Science & Technology Current Affairs by Pmfias.com – February & March 2021

Contents

Colour Codes:

1. **Recently in News & Very Important**
2. **Important for Prelims + Mains**
3. **Important for Prelims**

4. **Very Important for Prelims**
5. **Important for Mains**
6. **Key Word or Key Phrase**

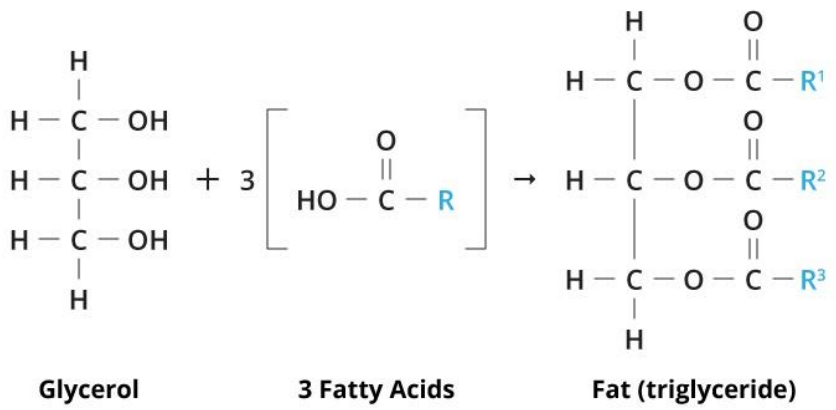
{S&T – Bio – 2021/03} Trans fat

TH | Prelims + Mains | GS2 > Issues related to health | Related: Carbohydrates | Proteins | Vitamins

- **Context:** The Food Safety & Standards Authority of India (FSSAI) has put a cap on **trans fatty acids (TFAs)** in food products, just weeks after it tightened the norms for oils & fats.
- FSSAI had capped **trans fats in oils & fats** to **3% by 2021**, & **2% by 2022** from the **current levels of 5%**.
- From 01/01/2022, India will limit **trans fat to 2% by mass of the total oils/fats present in a food product**.
- While FSSAI mentions edible oils & fats, it also applies to emulsions such as **margarines**.
- Even when the fat/oil contains less than 2% trans fat, **repeated heating can increase the trans fat content**.
- WHO has called for the elimination of **industrially produced trans fatty acids from the global food supply by 2023**. (India will be achieving the target a year in advance)
- **Denmark** became the first country to limit industrially produced trans fats in all foods to 2% of fats & oils.
- EU adopted a new regulation to limit industrially produced trans fat to 2% in foods sold within the EU.
- It is now well known that **trans fat can be completely eliminated & replaced with healthier substitutes without any change in the food taste or cost**.
- According to WHO, a dozen large multinational food companies have already committed to eliminate industrially produced trans fat from all their products by 2023.
- Over 77,000 deaths annually are attributed to trans fats consumption in India.

Fats

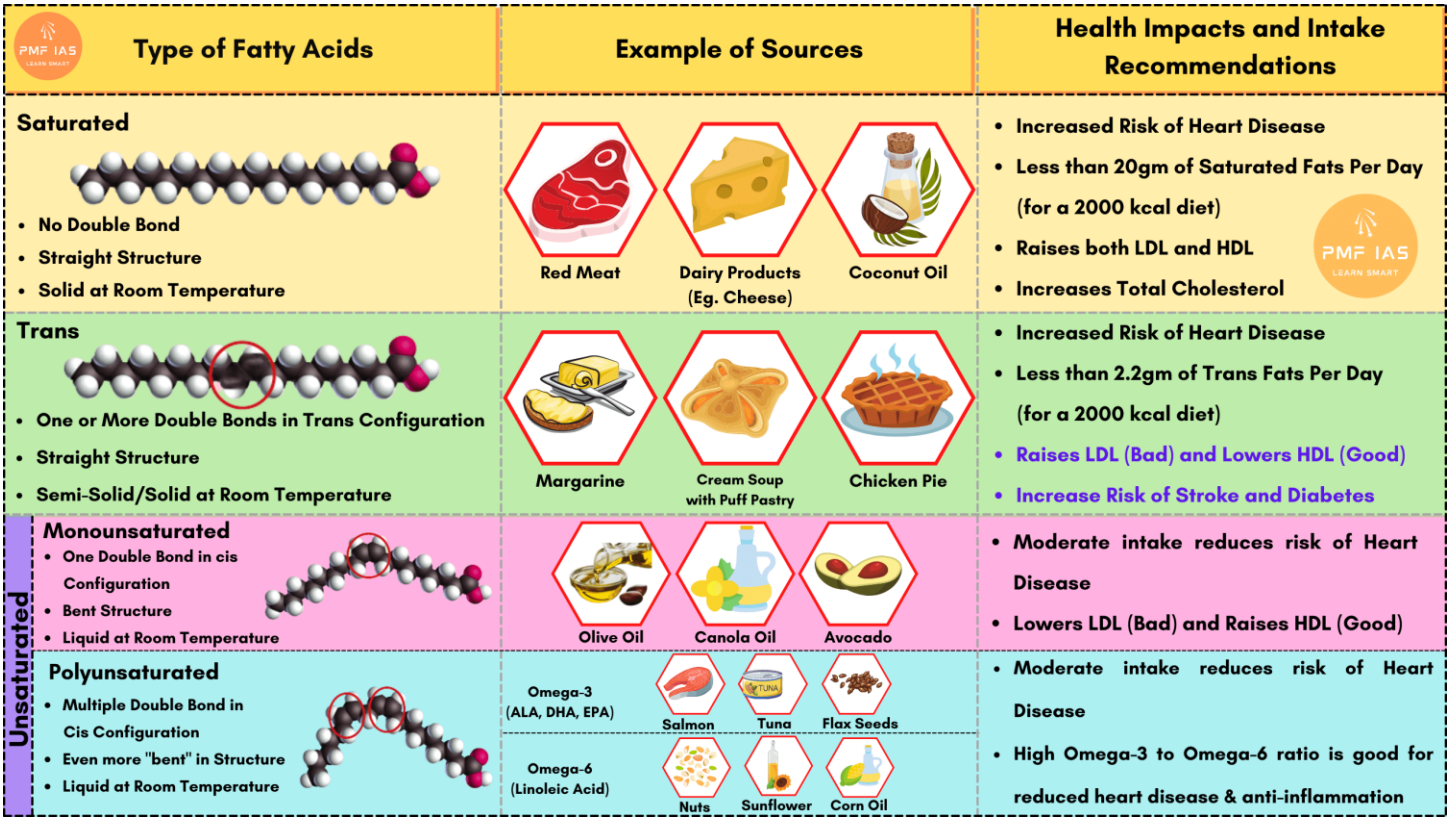
- Fat is one of the three main macronutrients: **fat, carbohydrate, & protein**.
- Fat is a major source of energy & **helps your body absorb vitamins**.
- Fat has the **most calories** compared to any other nutrient.
- Controlling fat intake is important for maintaining weight & preventing or delaying type 2 diabetes.
- Fats, also known as **triglycerides**, are **esters** of **three fatty acid chains** & the **alcohol glycerol**.



