TARGET PRELIMS 2024
BOOKLET-10; S&T-10
HEALTH

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2. NATIONAL FAMILY HEALTH SURVEY – 5 (NFHS)

- **Details: About NFHS**
  - The NFHS is a large-scale, multi-round survey, conducted in a representative sample of households throughout India. First survey was done in 1992-94 and since then 5 rounds have been conducted.
- **Who conducts this survey?**
  - **International Institute for Population Sciences (IIPS)**, Mumbai, is the National Nodal Agency.
  - MoHFW has decided to conduct integrated NFHS with a periodicity of three years in lieu of different surveys from 2015-16 onwards to meet the evolving requirements for frequent, timely and appropriate **data** at the National, State and District level.
  - **NFHS-5: Key Highlights**

Sl. No.	Indicator	NFHS-5 (2019-21)	NFHS-4 (2015-16)
	Fertility and Family Planning		
1	Total Fertility Rate (TFR)	2.0	2.2
2	Women age 15-19 years who were already mothers or pregnant at the time of the survey (%)	6.8	7.9
3	Current Use of Family Planning Methods-Any method (%)	66.7	53.5
4	Current Use of Family Planning Methods-Any modern method (%)	56.4	47.8
5	Total unmet need for Family Planning (%)	9.4	12.9
	Maternity and Delivery Care		
6	Mothers who had an antenatal check-up in the first trimester (%)	70.0	58.6
7	Mothers who had at least 4 antenatal care visits (%)	58.5	51.2
8	Mothers who received postnatal care from a doctor/nurse/LHV/ANM/midwife/other health personnel within 2 days of delivery (%)	78.0	62.4
9	Institutional births (%)	88.6	78.9
	Child Vaccination and Child Feeding Practices		
10	Children age 12-23 months fully vaccinated based on information from either vaccination card or mother's recall (%)	76.6	62.0
11	Children under age 6 months exclusively breastfed (%)	63.7	54.9
	Infant and Child Mortality Rates (per 1000 live births)		
12	Neonatal Mortality Rate (NNMR)	24.9	29.5
13	Infant Mortality Rate (IMR)	35.2	40.7
14	Under-five Mortality Rate (U5MR)	41.9	49.7

3. REPORTS

1) 'HEALTHY STATES, PROGRESSIVE INDIA' – A REPORT BY NITI AAYOG

- **Introduction**
  - » It is a comprehensive health index report which ranks states and UTs innovatively on their **year on year incremental change** in health outcomes, as well as their overall performance with each other.
  - » The report has been prepared by NITI Aayog with technical assistance from WB, and consultation with MoH&FW.
  - » States and UTs have been ranked in 3 categories namely Larger states, smaller states, and Union Territories (UTs) to ensure **comparison among similar entities**.
  - » The health index is a weighted composite index based on 24 indicators grouped under **three domains**, with each domain assigned weights based on its importance and higher scores for outcome **indicators**.
    - Health Outcomes (70%);
    - Governance and Information (12%);
    - Key inputs and processes (18%),

- **Significance -** An annual systematic tool; regular assessment of health sector; nudge badly performing states to do well; helps to move towards SDG goals.

4. SCHEMES/PROGRAMS/INITIATIVES

1) AYUSHMAN BHARAT – PRADHAN MANTRI JAN ARYOGYA YOJNA (AB-PMJAY)

- **About AB-PMJAY** (Pradhan Mantri Jan Arogya Yojana)
  - **Ministry:** MoH&FW
  - AB-PMJAY is an **entitlement based scheme** that aims to provide health insurance cover of upto **5 lakh rupees per family** to **over 10 crore poor families** (about 50 crore population) for **secondary and tertiary care hospitalization**. There is **no cap on the size of the family or age of the beneficiary**.
    - **All pre-existing conditions** are also covered from day 1 of implementation of PM-JAY in respective states/UT.
  - It is the world's largest government funded health care program.
  - **The eligible poor families** are decided on the basis of **SECC, 2011 data** and include poor, deprived rural families and occupational category of urban worker's families (Roughly 8.03 crore rural families and 2.33 crore urban families (11 occupational criteria))
    - In addition the beneficiary of RSBY are also included.
    - Further, there is no capping on number of family members or age of members -> this ensures that senior citizens and girl children also get good health services.
  - The scheme provides **cashless and paperless** access to services for the beneficiary at the point of service. Eligible people can avail the benefits at both **government and listed (empanelled) private hospitals**.
    - **In case of hospitalization,** members of the beneficiary families **don't need to pay anything** under the scheme, provided one goes to a government or an empanelled private hospital.
  - It is a **centrally sponsored scheme**, so, there is a state component too (**60:40**).

- It is a **portable** scheme, which means beneficiary can avail benefits in any of the states that is implementing the scheme.
- It subsumes Rashtriya Swastha Bima Yojana and the Senior Citizen Health Insurance Scheme (SCHIS**).**
- **Adhaar** card is **not mandatory** - identity to avail benefit can be established through ration card or election ID card.

2) AYUSHMAN BHARAT – DIGITAL HEALTH MISSION (AB-DHM)

- **Details**
  - The missions aim to create a **complete Digital Health Ecosystem** which will **connect the digital health solutions of hospitals across the country with each other**.
    - This digital ecosystem will enable a **host of other facilities** like Digital Consultation; Consent of Patients in letting medical practitioners access their records, etc. This will ensure that all medical records are stored digitally and are thus not lost. They would be accessible through app or web-portal.
    - All this will help in improving the quality, access, and affordability of health services by making the service delivery "quicker, less expensive, and more robust".

  - **Unique Health ID:**
    - Any person wanting to be part of ABDHM will get **a health ID**, which is a **randomly generated 14-digit number**. It will be used for **three purposes** - Unique Identification; Authentication; and Threading of the beneficiary's health records, only with their informed consent, across multiple systems and stakeholders.

    - **Facilities:**
      - You can access your digital records right from admission through treatment and discharge.
      - You can access and link your personal health records with your health ID to create a longitudinal health history.

  - **NDHM Sandbox**
    - It is a digital architecture that allows private players to be part of the National Digital Health Ecosystem as health information providers or health information users.

  - **Privacy:**
    - Citizen's consent is vital for all access.
    - Users can delete or exit the services anytime he wants.

  - **Upcoming features:**
    - Future features will enable access to verified doctors across the country.
    - The beneficiary can also create health ID for her child, a digital health records right from birth.
    - She can add a nominee to access her health ID and view or help manage the personal health records.

- Also, there will be much inclusive access with the health ID available to people who don't have phones, using assisted methods.

- **Why can't Adhaar be used as Digital ID**:
  - The Adhaar Act and Supreme Court verdict restrict the use of Adhaar ID for welfare schemes promoting government subsidies.

- **Significance:** (ease of living; optimal treatment; reduce re-testing; increased accountability; easy identification of specialists, doctors, labs; Big Data, Data Mining and Artificial intelligence-based solution etc.

A) E-SANJEEVANI – NATIONAL TELEMEDICINE SERVICE

- **Ministry:** MoH&FW
- It is an innovative, indigenous, cost-effective, and integrated **cloud based telemedicine system** application to **enable patient to doctor teleconsultation** to ensure a continuum of care and facilitate health services to all citizens in the confines of their home.

- **Two verticals of eSanjeevani**
  - **eSanjeevaniAB-HWC:** It endeavors to bridge rural-urban digital health divide by providing assisted teleconsultation, and ensuring that e-beneficiaries of AB Scheme are able to avail the benefits that they are able to entitled to.
    - It operates on Hub and Spoke Model wherein the 'Ayushman Bharat - Health and Wellness Centre' are set up at the state level, act as spokes, which are mapped with the hub (comprising MBBS/ Specialty/ Super Specialty doctors) at zonal level.
  - **eSanjeevaniOPD** is the latter vertical which caters to citizens in both **rural and urban alike**. It leverages technology via smartphones, tablets, laptops etc. enabling doctor consultation to be accessible from the patient's residence regardless of location.

- **Progress So far:**
  - As of Jan 2023, 1,12,553 HWC in rural areas and 15465 Hubs at tertiary level hospitals, and medical colleges in the states have been enabled in the **eSanjeevani**.
  - **Patients Served**: It has served 9.3 crore patients so far and is serving around 4 lakh patients daily.

- **E-Sanjeevani** is evolved into the **world's largest outpatient Services system**.
- It is a cohesive part of Ayushman Bharat Digital Health Mission (ABDM) and more than 45,000 ABHA IDs have been generated using eSanjeevani Portal.

3) PM AYUSHMAN BHARAT HEALTH INFRASTRUCTURE MISSION (PMAB-HIM)

- PMABHIM, announced in the Budget 2021-22, is the **largest pan-India Health Infrastructure Scheme** which aims to strengthen the PAN-India health infrastructure.

- It is a centrally sponsored scheme with a **budgetary outlay of Rs 64,180 crore** for the FY 2021-22 to 2025-26 and will i**mprove health care facilities from village to national level in this period**.

- There are **three major aspects** of the ABHIM - Augmenting Healthcare facilities for treatment; Setting up of integrated public health labs for diagnosis of diseases; and Expansion of existing research institutions that study pandemics.

4) DECRIMINALIZATION OF MEDICAL NEGLIGENCE

- **Why in news?**
  - » Bhartiya Nyaya Samhita has kept the punishment for medical negligence lower than the punishment for causign death by other kinds of negligence (Dec 2023)

- **Introduction**
  - » As per the **Section 106(1)** of the Bhartiya Nyaya (Second) Sanhita (BNSS), doctors will continue to face a two year imprisonment and/or fine if convicted. This is lesser than the Sanhita's recommended punishment of five years for other cases of death by negligence (for e.g. by rash driving).
  - » **Note**: The maximum imprisonment of doctors with this amendment remain the same as it was under IPC section 304A - upto 2 years of imprisonment or fine or both.
    - Medical negligence has not been clubbed with other accidental deaths where punishment has been kept higher.

- **Need of lower punishment for medical negligence:**
  - » Doctor's shouldn't be punished for honest mistakes and negligence is a complex issue in medical field and therefore this shouldn't be clubbed with other kinds of negligence.
  - » It will also reduce harassment of doctors from frivolous lawsuits and harassment.
  - » It will ensure that doctors will be able to provide care without fear of persecution and patients can be assured of quality care.

