ **CONTEXT: Over the last two and a half years, as the corona virus pandemic ravaged the world and exposed the vulnerabilities of humans to new diseases, scientists continued to push ahead with significant progress in utilising an exciting recent technology for permanent cures to some of the most intractable health disorders.**

- In the 10 years since it was developed, the genome-editing technology called CRISPR has begun to deliver on the near unlimited potential that scientists say it has to improve the quality of human life.
- The technology enables a simple but remarkably efficient way to 'edit' the genetic codes of living organisms, thus opening up the possibility of 'correcting' genetic information to cure diseases, prevent physical deformities, or to even produce cosmetic enhancements.
- Over the last three years especially, several therapeutic interventions using CRISPR for diseases like thalassaemia or sickle cell anaemia have gone into clinical trials, mainly in the United States, and the initial results have been flawless.
- In 2021, the Indian government approved a five-year project to develop this technology to cure sickle cell anaemia that mainly afflicts the tribal populations of the country.
- Hundreds of research groups and companies around the world are working to develop a range of specific solutions using CRISPR.
- The developers of the technology, Jennifer Doudna and Emmanuelle Charpentier, won the Nobel Prize for Chemistry in 2020, one of the fastest recognitions accorded by the Nobel committee following after a breakthrough.

❖ **The CRISPR technology**

- CRISPR is short for Clustered Regularly Interspaced Short Palindromic Repeats, which is a reference to the clustered and repetitive sequences of DNA found in bacteria, whose natural mechanism to fight some viral diseases is replicated in this gene-editing tool.
- Editing, or modification, of gene sequences to eliminate or introduce specific properties in an organism is not a new development. It has been happening for several decades now, particularly in the field of agriculture, where genetically modified variants, with specific desirable traits, are regularly developed. It usually involves the introduction of a new gene, or suppression of an existing gene, through a process described as genetic engineering.



- CRISPR technology is different. It is simple, and still far more accurate and it does not involve the introduction of any new gene from the outside. Its mechanism is often compared to the 'cut-copy-paste', or 'find-replace' functionalities in common computer programmes.
- A bad stretch in the DNA sequence, which is the cause of disease or disorder, is located, cut, and removed and then replaced with a 'correct' sequence. And the tools used to achieve this are not mechanical, but biochemical specific protein and RNA molecules.
- The technology replicates a natural defence mechanism in some bacteria that uses a similar method to protect itself from virus attacks.

❖ **Technology in action**

- The first task is to identify the particular sequence of genes that is the cause of the trouble. Once that is done, an RNA molecule is programmed to locate this sequence on the DNA strand, just like the 'find' or 'search' function on a computer. After this, a special protein called Cas9, which is often described as 'genetic scissors', is used to break the DNA strand at specific points, and remove the bad sequence.

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- A DNA strand, when broken, has a natural tendency to re-attach and heal itself. But if the auto-repair mechanism is allowed to continue, the bad sequence can regrow. So, scientists intervene during the auto-repair process by supplying the correct sequence of genetic codes, which attaches to the broken DNA strand. It is like cutting out the damaged part of a long zipper, and replacing it with a normally functioning part.
- The entire process is programmable, and has remarkable efficiency, though chances of error are not entirely ruled out.

❖ **Possibilities it presents**

- A vast number of diseases and disorders are genetic in nature that is, they are caused by unwanted changes or mutations in genes. These include common blood disorders like sickle cell anaemia, eye diseases including colour blindness, several types of cancer, diabetes, HIV, and liver and heart diseases. Many of these are hereditary as well. This technology opens up the possibility of finding a permanent cure to many of these diseases.
- This is also true for the deformities arising out of abnormalities in gene sequences, like stunted or slow growth, speech disorders, or inability to stand or walk.
  Also, CRISPR is just a platform; a tool to edit gene sequences. What is to be edited, and where, is different in different cases. Therefore, a specific solution needs to be devised for every disease or disorder that is to be corrected. The solutions could be specific to particular population or racial groups, since these are also dependent on genes.
- CRISPR-based therapeutic solutions are not in the form of a pill or drug. Instead, some cells of every patient are extracted, the genes are edited in the laboratory, and the corrected genes are then re-injected into the patients.
- Over the last three years, several such solutions have been undergoing clinical trials. These mainly pertain to blood disorders, diabetes, inherited eye diseases, and some kinds of cancers.
- The case of Victoria Gray, suffering from sickle cell anaemia, who was in the first batch of patients who were treated using CRISPR-based solutions, has been widely tracked. Gray is now considered cured of the disease. Several others who volunteered with her for the trials too have responded positively to the treatment.
- In India, Debojyoti Chakraborty and Souvik Maiti at CSIR's Institute of Genomics and Integrative Biology have indigenously developed a CRISPR-based therapeutic solution for sickle cell anaemia, which is now being readied for clinical trials. It would take about two to three years to reach clinical trial stage. This is the first disease that is being targeted for CRISPR-based therapy in India.
- Japan has already approved the commercial cultivation of a tomato variety that has been improved using CRISPR-based intervention. In India, several research groups are working on CRISPR-based enhancements for various crops including rice and banana.