Source & Credits

- Fats are solids at room temperature.
- Oil refers to a **fat with unsaturated fatty acid chains** that is liquid at room temperature.
- Fats, like other **lipids**, are generally **insoluble in water**.

Types of Fats



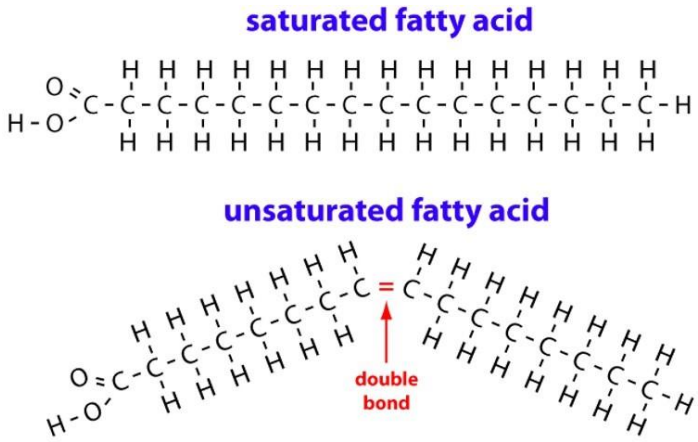
Saturated fat

- A saturated fat is a fat in which the fatty acids all have **single bonds**.

- A saturated fat has the **maximum number of hydrogens bonded to the carbons**, & therefore is **'saturated' with hydrogen atoms**.
- **Most animal fats are saturated** whereas the **fats of plants & fish are generally unsaturated**.
- Many experts recommend a **diet low in saturated fat**.
- Saturated fats are popular with manufacturers of processed foods because they are **less vulnerable to rancidity** & are, in general, **more solid at room temperature** than unsaturated fats.

Unsaturated fat

- An unsaturated fat is a fatty acid in which there is **at least one double bond** within the fatty acid chain.
- Where double bonds are formed, hydrogen atoms are eliminated.
- In cellular metabolism, unsaturated fat molecules contain **somewhat less energy** (i.e., fewer calories) than an equivalent amount of saturated fat.
- The greater the degree of unsaturation in a fatty acid (i.e., the more double bonds in the fatty acid) the more vulnerable it is to **rancidity** (lipid oxidation or rusting of fats).
- **Antioxidants** can protect unsaturated fat from lipid oxidation.



Healthy Fats – Omega-3 and Omega-6, Monounsaturated and Polyunsaturated

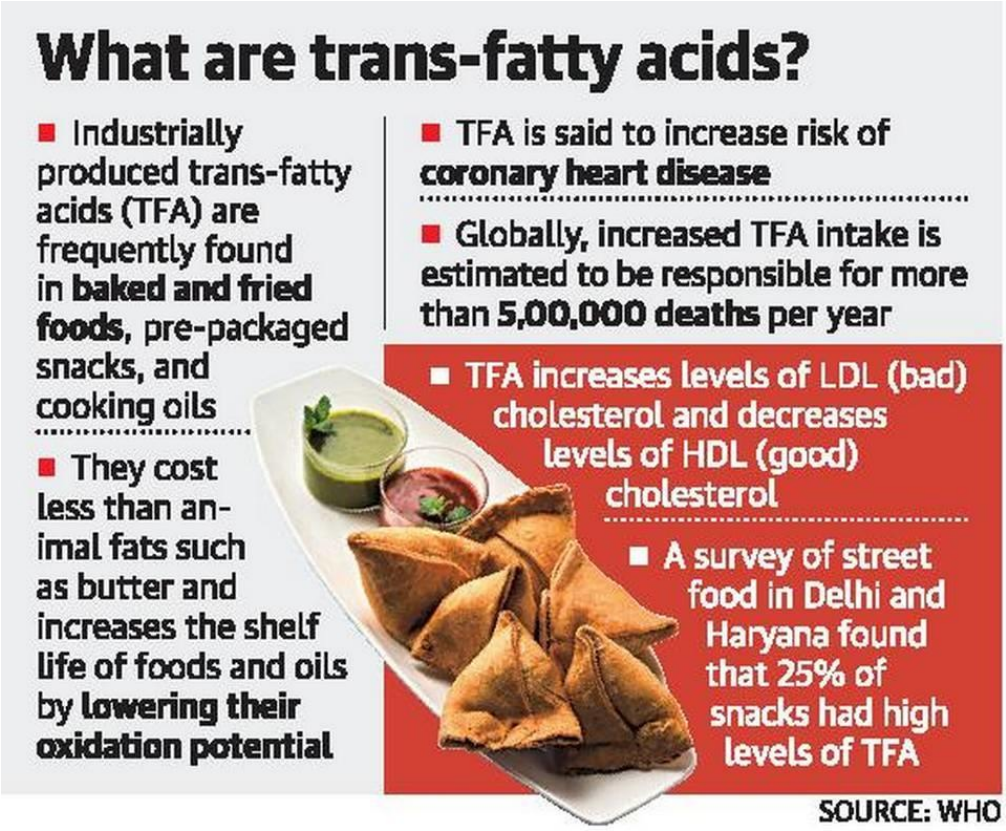
- The main types of "healthy" fats are:
  - ✓ **monounsaturated (single double bond),**
  - ✓ **polyunsaturated (more than one double bond),**
  - ✓ **alpha-linolenic acid (an omega-3 fatty acid)** and
  - ✓ **linoleic acid (an omega-6 fatty acid)**.
- **Omega-3 and Omega-6 fatty acids** are **heart healthy fats**.
- They are found in fish, soybean products, Walnuts etc.