- **Criticisms:**
  - » Critiques argue that doctors should be more careful and the scope of negligence should be lesser here.
  - » Owing to the "power imbalance" in the doctor-patient relationship, an act of negligence on the part of the doctor calls not for a lower punishment but a higher one.

5) IMMUNIZATION PROGRAM IN INDIA/ VACCINATION

- **Various Initiatives**
  - » The government had launched **Expanded Program for Immunization** in 1978 which was further replaced by **Universal Immunization Program (UIP)** in 1985. It is the largest Immunization Program in the world, with the annual coverage of 2.6 crore infants and 2.9 crore pregnant women. Through this India has achieved groundbreaking success in eradicating/ eliminating life threatening vaccine preventable diseases like smallpox, Polio, Maternal Neonatal Tetanus etc.

- But despite a lot of efforts and improvements, the immunization coverage had been slow to increase with a coverage of **62%** according to NFHS-4 released in 2015-16.

- **Key Factors behind low Immunization Coverage**
  - » **Rapid and Unplanned urbanization**
  - » **Large migrating and isolated population** is difficult to cover
    - Difficult terrains, areas under LWE etc. are also difficult to cover.
  - » **Lack of awareness** among uninformed masses and unaware population leads to low demand of immunization.

- **Other problems with vaccination system in India**
  - » **Inequality in vaccine administration**
  - » **Vaccine Hesitancy: Rumor Mongering/ Misinformation among some population** also prevents full coverage.

- **Negative Impact of COVID-19 on routine vaccination**

- **Various Efforts to deal with above challenges:**

  - » **Mission Indradhanush** was launched by the MoH&FW in 2014. It is a strategic endeavor under UIP with an aim to target under-served, vulnerable and inaccessible populations.
    - It covers **8 vaccines** (Diphtheria, Whooping Cough, Tetanus, Polio, Measles, Childhood TB, Hepatitis B and Meningitis) across the country, **2 vaccines** (Pneumonia and Hemophilus influenza type B) in selected states and **2 vaccines** (Rotavirus Diarrhea and Japanese Encephalitis) in selected districts.
    - **MI** contributed to an increase of 6.7% in full immunization coverage after the first two phases of Mission Indradhanush.

  - » **Intensified Mission Indradhanush** (IMI) was launched in Oct 2017 - to achieve a coverage of 90% with focus towards districts and urban areas with persistently low levels.

  - » **In Dec 2019,** Government had launched **Intensified Mission Indradhanush 2.0 (IMI 2.0)** to be implemented between Dec 2019 - March 2020 that seeks to escalate efforts to achieve the goal of attaining a 90% national immunization coverage across the country.

  - » **Intensified Mission Indradhanush 3.0** aimed to reach those children and pregnant women who have been missed out of the routine immunization program. The first phase ran from 22nd Feb 2021 for 15 days.

  - » **Intensified Mission Indradhanush 4.0** launched in Feb 2022.
    - Three rounds of IMI 4.0 was planned to catchup on the gaps that might have emerged due to COVID-19 pandemic. The activity will be conducted in 416 districts across 33 states/Uts.
    - These districts were identified based on vaccination coverage as per the latest National Family Health Survey-5 report, Health Management Information System (HMIS) data and burden of vaccine preventable diseases.

» **Intensified Mission Indradhanush 5.0** (IMI 5.0) campaign was being conducted in three rounds**:**
  - 7-12 Aug 2023; 11-16 Sep 2023; and 9-14 Oct 2023 (**6 days every month)**
  - It aims to ensure immunization coverage of all vaccines provided under the UIP as per the National Immunization schedule.
  - **Special focus** is on improvement of Measles and Rubella vaccination coverage with the aim of Measles and Rubella elimination by 2023.
  - It ensures that routine immunization services reach the missed-out and dropped out children and pregnant women **across country**. This year, for the first time the campaign was conducted **across all districts in the country** and include children upto 5 years of age (previous campaigns included children upto 2 years of age)
  - It saw participation from ***Jan pratinidhis*** and **Social media** influencers have come in large numbers across all states/ Uts to appeal to people to visit nearest vaccination centres.

» Since 2014, 11 phases of Mission Indradhanush have been completed.

6) BCG VACCINE – 100 YEARS AND COUNTING

- BCG was first used in humans in 1921.
- **Details about BCG vaccine (bacilli Calmette-Guerin)**
  - » BCG was developed by **two Frenchmen**, Albert Calmette and Camille Guerin.
    - ▫ It is a **live attenuated strain** derived from an isolate of **Mycobacterium bovis** and has been used widely across the world as a **vaccine for tuberculosis**. Currently, it is the **only licensed vaccine** available for the prevention of TB. It is the world's most widely used vaccine with about 120 million doses every year.

  - » **Interesting Fact**: Works well in **some geographical locations and not so well in others.** Generally, the farther a country is from equator, the higher is the efficacy. Therefore, it has high efficacy in UK, Norway, Sweden, and Denmark; and little or no efficacy in countries on or near the equator like India, Kenya, and Malawi, where the burden of TB is higher. These regions also have higher prevalence of environmental mycobacteria.
    - ▫ However, **in children BCG provides strong protection** against severe forms of TB. This protective effect appears to wane with age and is far more variable in adolescents and adults, ranging from 0-80%.
    - ▫ **A large clinical trial between 1968-1983 by ICMR's National Institute for Research** in TB in Chengalpattu district of TN, indicated that BCG offered no protection against pulmonary TB in adults, and a low level of protection (27%) in children.

- **Other uses of BCG**
  - ▫ BCG also protect against respiratory and bacterial infections of the newborns, and other mycobacterial diseases like leprosy and Buruli's ulcer.
  - ▫ It is also used as an immunotherapy agent in cancer of the urinary bladder and malignant melanoma.

- **BCG in India**
  - ▫ BCG vaccinations were first conducted in India in 1948 and it became part of the National TB control program in 1962.
  - ▫ It remains a part of basket of vaccines included under the **Universal Immunization Program**.

- **Other TB vaccines:**
  - Over the last ten years, 14 new Vaccines have been developed for TB and are in clinical trials.

5. MATERNAL HEALTH – SCHEMES

A) UNDERSTANDING MATERNAL MORTALITY RATE

- Maternal death is the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of duration of pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes.

Table VI.18: Trends in Mortality indicators

	2014	2016	2018	2020
Maternal Mortality Ratio (per lakh live births)	167 (2011-13)	130 (2014-16)	113 (2016-18)	97 (2018-20)
Infant Mortality Rate (per 1000 live births)	39	34	32	28
Neonatal Mortality Rate (per 1000 live births)	26	24	23	20
Under 5 Mortality Rate (per 1000 live births)	45	39	36	32
Early Neonatal Mortality Rate – 0- 7 days (per 1000 live births)	20	18	18	15

Source: Sample Registration System

- As per the **Sample Registration Survey (SRS) data**, India has successfully achieved the major milestones to bring Maternal Mortality Ratio (MMR) to below 100 per lakh live births by 2020 [laid down in the National Health Policy, 2017]
- **Eight states** have already achieved the 2030 SDG targets to reduce MMR to less than 70 per lakh live births by 2030. These include Kerala (19), Maharashtra (33), Telangana (43), Andhra Pradesh (45), Tamil Nadu (54), Jharkhand (56), Gujarat (57), and Karnataka (69).

B) NATIONAL HEALTH MISSION 2013

- With respect to mother's health, the NHM includes following initiatives:
  - Reproductive Maternal Neonatal Child and Adolescent Health (RMNCH+A) Program
  - **Janani Surakha Yojna** (JSY) to promote **institutional delivery** which is expected to reduce neo-natal and maternal mortality.

C) JANANI SURAKHA YOJANA (2005 SCHEME)

- **The JSY** is a safe motherhood intervention launched in 2005 as part of the NRHM to **improve maternal and neonatal health** by promotion of **institutional deliveries** (childbirth in hospitals).

- It is a 100% centrally sponsored scheme which **integrates cash assistance with delivery and post-delivery care**

- **Key Features**
  - » Financial assistance under JSY is available to all pregnant women in states that have low institutional delivery rates namely, UP, UK, Bihar, Jharkhand, MP, Chhattisgarh, Orissa, Assam, Rajasthan & J&K (categorized as low performing states).
  - » In remaining states (where institutional delivery are satisfactory, pregnant women from BPL/SC/ST households only are entitled for JSY benefits.

» It is implemented through ASHA, the accredited social health activists, acting as an effective link between the Government and poor pregnant women under the scheme.

D) JANANI SHISHU SURAKSHA KARYAKRAM

- The program launched in 2011 entitles all pregnant women delivering in public health institutions to absolutely free and no expense delivery including Caesarean section.
  - The program stipulates free drugs, diagnostics, blood and diet, besides free transport from home to institution, between facilities in case of a referral and drop back home.
  - Similar entitlement has been put in place for all sick infants accessing public health institutions for treatment.

E) MATERNITY BENEFIT SCHEME (MBS) / PRADHAN MANTRI MATRITVA VANDANA YOJANA (PMMVY)

- **Details of the Scheme:**
  - Under PMMVY a 'cash incentive of Rs 5,000 is provided directly to the bank account of the pregnant or lactating mothers for the first living child of the family.
  - It is aimed at improving health seeking behavior, arresting MMR, ensuring proper nutrition and **offsetting wage loss**.
  - The scheme is being implemented from 1st Jan 2017.

- **Target Women**
  - Eligible PW&LM, excluding women in regular employment who are in receipt of similar benefits under any law for the time being.

- **Other key provisions of the scheme**:
  - Center: State Share: 60: 40
  - The benefit of Rs 5000 to PW&LM in three installments for the birth of first live child by MWCD and remaining incentives as per the approved norms towards maternity benefit under existing programs after institutional deliveries so that on an average women would receive Rs 6,000.
  - Conditional cash transfer scheme would be in DBT mode.

- **Limitation of the Scheme**
  - **Only for first child**
  - **Amount too small**
  - **Several conditions attached**
  - **Subsuming of Janani Surakha Yojana**: JSY which is a cash based incentive of Rs 14,00 for institutional deliveries, has been subsumed under this scheme. JSY is an older scheme started for a different purpose and should not be confused with maternity benefits for wage compensation.