❖ **The ethical dilemma**

- Because of CRISPR's power to induce dramatic changes in an individual, scientists, including the main developer Doudna, have been warning of the potential for misuse of the technology.
- In 2018, a Chinese researcher disclosed that he had altered the genes of a human embryo to prevent the infection of HIV. This was the first documented case of creating a 'designer baby', and it caused widespread concern in the scientific community.
- Preventive interventions to obtain special traits are not something that scientists currently want the technology to be used for. Also, because the changes were made in the embryo itself, the new acquired traits were likely to be passed to future generations. Though the technology is fairly accurate, it is not 100 per cent precise, and could induce a few errors as well, making changes in other genes. This has the possibility of being inherited by successive generations.
- In case of therapeutic interventions, the changes in genetic sequences remain with the individual and are not passed on to the offspring.

ECONOMY

❖ **<u>Why is India's August unemployment rate the highest in the past 12 months?</u>**

❖ **CONTEXT: According to the data released by the Centre for Monitoring Indian Economy (CMIE), India's unemployment rate in August rose to 8.3%. This is the highest unemployment rate in the past 12 months. In August 2021, the unemployment rate was 8.35%.**

❖ **Is the unemployment rate different in rural and urban areas?**

- For instance, in August, urban unemployment was 9.6% and rural was 7.7%. Rural and urban unemployment rates have been over the past 12 months. Only in two months February and June has the rural unemployment rate been higher than the urban unemployment rate.

The Indian EXPRESS

Unemployment Rate in India

Unemployment rate (in %)	India
Aug-22	8.28
Jul-22	6.83
Jun-22	7.83
May-22	7.14
Apr-22	7.83
Mar-22	7.57
Feb-22	8.11
Jan-22	6.56
Dec-21	7.91
Nov-21	6.97
Oct-21	7.74
Sep-21	6.86

Source: CMIE

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The Indian EXPRESS

Unemployment rate in rural and urban India

Unemployment rate (in %)	Urban	Rural
Aug-22	9.57	7.68
Jul-22	8.22	6.17
Jun-22	7.32	8.07
May-22	8.24	6.63
Apr-22	9.22	7.18
Mar-22	8.28	7.24
Feb-22	7.57	8.37
Jan-22	8.14	5.83
Dec-21	9.3	7.28
Nov-21	8.2	6.41
Oct-21	7.37	7.91
Sep-21	8.64	6.04

Source: CMIE

❖ **What about state-wise unemployment rates?**

- As the data shows, there is a significant variance in the unemployment rate across states. Haryana, J&K and Rajasthan have the highest levels of unemployment rate each with over 30% of the unemployment rate.
- In sharp contrast, there are many states with remarkably low unemployment rates as well. Chhattisgarh, for instance, has an unemployment rate of just 0.4%. Maharashtra, Madhya Pradesh, Odisha and Meghalaya — all have unemployment rates well below 3%.

The Indian EXPRESS

Unemployment rate in different states of India

Unemployment rate (in %)	
States (India)	Aug-22
Andhra Pradesh	6
Bihar	12.8
Chhattisgarh	0.4
Delhi	8.2
Goa	13.7
Gujarat	2.6
Haryana	37.3
Himachal Pradesh	7.3
Jammu & Kashmir	32.8
Jharkhand	17.3
Karnataka	3.5
Kerala	6.1
Madhya Pradesh	2.6
Maharashtra	2.2
Meghalaya	2
Odisha	2.6
Puducherry	5.2
Puducherry	2.6
Punjab	7.4
Rajasthan	31.4
Tamil Nadu	7.2
Telangana	6.9
Tripura	16.3
Uttar Pradesh	3.9
West Bengal	7.4