- Both of these fatty acids are needed for growth and repair but can also be used to make other fatty acids.
- The **omega-3 and omega-6** are fatty acids are both **polyunsaturated**.
- The difference is in where the first of the double bonds occurs.
- Both omega-3 (ω-3) and omega-6 (ω-6) fatty acids are important components of cell membranes.
- There is increasing support for omega-3 fatty acids in protecting against fatal heart disease and it is known that they have **anti-inflammatory effects**.
- There is also growing interest in the role of **omega-3 fatty acids in the prevention of diabetes** and certain types of cancer.
- **Monounsaturated and polyunsaturated fat are considered "heart healthy" and can help with improving cholesterol** when used in place of unhealthy fats.
- Some sources of these fats include almonds, cashews, pecans, peanuts, pine nuts, pumpkin, sesame seeds, sunflower seeds, Olive oil and olives, vegetable oils (sunflower, safflower, corn, soybean, and cottonseed).

Unhealthy Fats – Saturated Fat & Trans Fat

- The main types of **"unhealthy" fats** are **saturated & trans fat**.
- Saturated fats are primarily found in foods that come from **animals, such as meat & dairy**.
- Saturated fats are **unhealthy** because **they increase LDL ("bad" cholesterol) levels** in your body.
- Many saturated fats are **"solid" fats** that you can see, such as the fat in meat.
- Other sources of saturated fats include high-fat cheese, butter, Ice cream, palm & coconut oils, etc.
- **Trans fats or trans-unsaturated fatty acids** are a type of **unsaturated fats** that are **uncommon in nature**.

- **Trans fats are worse than saturated fats**.
- Trans fat is simply **liquid oils turned into solid fats** during **food processing**.
- **Natural trans fats**, present in very small amounts in certain animal products, are **not considered harmful**.
- But industrially produced artificial trans fats (**manufactured by adding hydrogen to vegetable oil**) have the tendency to negatively alter the **lipoprotein cholesterol profile** by **increasing the level of bad cholesterol (LDL)** while **decreasing the level of HDL or good cholesterol**.
- These changes in the lipoprotein cholesterol clog arteries & cause hypertension, increase the risk of type-II diabetes, heart attacks & other cardiovascular diseases.
- Foods containing trans fat are usually labelled as "**partially hydrogenated**".
- Partially hydrogenated oil is less likely to spoil, so foods made with it have a **longer shelf life**.
- Trans fats are **easy to use, inexpensive to produce & last a long time**.
- Trans fats give foods a desirable taste & texture.
- These trans fats are largely found in **vanaspati oil, margarine, bakery items, & in baked & fried foods**.



Previous Prelims Question: Statements:

1. Trans fats are considered beneficial for the human body
2. Double bond chemistry of the fat molecules in Trans fats causes a Plaque formation
3. Omega-3 fatty acids are considered healthier than the saturated fatty acids

Codes:

a. 1 & 3

b. 2 & 3

c. 1 & 2

d. 1, 2, 3

Ans. B

{S&T – Digital India – 2021/03} Integrated Health Information Platform (IHIP)

PIB | Prelims + Mains | GS3 > Application of technology | GS2 > aspects of e-governance

- Context: New **fully digital version** of IHIP was launched **covering 33 diseases as compared to 18 earlier**.

What is Integrated Information Health Information Platform?

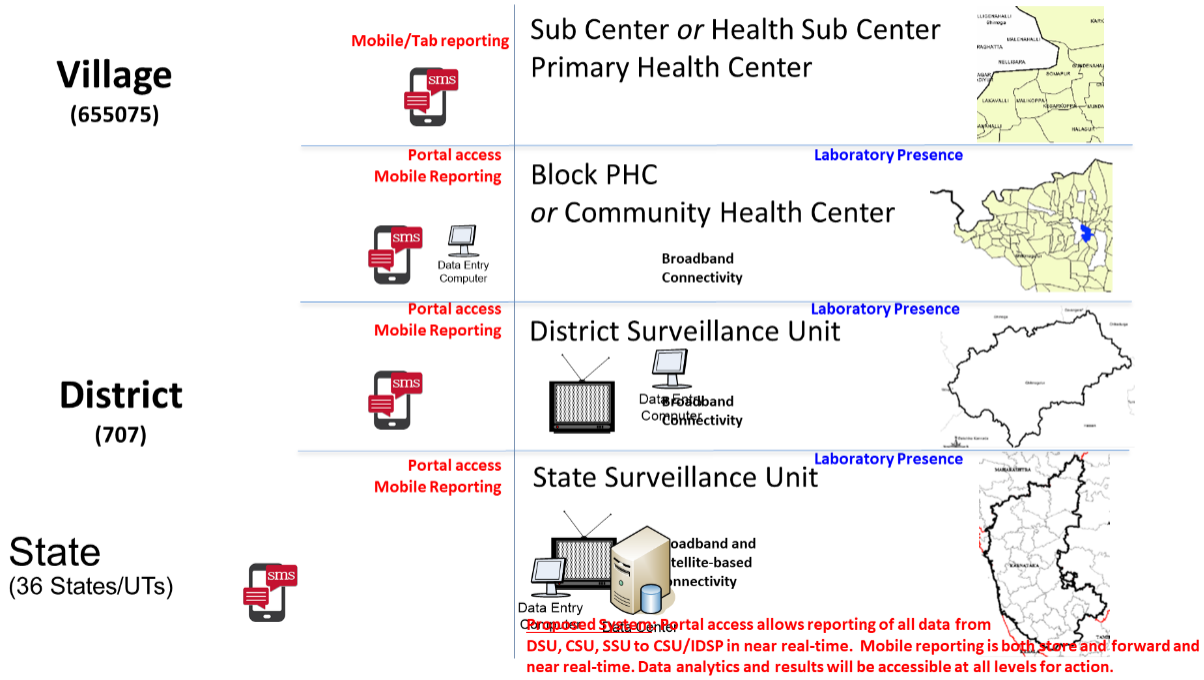
- It is a tool that supports the e-governance vision of **Health Ministry.**
- It integrates data from various sources to provide **real-time information on human health from across India** for decision-makers to take action.
- It provides a **single operating platform of the health data** and information of India.
- **Karnataka** was one of the first states to adopt and implement it in 2018.
- The Integrated Health Information Platform is the **next generation highly refined version** of the presently used **Integrated Disease Surveillance Programme.**
- The Integrated Health Information Platform provides the ability to:
  - ✓ **Integrate data sources from Public and Private sector facilities**.
  - ✓ **Describe and analyze geographic variations in diseases** in the context of demographic, environmental, behavioral, socioeconomic, genetic, and infectious risk factors.
- It is in sync with the **National Digital Health Mission** and fully compatible with the other digital information systems presently being used in India.
- IHIP is **real time, village wise; case based electronic health information system with GIS tagging** which will **help in prompt prevention and control of epidemic prone diseases**.