F) STATE GOVERNMENTS RUNNING THEIR EFFECTIVE SCHEMES (TN AND ODISHA)

- **Dr. Muthulakshmi Reddy Maternity Benefit Scheme** in TN provides for financial assistance of Rs **18,000** per child for the **first two children**.
- **MAMATA Scheme** of **Odisha** provides **Rs 5,000** for first two children.
  - These two schemes are working reasonably well due to their wider coverage and simpler process.
  - In 2020-21, MAMATA showcased a 57% increase in women who received all installments, and PMMVY showcased a decrease.

6. NUTRITION

1) VARIOUS INITIATIVES TO FIGHT MALNUTRITION IN THE COUNTRY

- The government is implementing several schemes and programs under the Umbrella ICDS Scheme as direct target interventions to address the problems of malnutrition in the country.

- Initiatives like **PDS, Mid-Day Meal Scheme**.
  - In **Sep 2021**, the Mid day meal scheme has been renamed to **PM POSHAN**.
    - Under this not only Children of class 1 to 8 (around 11.8 crore) will be covered, but also around 24 lakh students receiving pre-primary education at government and government aided schools will also be brought under the ambit of the scheme from next year. This is in line with NEP which had recommended that the pre-school education should be formalized.

- **Poshan Abhiyan** (POSHAN -> PM's overarching scheme for holistic nutrition) (earlier known as **National Nutrition Mission**) is being implemented since 2017. It is aimed at reducing malnutrition in the country in a phased manner, through a **lifecycle approach**. It focuses on **children, pregnant women, and lactating mothers**.
  - » It has an aim to build a people's movement (Jan Andolan) around malnutrition.
  - » For implementation of **POSHAN Abhiyan** the four-point strategy/pillars of the mission are:
    - Inter-sectoral convergence for better service delivery
    - Use of Technology (ICT) for real time growth monitoring and tracking of children
    - Intensified health and nutrition for the first 1000 days
    - Jan Andolan
  - » **Target** was to bring down the **stunting of the children** in the age group of 0-6 years to **25%** by the year 2022.

- **Mission Poshan 2.0**
  - » COVID-19 had worsened the situation and therefore, it was important to multiply our efforts towards **Poshan 2.0** with full vigour.
    - It is an umbrella program that encompasses ICDS (Anganwadi Services, Poshan Abhiyan, Scheme for Adolescent Girls, National Creche Scheme). It was announced in Union Budget 2021-22 and **has merged** supplemental nutrition programs and the POSHAN Abhiyan to tap the synergies.
    - Under this, malnutrition hotspots and aspirational districts will get extra attention.

- Steps to promote AYUSH systems for prevention of malnutrition and related diseases.

- A program to support development of **Poshan Vatikas at Anganwadis centres** to meet dietary diversity gap leveraging traditional knowledge in nutritional practices.

- **NFSA, 2013** which provides for coverage of upto 75% of the rural population and upto 50% of the urban population for receiving highly subsidized food grains under TPDS.

- **Pradhan Mantri Garib Kalyan Anna Yojna** (PMGKAY)

2) MICRONUTRIENTS VS MACRO NUTRIENTS

A) MICRONUTRIENTS

- These are the **vitamins and minerals** that our bodies need each day in order to properly function. Unlike macronutrients they are needed in small amounts.
    - **Vitamins** can be classified into **13 major types:** Vitamins A, B-Complex (Thiamine, riboflavin (Vitamin B2), niacin, pantothenic acid, biotin, vitamin-B-6, Vitamin B12, and folate), C, D, E and K.
        - They are organic compounds. They can be classified into two categories:
            i. **Fat Soluble**
                - A,D, E and K
                - Important role in overall health by promoting healthy bones, skin, eyesight, lungs and digestive systems.

            ii. **Water Soluble**
                - B-Complex and C
                - Not stored in fat (like fat soluble vitamins), so daily consumption is important.
                - They boost metabolism, act as powerful antioxidant and assist in the formation of collagen helping in healing wounds.

        - **Vitamin D**
            - Vitamin D is an essential vitamin that helps regulate calcium and phosphorus in the body. It also plays a role in maintaining bone structure.
            - There are different forms of Vitamin D, including **ergocalciferol (Vitamin D2)** and **Cholecalciferol** (Vitamin D3).
                - It is found in fish, eggs and fortified milk. It's also made in the skin when exposed to sunlight. During periods of sunlight, Vitamin D is stored in fat and then released when sunlight is not available.

    - **Minerals** can be further classified as **major minerals** and **trace minerals**.
        - The six major minerals include sodium, potassium, chloride, calcium, phosphorus and magnesium. They are required in large amounts in body as compared to trace minerals. They are important for maintaining proper fluid balance and electrolytes (sodium and potassium) as well as help in supporting bones, hair, skin and nail health.

- Trace minerals are required in smaller quantities, but are as important as major minerals. The **nine trace** minerals include cooper, zinc, iron, iodine, manganese, molybdenum, cobalt, selenium and fluoride.

B) MACRO-NUTRIENTS

- **These** are the main nutrients that make up the foods we eat. There are three macro-nutrients - **Carbohydrate, Protein and Fat**.

FATS - SIGNIFICANCE - LIMITATIONS AND TYPES

- **Significance of fats as nutrients**
  - It is the most concentrated form of energy. Body uses fat as a fuel source and as major storage of energy.
  - It helps in absorbing vitamins like A, D, E and K.
  - They also provide cushioning for the organs.
  - They are an important constituent of cell membrane and provide taste, consistency, and stability.

A) TRANS FAT VS SATURATED FAT VS MONO-SATURATED FAT VS POLY-UNSATURATED FAT

- All fats have a similar structure - a chain of carbon atoms bonded to hydrogen atoms.
- The differentiating factor is the length and shape of the carbon chain and the number of hydrogen atoms connected to the carbon atoms.

1) Trans Fat (worst type of dietary fat)

- According to the World Health Organization, approximately 5.4 lakh deaths take place each year globally because of the intake of industrially produced trans fatty acids. They come in both natural and artificial forms.

- Trans fats are the result of **partial hydrogenation of unsaturated fat**. This turns healthy oil into solids.
  - **Process:** Heating liquid vegetable oils in the presence of hydrogen gas and a catalyst, a process called hydrogenation.
  - **Advantages:**
    - Partial hydrogenation of vegetable oil makes them more stable and less likely to become rancid. The process also converts the oil into a solid, which makes it easy to handle.
    - Partial hydrogenation oils can withstand repeated heating without breaking down, making them ideal for frying fast foods.

  - **Note**: Partial hydrogenation is not the only source of trans-fat in our diet. Trans fats are also naturally found in beef fat and dairy fat in small amounts.
  - Trans fats have **no known health benefits** and **no safe level of consumption**.

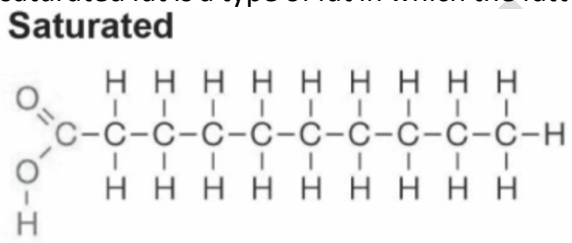
- **Disadvantages:**
  - Trans-fats are worst type of fat for the heart, blood vessels, and rest of the body:

- Eating trans-fat increases harmful LDL (low density lipoprotein) cholesterol in the blood stream and reduces the amount of beneficial HDL (high density lipoprotein) cholesterol. It is linked to heart disease, stroke, diabetes, and other chronic conditions.
- They contribute to insulin resistance.

- It is **banned** in many countries. India currently allows trans-fatty acids upto 3% (by weight).
- In Jan 2020, FSSAI has capped the amount of trans fatty acids (TFA) in oils and fats to 3% for 2021 and 2% by 2022, from the current permissible limit of 5% through an amendment to the Food Safety and Standards (Prohibition and Restriction on Sales) Regulations.
- **In May 2018**, WHO also gave a call to eliminate trans-fat in foods by 2023.
- For this WHO has launched an initiative **REPLACE**, that will provide guidance for all countries on how to remove artificial trans fats from their foods, possibly leading to worldwide eradication.
  - It stands for **Review** dietary sources, **Promote** use of healthier fats, **legislate**, **assess** changes, **create** awareness, and **Enforce** regulation.
  - The initiative promotes countries to establish legislation to eliminate the trans-fats.

3) Saturated Fats

- A saturated fat is a type of fat in which the fatty acid chains have all or predominantly single bonds.



- Common **source** of saturated fats are red meat, whole milk and other whole milk dairy products, coconut oils etc.

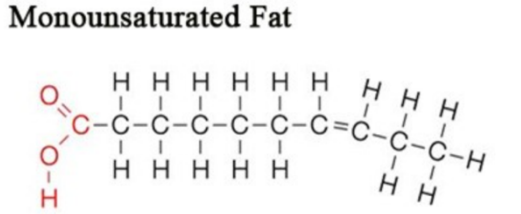
- **Health Impacts**
  - Can drive harmful LDL cholesterol.
  - But recent research, have again raised the debate whether saturated fats are actually harmful and cause heart disease.

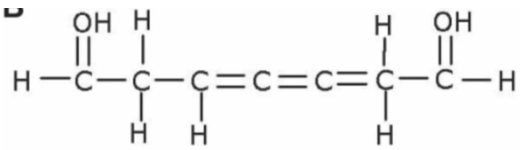
4) Monounsaturated Fat and Poly Unsaturated Fats

- **Monounsaturated Fats** are fatty acid chains that have one double bond in the fatty acid chain with all the remainder carbon atoms being single-bonded.

- **Poly Unsaturated Fats** are fatty acids with more than 1 double bond.
- Thus, these fats have fewer hydrogen atoms bonded to carbon atoms when compared to saturated fats.
- They are liquid at room temperature.

- **Sources of monounsaturated fats**





- Olive Oil, peanut oil, canola oil, avocados, nuts etc.

- **Sources of Polyunsaturated oils**
  - Corn oil, sunflower oil, and safflower oil, fish oil etc. are common examples.
  - These are **essential fats** and are required for normal body functioning, but our body can't make them. They are used in building of cell membrane and covering of nerves. They are also needed in blood clotting, muscle movement and inflammation.