Source: CMIE

❖ **What is the unemployment rate?**

- The unemployment rate is essentially the percentage of working-age people (15 years and above) who are demanding work but not able to get a job. Both aspects of the definition are important. To be counted as an unemployed person one has to both "demand" work that is, be part of the labour force and then fail to get a job.
- As such, the unemployment rate is calculated by looking at the labour force that is, all the people of the working age who are demanding work and then finding out what percentage of them are unable to land a job. That percentage is the unemployment rate.
- The underlying size of the labour force — that is, the percentage of working-age people demanding work itself varies over time and is measured by the Labour Force Participation Rate (LFPR).
- Unemployment rate = [Total unemployed / Total Labour Force]
- In other words, unemployment rates are expressed as a percentage of the labour force, not the total population.

❖ **Why did the unemployment rate go up in August?**

- Since the unemployment rate is essentially a ratio between the total unemployed and the total labour force, it can go up whenever the number of unemployed increases more than the increase in the total labour force. Reportedly, in August while the labour force increased by 4 million, the economy instead of creating new jobs, actually shed 2.6 million existing jobs.
- In other words, while the total number of unemployed went up by 6.6 million, the labour force only went up by 4 million. Hence the spike in the unemployment rate.

PRELIMS

1. 'Cheetah mitras' to watch towers, Kuno ready to host African guests

CONTEXT: Equipped with a small shed for shade and a few trees, a 50×30-metre quarantine enclosure is all ready at Madhya Pradesh's Kuno National Park to host eight cheetahs arriving from Namibia. Prime Minister Narendra Modi will release three cheetahs (two male siblings and a female) into the enclosure to launch the re-introduction of the species in India.

- The cheetahs, all aged between five and six, will be quarantined in the enclosures for the next one month where they will be under constant observation. "During their quarantine period, the cheetahs will need not hunt and will be fed buffalo meat. The idea is to ensure that no other animal finds its way inside, allowing the big cats to acclimatise well to the new environs.
- Each cheetah will be given 2-3kg of meat every 2-3 days. "During their quarantine period, there will be minimum human intervention to avoid human imprint. In case there is a need to intervention, it will be done using camouflage.
- After the quarantine period is over, the cheetahs will be released into a 550-hectare enclosure divided into nine compartments, inter-connected through gates. The compartments will ensure that the animals can be easily separated in case such a need arises.

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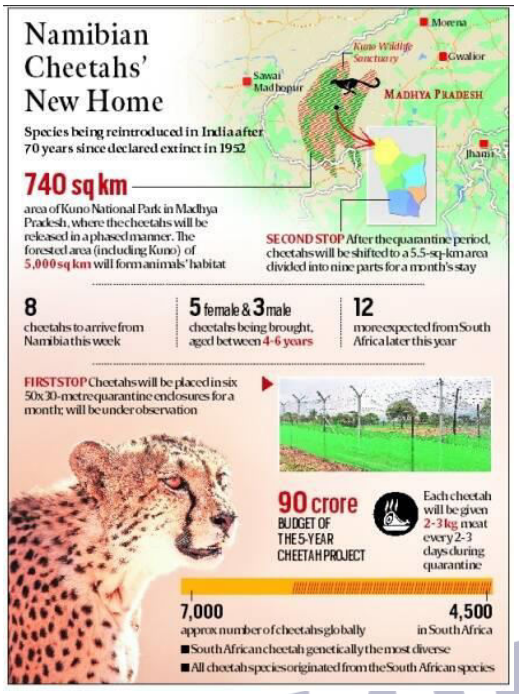
- The 'cheetah mitras' are a group of about 400 youngsters who have been trained to create awareness among the villagers about cheetahs how are they different from leopards, in behaviour and looks.
- After the month-long quarantine period, the cheetahs will have to hunt for their survival in the bigger enclosure where they will stay for another month.
- The cheetahs' behaviour will be under watch and once they have adapted to the new habitat, they will be released into Kuno National Park.
- The enclosure has a high prey base, including over 300 cheetals, and its 11.7-km-long peripheral fence has electric charge to keep other animals at bay.
- Officials pointed out that while leopards and cheetahs co-exist in Namibia in Africa, but the enclosures are being freed of leopards to make the guest animals feel safe in their new habitat.
- Once the cheetahs have acclimatised well, they will be released into the 748 square km Kuno National Park where they will have to survive with nearly 150 odd leopards.
- To keep poachers at bay, two drone squads have been readied, five watch towers with CCTV cameras have been erected and at least 24 retired military personnel have been hired