Integrated Disease Surveillance Programme (IDSP)

- The Integrated Disease Surveillance Programme (IDSP) is a **disease surveillance scheme**.
- It aims to **strengthen disease surveillance for infectious diseases and respond to outbreaks quickly.**

- It seeks to set up a **Central Disease Surveillance Unit** and a **State Surveillance Unit** in each State where data is collected and analyzed.
- IDSP was initiated by the **World Bank** in November 2004.

Real time data flow processes



Source and Credits

Old IDSP	New IHIP
• Capture & aggregate data. • The data from various collection points is not linked. • Paper-based data collection. • Weekly surveillance. • Monitor only 13 health conditions.	• Capture & disaggregate data of persons at all levels. • All the data from various collection points is linked. • It is fully digital. • Capture real-time or daily surveillance data. • Provide analysis on mobile and electronic devices. • Covers 33 health conditions. • Integrate with ongoing surveillance programs.

National Digital Health Mission

- The genesis of the new digital health infrastructure in India came about in the **2017 National Health Policy**, which proposed a new **National Digital Health Authority** (NDHM).
- The **NDHM** is implemented by the **National Health Authority (NHA)** under the **Health Ministry.**

- NDHM is overseen by a Mission Steering Group with Ministers from **IT, AYUSH, Women's & Child Development**, as well as Niti Aayog Member, NHA CEO, & others.

The NDHM is a complete digital health ecosystem

- NDHM envisions digital registries of doctors, hospitals, insurance companies, personal health records, etc.
- It will also include **e-pharmacy & telemedicine services.**
- The digital platform will be launched with four key features — health ID, personal health records, Digi Doctor & health facility registry.
- Patients can create a Health ID, allowing them to share their data between hospitals & doctors digitally.
- Beneficiaries of government schemes will be required to connect their ID to their Aadhaar.
- One copy of a patient's records is stored in their doctor's files & one is stored in their own individual locker (which can be owned by a company or by the government).
- Other than the registry of doctors, professionals, & institutions, **this allows for decentralised storing**.

National Health Policy 2017

- It envisages providing comprehensive primary health care through the 'Health & Wellness Centres'.
- It aims to allocate major proportion of resources to primary care & intends to ensure availability of two beds per 1,000 population distributed in a manner to enable access within **golden hour**.
  - ⇨ **Golden hour**: the first hour after traumatic injury, when the victim is most likely to benefit from emergency treatment.
- In addition, the policy proposes free drugs, free diagnostics & free emergency & essential health care services in all public hospitals in a bid to provide access & financial protection.
- The policy proposes **raising public health expenditure to 2.5 per cent of the GDP** in a time-bound manner, the **2.5 per cent of GDP spend target for this sector would be met by 2025**.
- Among key targets, the policy intends to
  - ✓ increase **life expectancy at birth from 67.5 to 70 by 2025**,
  - ✓ **reduce infant mortality rate to 28 by 2019** (was slightly over 28 – objective failed), &
  - ✓ **reduce under five mortality to 23 by the year 2025**.

{S&T – Diseases – 2021/03} Diphtheria

TH | Prelims | General Science for Prelims > Biology > Diseases

- **Context:** Study was conducted to understand the various causes for Diphtheria.

- It is **bacterial infection (not virus or parasite)** caused by **Corynebacterium diphtheriae**.
- Diphtheria bacteria **can spread from person to person**, usually through **respiratory droplets or touch.**

Signs and Symptoms

- It **usually begins with angina (type of chest pain).**
- Symptoms come gradually, **beginning with a sore throat, tonsillitis and mild fever**.
- In severe cases, a **grey or white patch develops** in the throat.
- The neck may swell in part due to enlarged lymph nodes.
- **Complications may include Myocarditis (inflammation of heart muscles).**
  - ✓ It may result in an abnormal heart rate and inflammation of the nerves may result in paralysis.
  - ✓ It **is fatal in nature**.

Source and Credits

Treatment

- It is a **vaccine preventable disease.**
- It **can be treated** with antitoxin and antibiotics if given at early stage.

{S&T – Diseases – 2021/04} Rare Diseases

PIB | TH | Prelims + Mains | GS3 > S&T developments and applications etc. | GS2 >Issues related to health

- **Context:** Recently National Policy for Rare Diseases 2021 was launched.

What is Rare Disease?

- A rare disease is any disease that affects a small percentage of the population.
- **WHO defines** rare disease as lifelong disease or disorder with a prevalence of **1 or less per 1000 population**.
- A rare disease or disorder is **defined in India when** it affects **less than 1 in 2500 individuals**.

Diagnosis

- Early diagnosis of rare diseases is a challenge owing to multiple factors like:
  - ✓ Lack of awareness among primary care physicians.
  - ✓ Lack of adequate screening and diagnostic facilities.
  - ✓ Poor research and development for most rare diseases is absent because patient pool is very small resulting in inadequate clinical experience.

National Policy for Rare Diseases 2021

- Health Ministry formulated a National Policy for Treatment of Rare Diseases (NPTRD) in 2017.
- It could not be implemented due to certain challenges like **lack of support from states** and **lack of clarity on government financial support**.