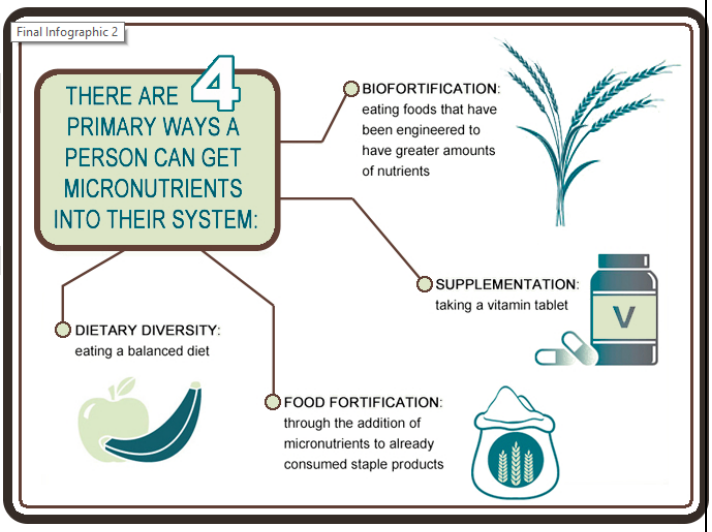
- **Two Main types of Polyunsaturated Fatty Acids**
  - **Omega-3 Fatty Acids**
  - **Omega-6 Fatty Acids**

3) FORTIFICATION OF FOOD

A) FOOD FORTIFICATION

- Fortification means deliberately increasing the content of **essential micronutrients** in a food so as to improve the nutritional quality of food and to provide public health benefits with minimal risk to health.

- **Advantages of Food Fortification** over other nutrition fulfillment mechanisms:
  - **Cost Effective:**
  - **Well Proven Method:**
    - » It has been used around the world since 1920s.
    - » WHO, UNICEF, FSSAI all approve it.
  - **Eating Habits not needs to be changed**
  - **Socio-culturally more acceptable**
  - **Scalable and Sustainable:** Can be introduced quickly and can provide nutritional benefit to people in short period of time.



- **Different ways in which people get micro-nutrients** and why food fortification can be effective.
  - Since most population in resource-poor settings do not have access to adequate quantities of fruits, vegetables, and meats where micronutrients are abundant, and because providing vitamin tablets poses logistical and economic constraints, food fortification is a practical and inexpensive alternative.

B) BIOFORTIFICATION:

- » Biofortification is the process by which the nutritional quality of the food crops is improved through **agronomic practices**, **conventional plant breeding**, or **modern biotechnology**.
- » It aims **to increase nutrient level in crops during plant growth** rather than through manual means during processing of the crops.

» Biofortification may therefore present a way to reach population where supplementation and conventional fortification activities may be difficult to implement and/or limited.
» Scientists at ICAR have been developing biofortified crops in India with a view to eradicating malnutrition amongst the poor sections of society. As per ESI 2021-22, currently in India the number of biofortified varieties have increased to **87**.
    - None of these are GM crops. They have been developed through conventional crop breeding techniques.
» E.g.
    - Zinc biofortification of wheat, rice, beans, sweet potatoes and maize

C) RICE FORTIFICATION: EXTRUSION TECHNOLOGY:

» In his Independence Day Speech (Aug 2021), PM Modi announced fortification of rice distributed under various government schemes, including the PDS and midday meals in schools, **by 2024**.

» **Various technologies** are available for rice fortification - coating, dusting etc. But **'extrusion'** is considered the best technology. This involves the production of fortified rice kernels (FRKs) from a mixture using an extruder machine. The fortified rice kernels are then blended with regular rice to produce fortified rice.
» **How does extrusion technology to produce FRK work?**
    - Dry rice flour is mixed with a premix of micronutrients, and water is added to this mixture. This mixture then goes into twin-screw extruder with heating zones, which produce kernels similar to shape and size to rice. These kernels are dried, cooled and packaged for use. FRK have shelf like of at least 12 months.
    - As per the guidelines issued by the Ministry of Consumer Affairs, Food and Public Distribution, t**he shape and size of the fortified rice kernel should "resemble the normal milled rice as closely as possible**". According to the guidelines, the length and breadth of the grain should be 5 mm and 2.2 mm respectively.

» **According to FSSAI norms, 1 kg of fortified rice will contain the following**:
    - Iron (28 mg-42.5 mg), folic acid (75-125 microgram), and vitamin B-12 (0.75-1.25 microgram).
    - Rice **may also be fortified** with zinc (10 mg-15 mg), vitamin A (500-750 microgram RE), vitamin B-1 (1 mg-1.5 mg), vitamin B-2 (1.25 mg-1.75 mg), vitamin B-3 (12.5 mg-20 mg) and vitamin B-6 (1.5 mg-2.5 mg) per kg

» **Why is rice fortification needed?**
    - High levels of Anaemia and malnutrition in India. Rice is a stable crop of India.

» **Cost of fortification:**
    - The Ministry estimates that the cost of producing FRK with three micronutrients - iron, folic acid, and vitamin B-12 - will come to around Rs 0.6 per kg. This cost is shared between centre and states and government will pay this cost to rice millers.

» **Identification:**

- Fortified rice will be packed in jute bags with the **logo ("+F")** and the line "Fortified with Iron, Folic Acid, and Vitamin B12" will be mandatorily printed on them.

» **Has any other country done this?**

- Rice fortification is mandatory in 7 countries: The USA, Panama, Costa Rica, Nicargua, Papua New Guinea, Phillipines, and the Solomon Islands.

4) DISEASES DUE TO NUTRITIONAL DEFICIENCIES

Disease	Deficiency of	Other comments
Rickets	Vitamin D along with calcium and potassium	- Rickets is characterized by weak and soft bones, bowed legs and bone deformities. - Fish, fortified dairy products, liver, oil and **sunlight** are some rich sources of vitamin D.
Osteoporosis	Vitamin D with Calcium	- Deficiency of Vitamin D and calcium in the body can negatively affect the health of the bones and spine. It leads to unhealthy, soft and brittle bones that are prone to fractures and defects in the spine structure. - Bananas, spinach, milk, okra, soy and sunlight are natural sources of Vitamin D and calcium that act to eliminate this deficiency
Pellagra	Vitamin B3 or Niacin	- **4D's**: Dementia, diarrhea, dermatitis and death are the four Ds that characterize Pellagra. - Tuna, whole grains, peanuts, mushrooms, chicken etc.
Scurvy	Vitamin C or ascorbic acid	- Scurvy basically inhibits the production of collagen in the body which is the structural protein that connects the tissues. • Decaying of skin and gums, abnormal formation of teeth and bones, delay or inability to heal wounds and bleeding are the effects of scurvy - **Vitamin C** can be derived from Citrus fruits like oranges, lemon, strawberry etc. and Broccoli regularly.
Beri-Beri	**Vitamin B1 or Thiamin**	- The most common symptoms of this illness are altered muscle coordination, nerve degeneration and cardiovascular problems. - Meat, eggs, whole grains, dried beans etc are rich in thiamine and thus, should be consumed in proper amounts every day to avoid this painful ailment

Xerophthalmia or Night Blindness	Vitamin A	- Xerophthalmia or night blindness is characterized by blindness due to the **poor growth, dryness and keratinisation of epithelial tissue or chronic eye infection**. - In worsened situations, night blindness can aggravate to complete loss of vision - The safest way to enhance the Vitamin A levels in the body is by consuming natural food sources like carrots, green and leafy vegetables, cantaloupes etc
Goitre	Iodine	- Goitre leads to **enlarged thyroid glands** causing hypothyroidism, poor growth and development of infants in childhood, cretinism and even mental retardation - This disease is commonly found to occur in places having **iodine deficit soil**. Iodised salt and saltwater fish are rich sources of iodine, and must be consumed regularly to avoid goitre.
Anaemia	Iron	- It is characterized by a decrease in the red blood cell count or haemoglobin in the body, resulting in fatigue, weakness, dyspnoea and paleness of the body. - It can be easily treated by changing to a healthy diet and consuming iron supplements on a regular basis. Squashes, nuts, tofu, bran etc are rich sources of iron for the body. -
Kwashiorkor	Protein and Energy	- It is characterized by anorexia, an enlarged liver, irritability and ulcerating dermatoses. - These are the one of the nutritional deficiencies in children, especially from famine-struck areas and places with poor food supply, **Kwashiorkor is caused by malnutrition**. - A healthy and balanced diet enriched with protein and carbohydrate sources like eggs, lentils, rice etc helps combat this problem
Depression	deficiency of Vitamin B7 or biotin	- This deficiency can be fatal if present in an aggravated form. - Consume poultry products, dairy items, peanuts, nuts etc that are rich sources of biotin. These must be consumed along with supplements to recover and prevent these illnesses

7. SOME NUTRITION BASED UPDATES

1) ANAEMIA

- **What is Anaemia:**
  - » It is a condition in which number of red blood cells or the hemoglobin concentration within them is lower than normal or there are abnormal red blood cells.
  - » This negatively hampers the ability of blood to carry oxygen to tissues (Note: It is the hemoglobin which attaches to oxygen).
  - » It results into symptoms such as fatigue, weakness, dizziness, shortness of breath etc.

- **Causes:**
  - » **Nutritional Deficiency** - particularly iron deficiency, deficiency of folate (vitamin B-9 is important for RBC formation and for healthy growth and function), vitamin B12 and Vitamin A.
  - » **Haemoglobinopathies**: (hemoglobin C disease, hemoglobin S-C disease, Sickle Cell Anemia, and Thalassemia)
  - » **Infectious** diseases which impact blood such as malaria, TB, HIV and parasitic infections may also cause Anaemia.

- **Impact:**
  - » Anaemia compromises immunity and impedes cognitive development.

- **Global Situation:**
  - » As per WHO, around 42% of children under 5 and 40% of pregnant women worldwide are anaemic.

- **Anaemia Situation in India:**
  - » Between 2005 - 2015, the anaemia situation declined marginally in India.
  - » **But, as per the NFHS-5, the incidence of Anaemia** in under-5 **children** (from 58.6 to **67%**), **women** (53.1% to 57%) and **men** (22.7% to 25%) has worsened in all states of India (20%-40% is considered moderate) (when compared to NFHS-4)

- **Factors which cause high levels of Anaemia?**
  - » Cereal centric diet with less consumption of iron rich food groups like meat, fish, eggs, and Dark Green Leafy Vegetables (DGLF).
  - » Poor sanitation situation; lack of women empowerment etc.