2. DART, the space mission

❖ **CONTEXT**: **NASA's DART spacecraft is scheduled to crash into the asteroid Dimorphos at approximately 7.14 PM EDT on September 26 (4.44 AM IST on September 27).**

❖ What **is DART?**

- NASA's Double Asteroid Redirection Test (DART) is the world's first full-scale mission to test technology for defending Earth against potential asteroid or comet hazards.
- It was launched on a **SpaceX Falcon 9 rocket** from Space Launch Complex 4 East at Vandenberg Space Force Base in California.

❖ **What is its relevance?**

- The mission will test a method that could be used to redirect asteroids that pose a threat to our planet.
- Using the impact of a massive object like a spacecraft to divert asteroids is called the **"kinetic impact method"** of asteroid impact avoidance.
- According to experts This is humanity's first planetary defence test mission. This is the first time defence technology will be tested in a civilian mission.

❖ **Why is the crash of DART with Dimorphos important?**

- The 160-meter-wide asteroid Dimorphos orbits the much larger asteroid Didymos, which is about 780 meters wide. After DART crashes into Dimorphos, it will ever so slightly change the way that it orbits Didymos.
- Telescopes on our planet and in space– including the Webb Telescope and Hubble will be trained on this asteroid system to take measurements of the changes in the system.
- While Dimorphos poses no actual threat to Earth, scientists will compare the data from DART's actual impact with the many computer-generated simulations they have already made. This will help ascertain whether the kinetic impact method will be effective as a mitigation strategy in the event of an actual asteroid threat.

❖ **What else you should know?**

- The exact mass of Dimorphos is unknown but NASA estimates it to be five billion kilograms. DART weighs around 600 kilograms. According to NASA, this would be similar to crashing a golf cart into the great pyramid.
- According to DART coordination lead at NASA. The only instrument on board the DART spacecraft is DRACO, or Didymos Reconnaissance and Asteroid Camera for Optical navigation. The high-resolution camera will capture images of Didymos and Dimorphos while simultaneously supporting DART's autonomous guidance system.
- Apart from the James Webb Telescope, the Hubble Telescope and various other space telescopes here on Earth, a satellite much closer to the vicinity of the asteroid system will also have its eyes trained on the impact. This is the CubeSat called **LICIACube**.
- According to the **Italian space agency Agenzia Spaziale Italiana**, which built the CubeSat, LICIACube detached itself from DART on September 12 and has begun operating autonomously. The two cameras on board the CubeSat will transmit back images even after the DRACO can no longer do so.

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- Apart from helping test an asteroid mitigation strategy, the DART mission will also test technologies like the **DRACO** camera and an advanced version of NASA's compact Roll-Out Solar Arrays (ROSA). The successful demonstration of these technologies will make them important tools in the "toolbox" for future space exploration.
- Also, according to the European Space Agency "In the world's first test of asteroid deflection, "Hera" will perform a detailed post-impact survey of the target asteroid, Dimorphos the orbiting Moonlet in a binary asteroid system known as Didymos.
  Once NASA's DART mission has impacted the moonlet, Hera will turn the grand-scale experiment into a well-understood and repeatable planetary defence technique.
- Demonstrating new technologies from autonomous navigation around an asteroid to low gravity proximity operations, Hera will be humankind's first probe to rendezvous with a binary asteroid system and Europe's flagship Planetary Defender."

ANSWER WRITTING

Q. The emergence of the Fourth Industrial Revolution (Digital Revolution) hasinitiated e-Governance as an integral part of government. Discuss.

The Fourth Industrial Revolution is a way of describing the blurring of boundaries between the physical, digital, and biological worlds. It's a fusion of advances in Artificial Intelligence (AI), robotics, the Internet of Things (IoT), quantum computing, and other technologies. It is about more than just technology-driven change; it is an opportunity to help everyone, including government, policy-makers and people to harness converging technologies in order to create an inclusive, human-centred future.

The recent technological changes have fundamentally altered the way states govern and people respond. The growth of computers, digital technologies and telecommunications has drastically changed the way the state conducts its functions.

Electronic governance or e-governance is one of them. E-governance is about a process of reform in the way governments work, share information and deliver services. Specifically, e-government harnesses information and communication technologies (ICT) to deliver information and services to citizens and businesses.