2021 Policy Features

- It provides financial support for one time treatment **(Group 1 diseases) up to 20 lakhs**.
- Increased focus on indigenous research with the help of a **National Consortium to be set up with health department**.
- Creation of a **national registry of rare diseases** so that adequate data is available.
- **Capacity building** of health professionals.
- Focuses on **early screening and prevention** at various levels:
  1. **Primary**: This aims at **preventing the occurrence** of the disease, i.e., preventing birth of an affected child. Ex: Avoidance of pregnancy in advanced age.
  2. **Secondary:** It focuses on **prenatal screening and diagnosis**.
  3. **Tertiary:** It focuses on **better care and medical rehabilitation** to those rare disease patients who present at an advanced stage of the disease.
- Setting up of **Centres of Excellence (COE)** and **Nidan Kendras**:
  - ✓ Government will notify selected Centers of Excellence as premier tertiary hospitals with facilities for diagnosis, prevention and treatment of rare diseases.
  - ✓ **Nidan Kendras** have been set up by **Department of Biotechnology (DBT)** under Unique Methods of Management and treatment of Inherited Disorders (UMMID) project for genetic testing and counselling.

Policy covers the following category of rare diseases:

- **Group 1:** Disorders capable to **one-time curative treatment** like:
  - ✓ Osteoporosis

- ✓ Liver Transplantation
- ✓ Renal Transplantation

- **Group 2:** Diseases requiring **long term treatment** having relatively lower cost of treatment like:
  - ✓ Maple Syrup Urine Disease (MSUD)
  - ✓ Tyrosinemia type 1 and 2
  - ✓ Glucose galactose malabsorbtion
- **Group 3:** Diseases for which treatment is available but it's very costly and needs lifelong therapy.
  - ✓ Hunter syndrome.
  - ✓ Spinal Muscular Atrophy.
  - ✓ Cystic Fibrosis.
- **Note:** Though the policy covers all 3 groups, the financial support for one time treatment **up to 20 lakhs is given to Group 1 diseases only**.

Criticism

- There is **no clear-cut definition** of Rare Disease in the document.
- New policy offers **no support to patients awaiting treatment since the earlier National Policy for Treatment of Rare Diseases 2017.**
- Several patients mostly children have already lost their lives in the interim period.
- Policy provides support to Group 1 only **excluding Group 2 and Group 3 (Requiring lifelong treatment).**
- India lacks in clinical data and policy **only classified certain diseases as 'rare.'**
- Where treatment and drugs are available, they are prohibitively expensive.
- There are no domestic manufacturers of rare diseases specific drugs in India.
- There is no clear-cut financial division amongst centre and states.

{S&T – ICT – 2021/02} Deregulation of Geospatial Sector & Geospatial Technology

IE | TH | FE | ET | DH | Source1 | Source2 | Prelims + Mains | GS3 > | GS2 > Government policy for development in various sectors and issues arising

- **Context:** The Ministry of S&T released new guidelines to liberalize (deregulate) the Geo-Spatial Sector.

Liberalization	Democratization
• Is about having minimal regulations, without approvals & complex processes leading to speedy delivery.	• The action of making something accessible to everyone.

• Liberalization can take place without democratization. • Anybody can use the resources, but they cannot decide how others use the same resource.	• It entails shared ownership over the resources in the communities. • Communities participate equally in deciding how the resources are used.

Geospatial Data

- Geospatial data is data about **objects** (mountains, crops, moving objects), **events** (volcano, earthquake, lightning, pandemic), or **phenomena** (gravity, heatwave) **that have a location on the surface of the earth**.
- Geospatial data combines Information on:
  1. Location,
  2. Attribute (the characteristics of the object, event, or phenomena concerned),
  3. Temporal or time.
- The evolution & convergence of technology has fuelled a vibrant marketplace for timely & accurate geospatial data.

Deregulation of Geospatial Data

- India **liberalised geospatial data guidelines allowing private companies & individuals** to **conduct mapping & share geospatial data** for various applications **without prior approval from the government**.
- **All government geospatial data** including Survey of India, data collected by security & law enforcement agencies **will be available for public use** & **no government approval** will be necessary for any changes.
- The policy allows the foreign companies to use such data by acquiring them from Indian companies but only for the purpose of serving their customers in India.
- **Self-certification** will be used to convey adherence to the new guidelines.
- The move aims to realise GOI's goal of an Atmanirbhar Bharat & the vision of a $5 trillion economy.
- The GOI further hopes the policy would encourage Indian private companies to enter the Rs 1 lakh crore sector with a vision of creating 22 lakh jobs by 2030.

Impact of Deregulation

Increased Competitiveness:

- By liberalising the system, the government will ensure more players in the field & competitiveness of Indian companies in the global market.

Increased Investment:

- The government also expects an increase in investment in the geo-spatial sector by companies, & also an increase in export of data to foreign companies & countries, which in turn will boost the economy.

Current State of the Geospatial Sector & the need for new guidelines

- **Strict Restriction:** At present, there are strict restrictions on the collection, storage, use, sale, dissemination of geo-spatial data & mapping.
- **Regulatory inertia:** The policy for the sector has not been renewed in decades.

Long waiting periods & Redtape

- The sector so far is dominated by the GOI as well as government-run agencies such as the Survey of India.
- Private companies need to navigate a system of permissions from different departments of the government as well as the defence & Home Ministries, to be able to collect, create or disseminate geo-spatial data.

Lack of Data

- The lack of data impedes planning for infrastructure, development & businesses which are data-based.
- The mapping of the entire country with high accuracy by the Indian government alone **could take decades**.
- The government therefore felt an urgent need to incentivise the geo-spatial sector for Indian companies & increased investment from private players in the sector.