- **India's great anaemia mystery** – class discussion

8. VIRAL DISEAES VS BACTERIAL DISEASES

i. **Why can't we cure virus infection?**
   - ▫ **Bacteria** are living cells. They have outer antigens which can be targeted by human immune system and form the basis of vaccines. The cells of a bacteria contain unique (to bacteria) structures which can be disrupted by bactericidal antibiotics without affecting human cells too

much; these provide broad targets for therapy. The majority of bacteria find a place to grow inside a human/further invade tissues, but don't actually enter and live within a human cell. This gives them greater exposure to antibiotics and easier exposure to immune system.

- **Bacteria are virulent by two mechanisms.**
  - **Toxin production**
  - **Invasion/inflammation**
  - Exotoxins in particular are often treated with formaldehyde, acid, or heat in order to convert them into **toxoids**, which means they are still antigenic but have lost their toxicity. This provides another critical target for vaccines and treatments of bacteria that doesn't exist in (most) viruses. **Component of bacterial vaccines include these inactivated toxoids,** the outer capsular antigens of bacteria without the bacteria inside or other purified bacterial proteins, killed bacteria, or live (attenuated) bacteria.
  - Furthermore, antitoxins (pre-formed immune globulins which will target the bacterial antigens) are available to counteract the toxins of such bacteria as tetanus, diptheria etc.
- **Bacteria** can also be targeted by several branches of immune system at its own.

- **Viruses** on the other hand are not cellular. We can't kill them simply by disrupting their cells. They are infective nucleic acid that cannot replicate outside living cells.
  - Some viruses replicate inside human cells and then bud off from the human cell inside an "envelope" made from the human cell's membrane, which helps them evade the immune system on their way to infecting another human cell.
  - Many viruses are protected by protein capsids, which are extremely protective -- unlike a bacterial cell wall or membrane, the virus doesn't have to be alive inside the capsid or exchange nutrients and waste with environment across the capsid; the capsid is merely there to protect the nucleic acid of the virus.
  - **Each virus uses a different receptor**
    - Viruses need to match some sort of receptor in order to gain entry into human cells, and in some viruses, this receptor is one of the few good targets for drug therapy; however, unlike antibacterial, the drug will only work for that particular virus/receptor, because each virus uses a different receptor

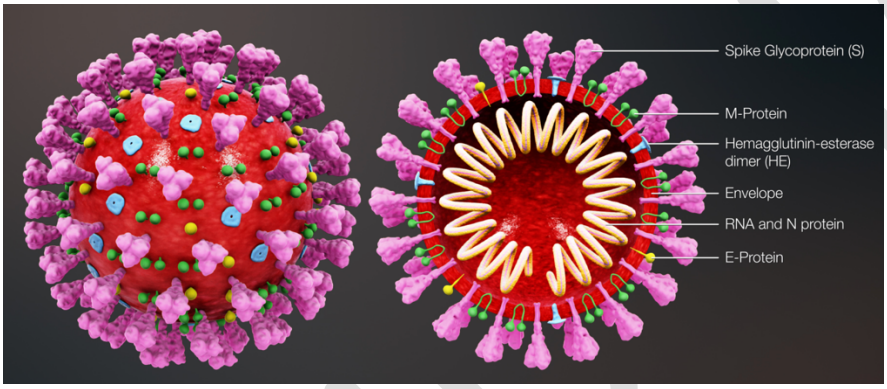
9. COVID-19

1) CORONA VIRUSES

- Coronaviruses are a group of viruses in the **subfamily Orthocoronavirinae,** in the **family Coronaviridae.** In humans they are known to cause infection in upper respiratory tract (sinuses, nose and throat) and/or lower respiratory tract (windpipe and lungs).
  - » **Most** of these viruses are harmless, but **some** can cause less severe common cold to more severe diseases such as severe acute respiratory syndrome (SARS), Middle East Respiratory Syndrome (MERS) and COVID-19.

- Coronaviruses were first identified in the 1960s. Almost everyone gets a coronavirus infection at least once in their life, most likely as a young child. The symptoms of most coronavirus are similar - a runny nose, coughing, sore throat and sometimes a fever.

- Many Coronaviruses are **zoonotic** i.e., they are transmitted from animals to humans.
  - » **SARS** coronavirus is believed to be an animal virus from an as-yet-uncertain animal reservoir, perhaps bats, that spread to other animals (civet cats) and first infected humans in the Guangdong province of Southern China in 2002.
  - » The **MERS** coronavirus was passed on from dromedary camels to humans in Saudi-Arabia in 2012.
  - » **SARS-COV-2** also seems to have transmitted from bats to humans (not confirmed yet). Pangolin may have acted as intermediary.
    - Note: SARS-COV-2 is a coronavirus very similar to the one that causes SARS.
- **Structure**



  - » They are enveloped viruses with a **positive sense single stranded RNA genome** and a nucleocapsid of helical symmetry.
  - » The genome size of the coronaviruses ranges from approximately 26 to 32 kilo bases, one of the largest among RNA viruses.

2) SARS-COV-2: NAMING, STRUCTURE AND PHYSIOLOGY

- SARS-COV-2 is one of the seven known types of known Corona virus, including SARS and MERS.
  - » **Naming of the Virus**: The Coronavirus Study Group of the International Committee on Taxonomy of Viruses, which had assessed the novelty of the human pathogen, has named the virus as "**Severe Acute Respiratory Syndrome Coronavirus 2**", or "**SARS-COV-2**".

3) STRUCTURE OF THE VIRUS

- Like other Coronaviruses, SARS-COV-2 virus particles are **spherical** in shape and have mushroom shaped protein called **spikes** protruding from their surface.
  - » The **spike binds and fuses with human cell**s, allowing the virus to gain entry.
  - » The spike protein of the novel coronavirus **shares 98% sequence identity** with the spike protein of the bat coronavirus.
  - » The spike of the virus has something called a **receptor binding domain** (RBD) which facilitates the virus entry into the target cells by binding with the cellular receptor called **Angiotensin**

Converting Enzyme 2 (ACE2), which serves as the entry point into human cells. SARS corona virus also used the same mechanism for entry into the cells.

- But unlike SARS the case of SARS Corona, the **spike protein of the novel coronavirus binds to the cell receptor with much higher affinity - 10 to 20-fold higher**.
- This much higher binding affinity to the cell receptor explains high human to human transmission of the virus compared to SARS coronavirus.

- The virus (or virus particle) is **50-200 nm** in diameter.

4) NAMING OF THE DISEASE – CORONA VIRUS DISEASE-19 (COVID-19)

- On Feb 11, 2020, the **WHO officially announced COVID-19** as the name for the disease caused by the n-COV (novel Coronavirus)
  - » The name has a **standard format** to be used in any future corona virus disease.

- **Why was it important to name the disease?**
  - » To prevent the use of other names that can be "inaccurate or stigmatizing".

- Based on WHO's May 2015 guidelines.

5) COVID-19 DISEASE CAUSED BY INFECTION OF SARS-COV-2 (2019 N-COV)

- **Early symptoms** include - Fever, Dry Cough and Fatigue.
- The virus can lead to **pneumonia**, **respiratory failure**, **septic shock**, and **death**.

- **How does SARS-CoV-2 spread?**
  - It mainly spreads from person to person.
    - When a sick person coughs or sneezes, droplets containing virus are released in air, on various surfaces. If you inhale or swallow this virus, the virus gets into your body.

- **Vertical Transmission across Placenta**
  - » A study has found evidence that confirms vertical transmission of SARS-CoV-2 virus from the mother to foetus. The route of infection is **through the womb (in utero)** well before onset of labor and delivery of baby.

- **What is community transmission?** (Class discussion)

- **Reproduction Number (Ro)** (pronounced R naught) is used to describe the intensity of an infectious disease outbreak.
  - » Early studies of **COVID-19** in Wuhan estimated the average R0 between 2.2 and 2.7.

6) DIAGNOSIS

- Antibody test
- RTPCR

7) CYTOKINE STORMS AND ITS IMPACT ON COVID-19 DEATHS

- **What are Cytokines and what is their role in immune system?**
  - » Cytokines are small proteins released by many different cells in the body, including those of the immune system where they coordinate the body's response against infection and trigger **inflammation**.
  - » Cytokines are signalling proteins that are released by cells **at local high concentratio**n.

- **However, sometimes the body's response to infection can go to overdrive**: **Cytokine Storm Syndrome ->** Immune system over reacts

8) MUCORMYCOSIS OR BLACK FUNGUS

- **Details**
  - » The disease is caused by a group of molds known as **mucoromycetes** present naturally in the environment.
    - ▪ It mainly effects **people who are on medication for health problems that reduce their ability to fight environmental pathogens**. It generally doesn't pose a serious threat to individuals with healthy immune system.
- **Treatment: Antifungal medicines**; Surgery may be required in worse cases.

- **Management of COVID-19 patients** with Mucormycosis is a team effort involving microbiologists, internal medicine specialists, intensivist neurologist, ENT specialists, ophthalmologists, dentists, surgeons and others.

- **Life after Mucormycosis:**
  - ▫ It can lead to loss of upper jaw and sometimes even the eye.
    - » Once the patient stabilizes, prosthetic replacement of the missing facial structures can commence.

9) VARIANTS OF CONCERN

- **Variant of Concern:** WHO classifies a variant as Variant of Concern when it is associated with an increase in transmissibility or detrimental change in COVID-19 epidemiology; increase in virulence; or decrease in effectiveness of the public health measure or available diagnostics, vaccines, therapeutics.

- **So far, WHO has 5 variants of concerns (**Omicron was the fifth one)

A) DETAILS OF DELTA VARIANT

» The original Wuhan variant mutated into the successively more dangerous **Alpha, Beta, Gamma and Delta Variants**.
» **Note:** All mutations don't mean that they are more harmful.

- T**he Delta variant, or the B.1.617.2 lineage** was **first discovered in Maharashtra, India, in Oct 2020.**
  » It has **mutation in its spike protein**, which helps it bind to the ACE2 receptors present on the surface of the cells more firmly, making it more transmissible and capable of evading the body's immunity.