Some positive examples of the e-governance that have promoted effectiveness of government at the national level include:

- Digital India: Itstrivesto bring inclusive growth and bridge the digital divide by leveraging technology solutions that are low cost, developmental, transformative and designed to empower ordinary Indians.
- BharatNet: One of the largest digital infrastructures of the world was conceived to connect all the 250,000 gram panchayats by a high-speed optical fibre network.
- India isseeing a dramatic growth in the number of online transactionsinvolving citizens and the government. It proves that citizens are quick to adopt these technologies. The onus lies on the government to provide the relevant infrastructure and policies to enable effective digitization of the economy.
- Umang: It is a platform that enables access to services offered by the Government, such as EPF, Ayushman Bharat, on mobile phone.
- Direct Benefit Transfer (DBT): Under this inititative subsidies and scholarsips are directly credited in the bank account of the beneficiary. It has immensly helped in targeted delivery of benefits and reducing corruption.

Industrial Revolution 4.0 brings with it immense potential to improve governance. Its right use will result in improving accountability, access to services, and strengthening of democracy.

MCQ

1. Consider the following statements:
   1. CRISPR-Cas9 technology enables geneticists and medical researchers to edit parts of the genome.
   2. It is the most versatile and precise method of genetic manipulation.

   Which of the following statements given above is/are correct?
   a) 1 only
   b) 2 only
   c) Both 1 and 2
   d) Neither 1 nor 2
2. With reference to CRISPR technology, consider the following statements:
   1. The CRISPR technology replicates a natural defence mechanism in some bacteria that use a similar method to protect themselves from virus attacks.
   2. Feluda test for COVID-19 uses indigenously developed CRISPR gene-editing technology to identify and target the genetic material of SARS-CoV2.
   3. CRISPR technology can be used to control the growth of mosquitoes.

   Which of the statements given above is/are correct?
   a) 1 only
   b) 2 and 3 only
   c) 2 only
   d) 1, 2 and 3

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3. Consider the following pairs:

Terms Sometimes seen in news		Context/Topic
1. Bell II experiment	-	Artificial intelligence
2. Blockchain	-	Digital/Cryptocurrency
3. CRISPR - Cas9	-	Particle Physics

Which of the pairs given above is/are correctly matched?
a) 1 and 3 only
b) 2 only
c) 2 and 3 only
d) 1, 2 and 3

4. What is cas9 protein that is often mentioned in the news?
a) A molecular scissors used in targeted gene editing.
b) A biosensor used in the accurate detection of pathogens in patients.
c) A gene that makes plants pest-resistant
d) A herbicidal substance synthesized in generally modified crops

5. Consider the following statements
1. IUCN status of African cheetah is Vulnerable.
2. The Asiatic Cheetah was officially declared extinct from India in 1952.
3. After introduction of Asiatic Cheetah in India it will automatically eligible to listed in IUCN's Green list of species.

Select the correct statement.
a) 1 and 2 only
b) 2 and 3 only
c) 1 and 3 only
d) All of the above

6. Which of the following initiatives can help in fight against Unemployment in India?
1. SMILE initiative
2. PM-DAKSH
3. MGNREGA
4. PM-KVY
5. Start-UP India

Choose the correct answer using the codes given below
a) 1,2 and 3 only
b) 2.3.and 4 only
c) 2,3,4 and 5 only
d) All of the above

7. Nagorno-Karabakh region is a disputed area between which of the following countries?
a) Russia and Ukraine
b) South Korea and North Korea
c) Armenia and Azerbaijan
d) Israel and Palestine

8. 'Exercise Kakadu – 2022' often mentioned in news is hosted by which of the following country?
a) USA
b) Australia
c) Philippines
d) Sri Lanka

9. Consider the following pairs?
1. DART— to test an asteroid mitigation strategy.
2. Hera — to perform a detailed post-impact survey of the target asteroid, Dimorphos.
3. LICIACubea— CubeSat riding with DART provided by the Italian Space Agency (ASI).
4. DARCO — to assist NASA's efforts to identify and characterize the population of near-Earth objects.

How many above pairs are not correctly matched?
a) Only one pair
b) Only two pairs
c) Only three pairs
d) All the four pairs

10. Hindi Diwas celebrated on which of the following date?
a) 11th September
b) 12th September
c) 13th September
d) 14th September

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