Changing Needs (Geo-spatial data is the new oil which is not exploited to the fullest)

- For decades, geo-spatial data has been a priority for strategic reasons & for security concerns.
- Google Earth showed satellite imagery but Indian companies weren't allowed the same!
- Kargil war highlighted the dependence on foreign data & the need for indigenous sources of data.
- Geo-spatial data has now become imperative for the government in planning for infrastructure, development, social development, natural calamities as well as the economy.
- Maps & accurate geospatial data are **crucial for national infrastructure projects** such as linkages of rivers, creation of industrial corridors, & deployment of smart power systems.
- Emerging vibrant initiatives such as Digital India, Smart Cities, eCommerce, **health (tracking of diseases, patients, hospitals etc.)**, autonomous drones, delivery, logistics & urban transport require a leap forward in mapping with greater depth, resolution & precision.

Global Push:

- There has also been a global push for open access to geo-spatial as it affects the lives of ordinary citizens.

- Large amounts of geo-spatial data are also available on global platforms, which makes the regulation of data that is freely available in other countries, untenable.

Benefits are encouraging

- Unprecedented accuracy down to a few centimeters in mapping.
- Increased speed to process data in real time.
- Facilitating the need for a scale, to cover the entire country.
- Enhance the preparedness of the country for emergency response.
- Further boost to **Digital India** & development in all sectors.
- Fetching implications on agriculture, mining, logistics, delivery services, construction of dams, highways, railways & communication.

Sectors that will benefit the most

- E-commerce websites like Amazon, food delivery apps like Swiggy, Zomato & transport apps like Uber & Ola.
- Finance and banking sector applications like Phone Pay, Paytm, etc.

Land Demarcation: SVAMITVA scheme

- Central sector scheme launched by PM Modi on **National Panchayat Day, 24 April 2020.**
- Aims to provide an **integrated property validation solution for rural India**.
- Demarcation of rural areas to be done using **Drone Surveying technology**.
- The new scheme will **help dissolve the problem of property disputes**.
- It will provide a **"record of rights"** to village household owners enabling them to use their property as a financial asset for procuring loans from banks.

Impact on Startup India & Digital India

Start up India	Digital India
• In will encourage creating applications like hyper spectral imaging sensors, providing information on crop quality, type etc.	• The reforms will **allow Indian companies to develop applications like Google Earth & Google Maps**. • Will greatly help companies like mapmyindia.com
• Will encourage building tools for mapping & surveying, such as drones, aerial vehicles,	• Democratizing data will enable the rise of new technologies like **remote sensing** in agriculture & allied sectors.

mobile mapping systems, LIDAR & RADAR sensors, etc.	
• Will provide a base for increased skill development to meet the new technology.	• The reforms will unlock opportunities for our country's private sector, public sector & research institutions to drive innovations & build scalable solutions.

Concerns

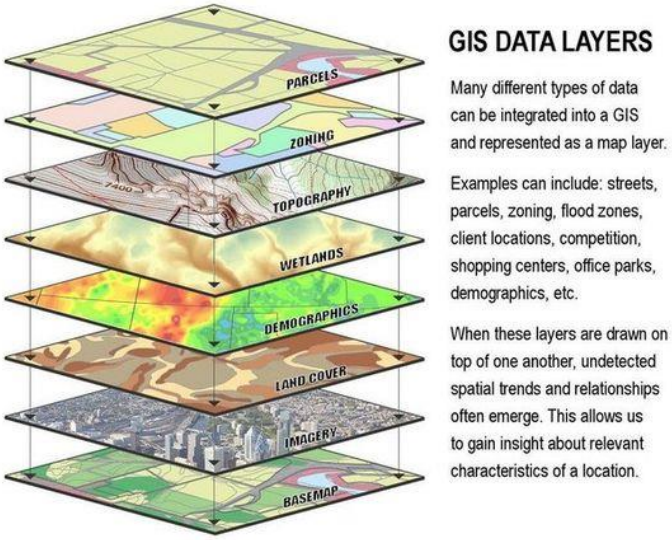
- The armed forces have opposed geospatial mapping of borders & coastline by private companies.
- Every satellite imagery expert had demarcated the LAC according to their own perception.
- Checks & balances are required so that borders are not wrongly mapped & published by private entities.

Geospatial Technology

- Geospatial technology enables us to acquire data that is referenced to the earth & use it for analysis, modelling, simulations & visualization.
- It allows us to make informed decisions based on the importance & priority of resources.
- Geospatial Technology includes **Geographic Information System (GIS), Remote Sensing (RS)** & **navigation systems** like Global Positioning System (GPS).

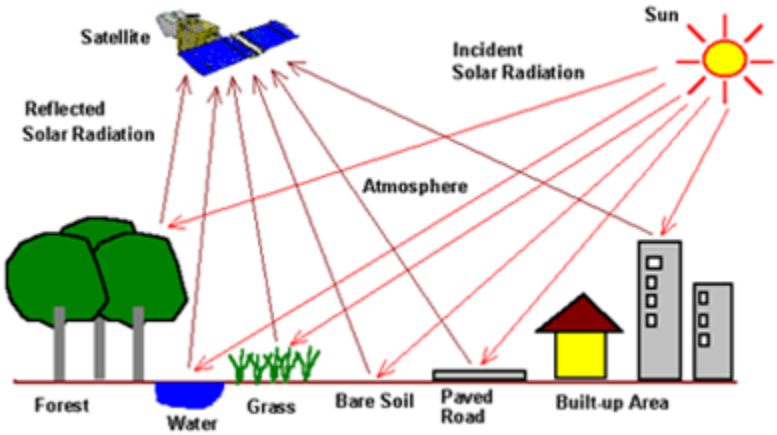
Geographic Information System (GIS)

- GIS is a **computerised data storage & retrieval system**, which can be **used to manage & analyse spatial data**. It can integrate all types of information & interface with other decision support tools.
- GIS can display analysed information in maps that allow better understanding of interactions & decision-making based on such spatial relationships.