- **Key characteristics of Delta Variants:**
  » **Delta variant spreads faster** and **reduces protection gained from previous infections or vaccines**
  » **Doesn't cause more severe illness**
  » **Vaccines are effective** (a bit less) **on delta** variants. It's just that delta variant is less sensitive to neutralizing antibodies.

- **Why Delta variant spreads faster?**
  » **Evolution** (Class discussion)

B) DETAILS OF OMICRON VARIANT (VARIANT B.1.1.529)

» Omicron is WHO's fifth variant of concern.
» It was first reported to WHO on 24th Nov 2021 and was classified as a variant of concern by WHO on 26th Nov 2021.
» It spreads much easily than original virus and the Delta variant.
» It generally causes less severe disease than infection with prior variants.
» Symptoms: Similar to previous COVID-19 symptoms.

C) RECENT MUTATIONS IN NEWS:

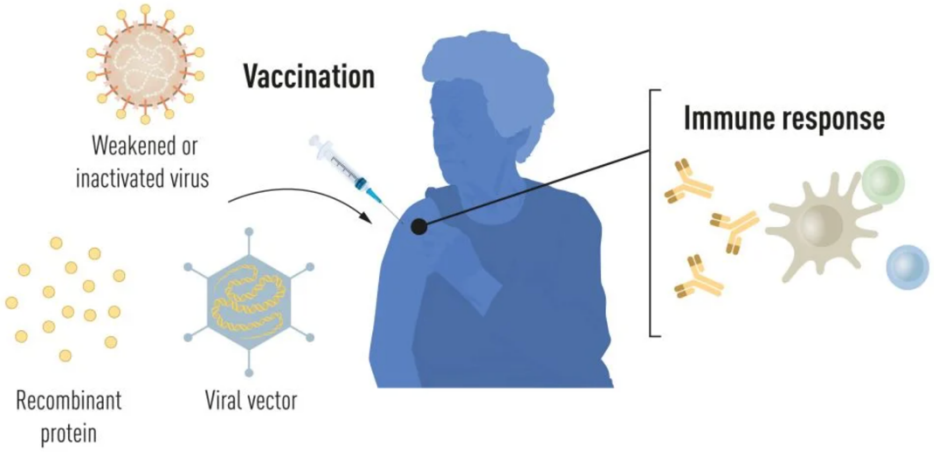
FLip: The omicron subvariant JN.1. is likely to soon become the dominant lineage of the SARS-CoV-2 virus worldwide, according to researchers at the University of Tokyo. The subvariant has a mutation in its spike protein, L455S, also called a "FLip" mutation.

10. VARIOUS TYPES OF VACCINES:

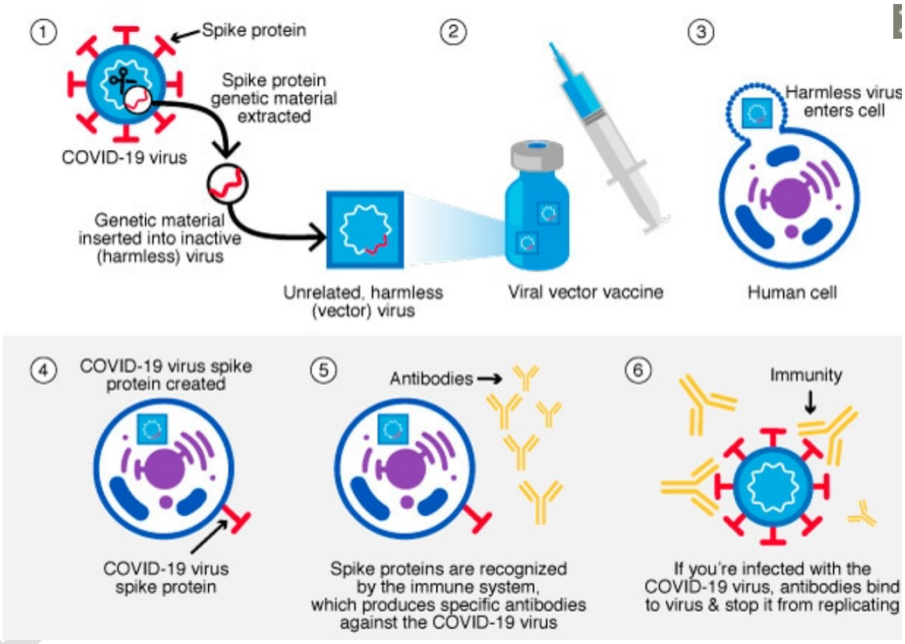
1) **Live Attenuated virus vaccines** such as the combined rubella-mumps-measles vaccines and the yellow fever virus vaccine, induce **robust and long-lived antibody and T-cell mediated immunity**.
   - **Note**: For the development of yellow fever vaccine, Max Theiler was awarded the Nobel Prize in Physiology or Medicine in 1951.
   - These vaccines induce effective but transient immune responses, requiring repeated boosting.
   - COVID-19 vaccine developed using this mechanism - **Covaxin** developed by Bharat biotech.

2) **Viral Vector Vaccines**: It uses a safe virus (not harmful) which serves as a platform to produce target proteins to generate immune response.

- Such viral vector efficiently enter cells where the encoded antigen are produced by the bodies protein synthesis machinery.
    - The first example of a licensed viral vector vaccine was the Vesicular stomatitis virus - based vaccine against **Ebola**, approved in 2019, which was soon followed by an adenovirus based Ebola vaccine.



- **During COVID-19** various vaccines
    - **Oxford-AstraZeneca** (ChAdOx1 nCoV-19) used adenovirus route.
        - **Covishield** used in India is a version of this.
    - **Sputnik V Vaccine** also has gone adenovirus route.



- **Both the above methods** (live attenuated virus or viral vector vaccine) used cell culture based manufacturing facilities which is **resource intensive**. Further they may also introduce diseases and is safer and stable than vaccine containing whole pathogens.

- **Therefore, researchers have focused upon sub-unit vaccines** that circumvent the need of large-scale cell cultures by delivering nucleic acid (DNA or mRNA) directly to vaccine recipients, exploiting the body's own capacity to produce proteins.

3) **Sub-Unit Vaccines**: (Protein subunit vaccines)
   - Protein subunit vaccines **include only the parts of virus that best stimulate immune system**. These vaccines contain single protein components of the respective virus and are referred as subunit vaccine.
     - It includes Hepatitis B Vaccine (HBV) and Human papillomavirus (HPV) vaccine.

   - **advantages:**
     - » No risk of introducing the disease and is safer and stable than vaccine containing whole pathogens.
     - » Suitable for immunocompromised individuals.
     - » Well established tech

   - **Disadvantage**
     - Relatively complex to manufacture (compared to other vaccines like RNA vaccines)
     - May require multiple doses.

   - **COVID-19 vaccine** developed using this method:
     - **Corbevax** is a protein subunit COVID-19 vaccine developed by Texas Children hospital. It delivers spike protein to the body directly.
       - **How was protein manufactured?**
         - Add gene of spike protein into yeast to produce large amount of proteins. After isolating the virus spike protein from the yeast and adding an adjuvant, which helps trigger an immune response, the vaccine was ready.

4) **DNA and RNA subunit vaccines**:
   - » **Advantages** of sub-unit vaccines (DNA or mRNA vaccines)
     - **Less Resource intensive** and thus easy to manufacture.
     - **More flexibility** - Since the sequence can be easily changed to encode different antigens.
     - This also makes iterative testing of new candidate vaccines and generation of updated vaccines rapid and efficient.

   - » **Initially DNA vaccine was thought to be more promising** but didn't translate into success. A likely reason for it was that injected DNA must cross two barriers, the plasma membrane and the nuclear membrane, to reach the cellular compartment where transcription takes place (DNA conversion to mRNA). In contrast, mRNA-based vaccines only need to gain access to the cell cytoplasm where translation takes place (mRNA conversion to protein)

   - » **Another advantage of mRNA vaccine**: Delivered nucleic acid can't integrate into the host genome. This is an additional safety aspect of this method.
     - **E.g for mRNA vaccine** (developed for COVID-19): Moderna COVID-19 (mRNA-1273) vaccine.

1) 2023 NOBEL PRIZE IN PHYSIOLOGY OR MEDICINE

- The 2023 Nobel Prize in Physiology or Medicine has been awarded to **Katalin Kariko (**Hungary) and **Drew Weissman** (USA) for their **discoveries concerning nucleoside base modifications that enabled the development of effective mRNA vaccine against COVID-1**9. Through their groundbreaking findings, which have fundamentally changed our understanding of how mRNA interacts with our immune system, the laureates contributed to the unprecedented rate of vaccine development during the COVID-19 crisis.

- **Background:**
  - **During the 1980s**, efficient methods of producing mRNA without cell culture were introduced, called in-vitro transcription. Ideas of using mRNA technologies for vaccine and therapeutic purposes also took off, but **roadblocks lay ahead**.

In vitro transcription	In vitro transcription is a laboratory technique used to synthesize RNA molecules outside of a living cell. This process involves using a DNA template and the enzyme RNA polymerase to generate a complementary RNA strand. In vitro transcription is a fundamental tool in molecular biology and biochemistry, and it has various applications, including the production of RNA molecules for research, such as RNA probes, RNA sequencing, and gene expression studies

    - *In vitro* transcribed mRNA was considered unstable and challenging to deliver. It required development of sophisticated carrier lipid systems to encapsulate the mRNA.
    - This mRNA also gave rise to inflammatory reactions.
    - These problems limited the enthusiasm for developing the mRNA technology for clinical purposes.

- **Contributions**:
  - **In 1990s**, Kariko was an assistant professor at the University of Pennsylvania and met immunologist **Drew Weissman there**.
  - They worked together to prevent the immune system from launching an inflammatory reaction against lab-made mRNA, previously seen as a major hurdle against therapeutic use of mRNA.
    - They found that **inflammatory response** was almost abolished when base modification was included in the mRNA. Therefore, in 2015 they published those adjustments (modifications) to nucleosides, can keep the mRNA under the immune system's radar.
    - Later, they also showed that the delivery of mRNA generated with base modification markedly **increased protein production compared to unmodified mRNA**. This effect was due to the reduced activation of an enzyme that regulates protein production.

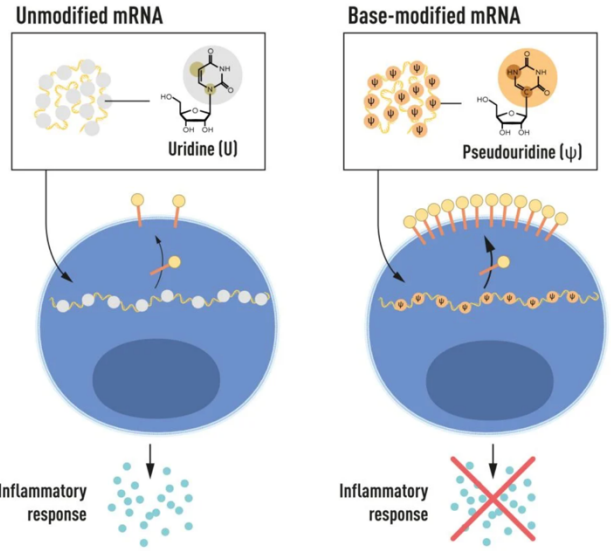


Figure 2. mRNA contains four different bases, abbreviated A, U, G, and C. The Nobel Laureates discovered that base-modified mRNA can be used to block activation of inflammatory reactions (secretion of signaling molecules) and increase protein production when mRNA is delivered to cells.

- **Development of Vaccines**:
  - After the above discoveries, interest in mRNA technology picked up. Vaccines for Zika and MERS-CoV were pursued.
  - **After the outbreak of COVID-19 pandemic**, two base-modified mRNA vaccines encoding the SARS-CoV-2 surface protein were developed at record speed. Protective effects of around 95% were reported, and both vaccines were approved as early as Dec 2020.
  - The impressive flexibility and speed with which mRNA vaccines can be developed pave the way for using the new platform also for vaccine against other infectious diseases.
  - In the future, the technology may also be used to deliver therapeutic proteins and treat some cancer types.

- **How mRNA vaccine protects you against COVID-19**:

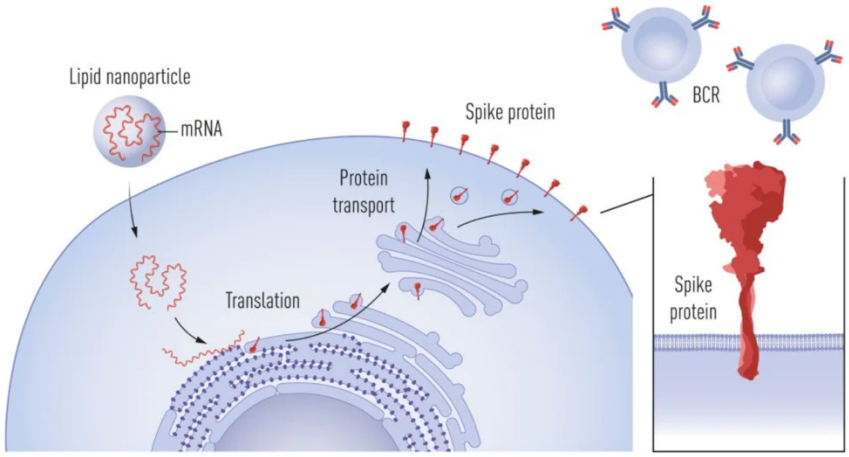


Figure 4. Spike production following mRNA vaccination and recognition of spike by B cells.
Following uptake of mRNA into cells, facilitated by lipid nanoparticles, the mRNA acts as a template for spike protein production. Spike is then transiently expressed on the cell surface, where it is recognized by B cells via their B cell receptors (BCRs), stimulating the secretion of spike-specific antibodies.

- Through their fundamental discoveries of the importance of base modification in mRNA, this year's Nobel Laureates critically contributed to this transformative development during one of the biggest health crisis of our time.

11. OTHER VIRAL DISEASES

1) MEASLES

- **Measles** is a highly contagious infectious disease caused by **measles virus**. It spreads through air when an infected person coughs or sneezes. It is an acute respiratory illness. **Infection** is characterized by a prodrome of fever (as high as 105 degree F) and malaise, cough, coryza, and conjunctivitis - the three "C"s, followed by maculopapular **rash**. The rash spreads from the head to the trunk to the lower extremities.
  - It can severely sicken **young children**, but is normally kept under check due to **large-scale vaccination**.

- **About the Virus:**

- It is a single stranded, enveloped RNA virus with 1 serotype. It is classified as a member of the genus Morbillivirus in the Paramyxoviridae family.
- **Humans** are the only natural host of the measles virus.

- **Detection: RT-PCR;** Anti-body test

- **Vaccinations:** Measles can be prevented with **Measles-containing vaccine**, which is primarily administered as the combination of measles-mumps-rubella **(MMR) vaccine**.
  - It can be used for children aged 12 months through 12 years. One dose of MMR vaccine is approximately 93% effective and two doses are approximately 97% effective.

- **Rise of Cases in 2022:** Covid-19 led to disruption in routine vaccination in 2020 and 2021.

- **WHO Report and India's Response** (Nov 2023)
  - A new report from the WHO and US Centre for Disease Control and Prevention (CDC) said measles cases in 2022 have increased by 18%, and deaths by 43% globally, compared to 2021.
    - **Cases:** 9 million & **Deaths** - 1,36,000
  - The report also said that globally 22 million children and **in India 1.1 million infants** didn't get the first dose of vaccine.
  - **India has differed from this report**:
    - MoH&FW says that just over 21,000 Indian children didn't get the shot.

2) RUBELLA

- Rubella is a contagious viral disease. Most people who get Rubella usually have a mild illness, with symptoms that can include a low-grade fever, sore-throat, and a rash that starts on the face and spreads to the rest of the body. It can cause a miscarriage or serious birth defects in a developing baby if a woman is infected while she is pregnant.

- **The best protection** against rubella is **MMR** (Measles, Mumps, Rubella) vaccine.

3) HUMAN IMMUNODEFICIENCY VIRUS (HIV) AND AIDS (ACQUIRED IMMUNODEFICIENCY SYNDROME)

- **Why in news?**
  - » Hopes dashed as last HIV vaccine trial in Africa for his decade ends in failure (Dec 2023: Source - DTE)

- **Introduction:**
  - » **About virus:**
    - HIV are two species of Lentivirus (genus) *of Retroviridae* family. The virus first emerged in 1920 in **Kinshasa (then Leopoldville)**, Belgian Congo.

  - » The Human Immunodeficiency **Virus (HIV) targets the immune system** and weakens people's surveillance and defence systems against infections and some types of cancers.

- As the virus destroys and **impairs the function of the immune cells**, infected individuals gradually become immunodeficient. Immune function is typically measured by CD4 cell count (a type fo white blood cells) .
- The most advanced for of HIV infection is **acquired immunodeficiency syndrome (AIDS),** which can take from 2 to 15 years to develop depending on individual. It is defined by developments of certain cancers, infections, or other severe chemical manifestations.

- **Transmission**
  - » **Exchange of a variety of body fluids - blood, breast milk, semen and vaginal secretion**
  - » **Note:** Individual can't be infected through ordinary day to day contact such as kissing, hugging, shaking hands, sharing food or water etc.

- **Behaviours or conditions which can put individual on risk:**
  - » Unprotected sex (including anal); use of contaminated syringes; unsafe blood transfusion; from mother to unborn child etc.

- **Diagnosis**
  - » **Three types of tests:**
    - **Antibody test**
    - **RNA** (viral load) test (RT-PCR)
    - **A Combination test.**
      - It detects both antibodies and viral protein called p24 (antibody-antigen test, or HIV Ab-Ag test).
        - P24 forms part of the core of the virus (an antigen of the virus).
- **Prevention**
  - » **Avoid risk behaviours** (i.e. use condoms, test and counsel for HIV and STIs, Voluntary medical male circumcision, using only sterile injecting instruments)
  - » **Antiretroviral (ART) use for prevention.**
    - **ART as Prevention -** If an HIV positive person adheres to an effective ART regimen, the risk of transmitting the virus to their uninfected sexual partner can be reduced by 96%.
    - **Pre-exposure prophylaxis (PrEP) for HIV negative partner:** Oral PrEP of HIV is the daily use of ARV drugs by HIV uninfected people to block the acquisition of HIV.
    - **Post Exposure prophylaxis for HIV (PEP):** PEP is the use of ARV drugs within 72 hours of exposure to HIV in order to prevent infection. PEP includes counselling, first aid care, HIV testing, and administering of a 28-day course of ARV drugs with follow up care.

  - » **Drug releasing Vaginal Ring Cap:** To prevent HIV-AIDS in Women
    - The ring is made of flexible silicon matrix polymer. The woman inserts it into the vagina, where it, over the course of a month, **releases the antiretroviral drug dapivirine**. It has to be changed after 28 days.

A) STEM CELL THERAPY TO TREAT HIV HAVE SHOWN SUCCESS:

- » In 2022, a US patient was reported cured of HIV after stem cell transplant. By July 2023, six persons had been cured by this method.

» In the first five cases, the treatment teams specifically looked for **donors with CCR5 delta 32 mutation**. It is associated with lower risk of HIV.
  - People who inherit **CCR5 delta 32 mutation** from both parents don't from the receptors which are used by HIV virus to enter the cells. Those who inherit the mutation from one of the parents have fewer receptors and are less likely to get infection.
  - **Only 1% of the people** on earth carry 2 copies of CCR5-delta 32 mutation.

» **Why can't stem cell transplant become routine treatment for HIV?**
  - Finding matching donor for all 40 million patients would be impossible.
  - The CCR5 delta 32 mutation occurs mostly in Caucasians whereas most of the cases are in the African continent.
  - Further, stem cell transplant is a complex process and comes with its own risks.

- **SDG Goal 3.3**: To achieve the end of AIDS by 2030 i.e. zero new infection by 2030.

B) GLOBAL SITUATION OF HIV:

- **Successes Achieved in HIV Response**:
  » As per UNAIDS**,** in 2022, 39 million people globally were living with HIV, of whom 29.8 million were accessing ART.
    - Coverage of ART has become 4 times of the number in 2010.
  » **New Cases**: Around 1.3 million people got newly infected with HIV in 2022 - which is 59% lower from the peak in 1995.
  » It is possible to end AIDS by 2030: UNAIDS.