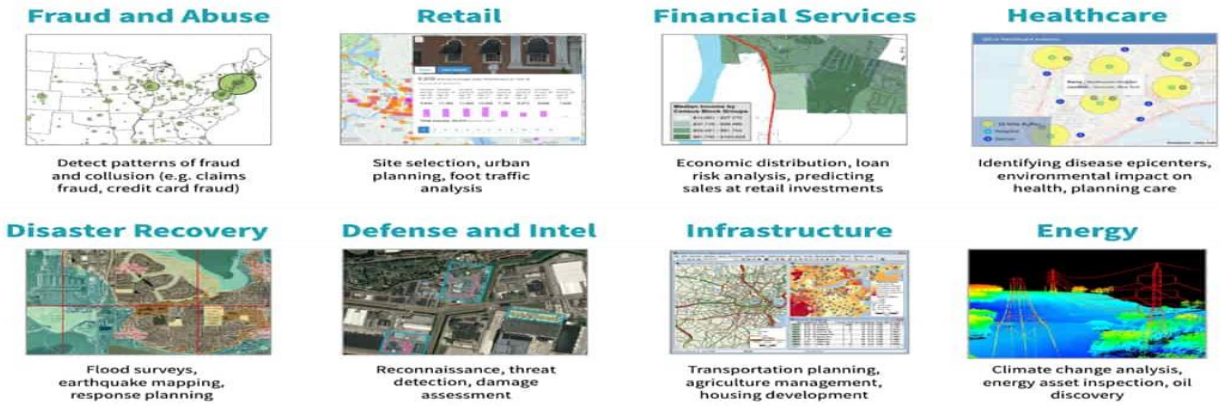
Remote Sensing (RS) Technique

- RS is the science of making inferences about material objects from measurements, made at distance, without coming into physical contact with the objects under study.
- The RS system consists of a sensor to collect the radiation & a platform — an aircraft, balloon, rocket, satellite — on which a sensor can be mounted.



Applications of Geospatial Technology

- Everyday billions of handheld & IoT devices along with thousands of airborne & satellite remote sensing platforms generate tremendous geospatial data.
- This boom of geospatial big data combined with advancements in machine learning is enabling organizations across industry to build new products & capabilities.
- For example, companies are amassing highly contextualized **geospatial data from vehicle sensors** to deliver the next innovation in **self-driving cars (autonomous vehicles)**.
- E-commerce companies & government agencies are also looking to make best use of their geospatial data.
- For example, foot-traffic analysis can help determine the best location to open a new store or, in the Public Sector, improve urban planning.



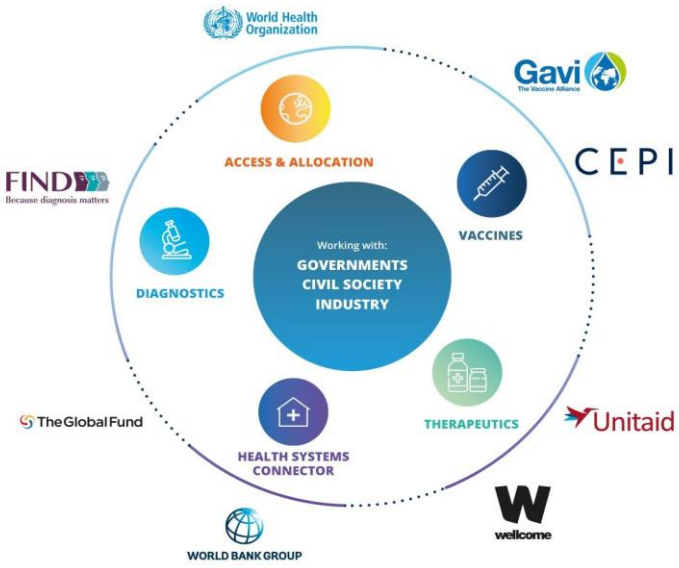
Maps leveraging geospatial data are used widely across industry, spanning multiple use cases, including disaster recovery, defense & intel, infrastructure, e-commerce & health services. Source & Credits

{S&T – In News – 2021/04} In News Topic for Prelims

ACT-Accelerator

D2E| Prelims | General Science & Science & Tech for prelims

- The **Access to COVID-19 Tools (ACT) Accelerator** is a **G20 initiative** global collaboration to accelerate development, production, and **equitable access to COVID-19 tests, treatments, and vaccines**.
- It brings together governments, scientists, businesses, civil society, and philanthropists and global health organizations.



Source and Credits

Prelims Practice: ACT-Accelerator, which was recently in news, is related to:

a) Advanced version of Large Hadron Collider (LHC) particle accelerator.
b) Global collaboration to accelerate Covid-19 treatments and vaccines.
c) NASA's first aerospace accelerator program.
d) It is 6-week program to identify high potential start-ups under Startup India scheme.

Front Hard Armour Panel (FHAP) Jacket

PIB| Prelims | General Science & Science & Tech for prelims

- **Context:** DRDO has developed light weight Bullet Proof Jacket (BPJ).

- The **Front Hard Armour Panel (FHAP) jacket** was tested has met relevant BIS standards.
- It reduced the weight from 10.4 to 9.0 kg.

What is bullet proof jackets made of? (Material used to make BPJ)

- **Kevlar synthetic fibre** has long been the most widely used material in bulletproof vests all due to its **high tensile strength-to-weight ratio**:
  - ✓ It is a **heat-resistant, strong & lightweight synthetic fibre**.
  - ✓ It has many applications, ranging from bicycle tires and racing sails to bulletproof vests.
  - ✓ It is **5 times stronger than steel**.

{S&T – Space – 2021/04} Baikal-GVD (Gigaton Volume Detector)

IE | Prelims + Mains | GS3 > Awareness in the field of Space etc.

- **Context:** Russian scientists launched one of the world's biggest **underwater neutrino telescopes** called the **Baikal-GVD (Gigaton Volume Detector)** in the waters of **Lake Baikail, the world's deepest lake**.
- The **Baikal-GVD** is one of the **three largest neutrino detectors** in the world along with the **IceCube at the South Pole** & **ANTARES in the Mediterranean Sea**.
- The construction of the telescope started in 2016.
- It aims to study in detail the **fundamental particles** called **neutrinos**.
- Some neutrinos were formed during the **Big Bang**, others continue to be formed because of **supernova explosions** or because of **nuclear reactions in the Sun**.
- Hence detecting these will aid scientists' understanding of the origins of the universe.

Why Lake Baikal?

- Baikal-GVD is located at the southern part of Lake Baikal.
- The place was chosen due to:
  - ✓ The depth of the lake (1366 meters).
  - ✓ Its flat bottom.
  - ✓ The transparency of water.
  - ✓ Existence of a railway connection.

What are fundamental particles?

- In particle physics, an elementary particle or **fundamental particle** is a **subatomic particle with no sub-structure, i.e., it is not composed of other particles**.
- These fundamental particles are **indivisible**.
- Broadly, particles of matter that scientists know **(5% of the matter)** are classified into **quarks & leptons**.
- There are 12 such quarks & leptons, but three of these (protons, neutrons & electrons) is what everything in the world is made up of.
- **Protons, neutrons & electrons** make what is referred to as the building block of life– the **atom**.
- In different combinations, these particles can make different kinds of atoms, which in turn make up molecules that form everything.
- **Protons (carry a positive charge) & neutrons (no charge)** are types of **quarks**.
- **Electrons (carry a negative charge), neutrinos, muons** & **taus** are types of **leptons**.
- Not much is known about the remaining 95 per cent of the universe.

Why Study Fundamental Particles?

- It gives scientists a window into understanding the universe a better way.
- This is one reason why scientists are so keen on studying neutrinos (not the same as neutrons), which are also a type of fundamental particle.
- **Fundamental** means that **neutrinos, like electrons, protons & neutrons cannot be broken down further into smaller particles**.

What are Neutrinos?

- Neutrinos are abundant in nature, with about a thousand trillion of them passing through a human body every second.

- They are the **second most abundant particles, after photons, which are particles of light.**
- While neutrinos are abundant, it is not easy to catch them because **they do not carry a charge**, as a result of which **they do not interact with matter**.
- One way of detecting neutrinos is in **water or ice**, where neutrinos **leave a flash of light or a line of bubbles** when they interact.
- To capture these signs, scientists have to build large detectors.
- An underwater telescope such as the GVD is designed to detect high-energy neutrinos that may have come from the **Earth's core**, or could have been produced during nuclear reactions in the Sun.

Basics: Dark Energy & Dark Matter

{S&T – Space – 2021/04} Supernova explosion traced

PIB | Prelims | GS3 > Awareness in the field of Space etc. | Basics: Star Formation (Life Cycle of A Star)

- **Context:** Indian astronomers have tracked a rare supernova explosion & traced it to one of the hottest kind of stars called Wolf–Rayet stars or WR stars.
- The rare **Wolf–Rayet stars** are **highly luminous objects a thousand times that of the Sun**.
- They are **massive stars & strip their outer hydrogen envelope** which is associated with the **fusion of Helium** & other elements in the massive core.
- Tracking of certain types of massive luminous supernovae explosion can help probe these stars that remain an enigma for scientists.

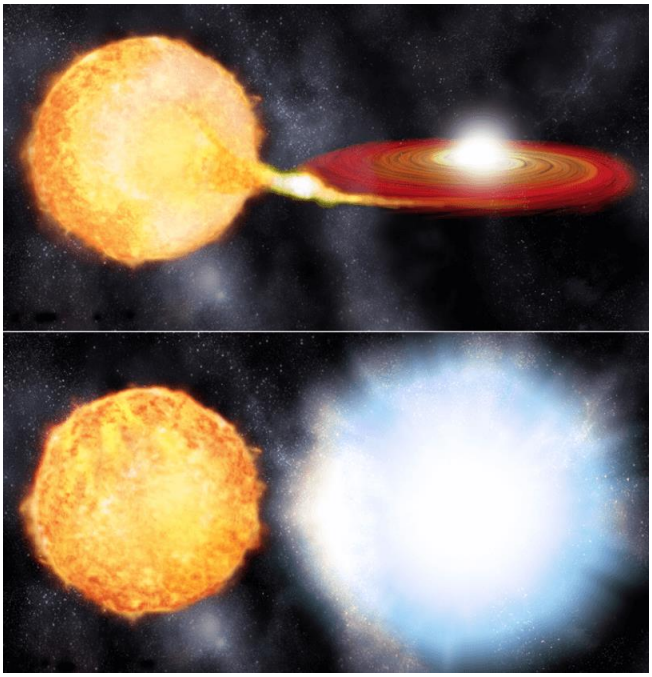
What is Supernova?

- A supernova is the **explosive death of a star** & often results in the star obtaining the brightness of 100 million suns for a short time.
- The extremely luminous burst of radiation expels much or all of a star's material at a great velocity, driving a **shock wave** into the surrounding interstellar medium.
- These **shock waves trigger condensation is a** nebula **paving the way for the birth of a new star** — if a star has to be born, a star has to die!
- Supernovae releases an **enormous amount of energy.**
- A great proportion of **primary cosmic rays comes from supernovae**.

Supernovae can be triggered in one of two ways:

Type I supernova or Type Ia supernova (read as one-a)

- Occurs when there is a **sudden re-ignition of nuclear fusion** on the surface of a **degenerate** white dwarf in a **binary system**.
- A degenerate white dwarf may accumulate sufficient material from a companion star to raise its core temperature, ignite **carbon fusion**, & trigger **runaway nuclear fusion**, **completely disrupting the star**.



Source & Credits

The difference between Nova & Type I supernova

Nova	Type I supernova
In a nova, the system can shine up to a million times brighter than normal.	A supernova is a violent stellar explosion that can shine as brightly as an entire galaxy of billions of normal stars.
As long as it continues to take gas from its companion star, the white dwarf **can produce nova outbursts at regular intervals**.	If enough gas piles up on the surface of the white dwarf, a **runaway thermonuclear explosion blasts the star to bits**.

Type II supernova

- **Type II supernova** is a supernova that occurs by the **gravitational collapse of the core** of a **massive** star (mostly made of iron). E.g., **Supernova of a** red supergiant.

Importance of supernova: Creating & dispersing new elements

- When a star's core runs out of hydrogen, the star begins to die out. The dying star expands into a red giant, & this now begins to manufacture **carbon by fusing helium atoms**.
- More massive stars begin a further series of nuclear burning.
- The elements formed in these stages range from **oxygen** through to **iron**.
- During a supernova, the star releases very large amounts of energy as well as neutrons, which allows elements heavier than iron, such as **uranium & gold,** to be produced.
- In the supernova explosion, all of these elements are expelled out into space, & new stars are born out of this matter (recycling of matter in the universe!).