C) VACCINATION EFFORTS:

- **Hopes Dashed as last HIV vaccine trial in Africa for this decade ends in failure** (Dec 2023)
  » The study, known as **PrEPVacc,** was led by African researchers with support from European Scientists.
    - They were testing two different vaccine regimes on about 1500 volunteers in Uganda, Tanzania, and South Africa.
  » After, **multiple other high-profile trails** failed in the past, PrEPVacc researchers were quite optimistic and had described the latest study as the **final trial of the decade**.

D) HIV SITUATION IN INDIA

» More than 2 million people in India live with HIV.
  - HIV Epidemic has an **overall decreasing trend** in the country with estimated annual new HIV infections declining by 37% between 2010 and 2019.

» **Success in controlling AIDS.**
  - 2015 HIV estimates results reaffirm the country's success story in responding to HIV/AIDS epidemic. India has **successfully achieved 6th Millennium Development Goal (MDG6)** of halting and reversing the HIV epidemic.

» **Emergence of three north Eastern States as new HIV Hotspots: Mizoram** (1.19%), Nagaland (0.82%), Meghalaya (0.73%), Tripura (0.56%) and Manipur (0.47%)
    - Reasons: Injecting Drug Users and Unsafe Sexual Practices.

- **Steps taken by government of India in recent times to Reduce HIV transmission.**
    - **National Aids Control Program** was launched in 1992 and its four phases have been completed so far. It is a central sector scheme.
        - » It has been extended for five years (1st April 2021 to 31st March 2026)
        - » It is a comprehensive program for prevention and control of HIV/AIDS in India.
        - » Under this, ART Centres run by National AIDS Control Office (NACO) provide lifetime free medicines, diagnostic kits and other essentials for those in need.
    - **National Aids Control Organization** (NACO), under MoH&FW, provides leadership to HIV/AIDS program.
    - **HIV & AIDS Prevention and Control Act 2017** provides a legal framework for protecting the rights of HIV positive people.
    - Implementation of **90:90:90** strategy adopted by UNAIDS
    - **Other steps** include - Multimedia campaigns; Red ribbon clubs in colleges; training and sensitization program for SHGs; etc;

4) POLIO

- **Basics:**
    - » Polio is a highly infectious disease caused by a virus. It invades the nervous system and can cause total paralysis in a matter of hours.
    - » **Transmission:** The virus is transmitted by person to person and spread mainly through **faecal-oral routes,** or less frequently by, a common vehicle (e.g., contaminated water or food) and multiplies in the intestine.
    - » **Affect:** 1 in 200 infections leads to irreversible paralysis (usually in legs). Among those paralyzed, 5% to 10% die when their breathing muscles become immobilized.
    - » **People most at risk**
        - Polio mainly affects children under five years of age
    - » **Prevention and Cure**
        - There is no cure
        - It can only be prevented. **Polio vaccine** given multiple times can protect a child for life.

- **Three Different strains of Polio Virus**
    - » 3 strains of poliovirus (type 1, type 2, and type 3).
    - » Wild polio virus **type 2 was eradicated in 1999**.
    - » Wild Polio virus **type 3 was eradicated in 2019**.
        - WPV3 is the **second strain of the polio virus to be wiped out**, following the certification of the eradication of WPV2 in 2015.
        - The **last case of WPV3** was detected in Northern Nigeria in 2012.

A) TWO TYPES OF VACCINES: OPV AND IPV

- **Oral Polio Vaccine (OPV)** is taken orally as drops. It has served as the main preventive measure against polio and is easily administered not requiring very trained health workers. Further, the cost per dose of OPV is much less than IPV. It also leads to passive immunization.
    - **Other Advantages**
        - **Passive immunization**
    - **Limitations**
        - Virus may mutate and turn virulent Or;
        - Virus may multiply in intestine and spread through excreta and over the period mutate to become virulent.

- **Inactivated Polio Vaccine** (IPV) is given through an injection by a trained health worker.
    - It is not a "live" vaccine (i.e. it is inactivated) and thus carries no risk of vaccine associated paralysis.
    - In countries still using OPV, IPV hasn't replaced OPV but is used to strengthen a child's immune system and protect them from polio.

B) ISSUE OF VACCINE DERIVED POLIO VIRUS

- **How vaccines may lead to infection**
    - Oral Polio Vaccine (OPV) contains an attenuated vaccine-virus. This weak form of the virus is used to activate an immune response in the body, which protects the child when challenged by WPV.
    - But when child is immunized with OPV, the virus replicates in the intestine and during this time the virus is excreted.

- **WHO recommendations**
    - » Use of OPV must eventually be stopped (starting with OPV containing Type-2 poliovirus) worldwide and at least one dose of IPV must be introduced, to protect against Type-2 Polio virus and to boost population immunity.
    - » **Why??**
        - Since, wild Polio virus of type 2 was eradicated in 1999, the risk of paralytic disease due to OPV type 2 now outweighs its benefits.
        - A single dose of IPV before OPV protects against VAPP (Vaccine Associated Paralytic Poliomyelitis).

- **IPV is very safe** vaccines in humans, whether used alone or in combination vaccines.
    - » No serious adverse events have been reported, only minor side effects.

- **Situation in India**
    - » India was declared Polio free in 2014, 3 years after the last case of Polio in 2011. But we still see cases of **vaccine derived Polio**.
    - » Further, there have been cases of **Non-Polio Acute Flaccid Paralysis (NPAFP)** which are associated with OPV.

5) EBOLA VIRUS DISEASE (EVD)

- **Introduction**:
  - » The Ebola virus causes an acute, serious illness which is often fatal if untreated.
  - » Ebola Virus Disease first appeared in 1976 in two simultaneous outbreaks, one in Nzara, Sudan, and the other in Yambuku, Democratic Republic of Congo. The later occurred in a village near the Ebola River, from which the disease takes its name.
  - » **2014-2016 outbreak:** This outbreak in Wet Africa was the largest and most complex Ebola outbreak since the discovery of virus. It had mostly impacted **Guinea, Sierra Leone and Liberia**.

- **Virus**: The virus family **Filoviridae** includes the **Ebolavirus genus**. This Ebolavirus Genus has 5 identified species so far: Zaire, Bundibugyo, Sudan, Reston and Tai Forest. The first three Zaire Ebola virus, Bundibugyo Ebolavirus, and Sudan Ebolavirus have been associated with large outbreaks in Africa. 2014 outbreak has been caused by Zaire Ebolavirus.

- **Transmission**
  - **Introduction in Human:** It is believed that **fruit bats** of the Pteropodidae family are **natural Ebola virus host**s.
  - **Human to Human:** Via **direct contact** (through broken skin or mucous membranes) with the **blood, secretions, organs or other fluids** of infected people, and with surface and materials (e.g., bedding clothing) contaminated with these fluids.

- **Diagnosis**
  - **Difficult to distinguish EVD from other infectious diseases** such as malaria, Typhoid fever and meningitis.
  - **Confirmation tests**: Electron Microscopy, ELISA, RT-PCR etc.

- **Treatment and Vaccine**
  - Supportive care rehydration with oral or intravenous fluids - and **treatment of specific symptoms**, improves survival.
  - There is as yet **no proven treatment available** for EVD.
  - **Vaccines** has been developed and is being used in DRC.
    - Vaccine rVSV-ZEBOV (tradename "Ervebo") was approved by US FDA in Dec 2019.
  - **Monoclonal Anti-Bodies** have also been found effective in treatment: WHO

6) RABIES

- **About Rabies:**
  - » It is a vaccine preventable viral disease which occur in more than 150 countries in the world.
    - » **Dogs** are the main source of human rabies deaths, contributing to 99% of all rabies transmission to humans.
      - It is spread when infected animal bites or scratches a human or other animal. Saliva from an infected animal can also transmit rabies if the Saliva comes into contact with the eyes, mouth, or nose.

- » **Interrupting transmission** is feasible through vaccination of dogs and prevention of dog bites.
- » **Immediate, thorough wound washing with soap and water** after contact with a suspected rabid animal is crucial and can save lives.
- » **Rabies is virtually 100% fatal** once the clinical symptoms appear. And it is also **100% vaccine preventable**.

» **WHO** is also leading a collective "**United Against Rabies"** to drive progress towards "Zero Human Deaths from dog mediated rabies by 2030".

» **World Rabies Day** is held on 28th September.

» **About the Virus:**

- » It is caused by **lyssaviruses**, including the rabies virus and Australian bat lyssavirus.
- » The virus infects the central nervous system. If a person doesn't receive the appropriate medical care after potential rabies exposure, the virus can cause disease in the brain, ultimately resulting in death.

- **Situation of Rabies in India**
  - As per WHO India is endemic to rabies and suffers approx. 36% of the world's human rabies deaths, transmitted by dogs.

- **Key Highlights about Efforts in India:**
  - The ministers have urged all the States to make **Rabies a notifiable Disease**.
  - They launched 'Joint Inter-Ministerial Declaration Support Statement' for elimination of Dog Mediated Rabies from India by 2030 through One Health Approach.
  - On the occasion of the World Rabies Day (28th Sep), the MoH&FW and the Minister of Fisheries, Animal Husbandry and Dairying unveiled the **National Action Plan for Dog mediated Rabies Elimination by 2030 (NAPRE).**

7) HUMAN PAPILLOMA VIRUS (HPV)

- **What is HPV**?
  - » HPV is a group of 150 related viruses.
  - » **Cancer Causing:** Some HPV can lead to cancer, especially cervical cancer.
  - » There are more than 40 HPV that can infect genital areas of males and females.

- **How do people get HPV?**
  - » Transmitted through **intimate skin to skin contact** which can happen during vaginal, anal or oral sex with someone who has virus. **Most common sexually transmitted disease**. HPV is so common that nearly all sexually active men and women get it at some point in their lives. HPV can be passed even if the infected person has no signs or symptoms.

- **Does HPV Cause Health Problem?**
  - » In **most cases**, HPV goes away on its own and doesn't cause any health problems. But when HPV doesn't go away, it can cause health problems like genital warts and cancer.
    - **Genital Warts** usually appear as a small bump or group of bumps in the genital area.

- **Cancer**: HPV can cause cervical cancer and other cancers including cancer of vulva, vagina, penis and anus. The types of viruses that cause genital warts are not the same as types of HPV that cause cancers.

- **How can I avoid HPV and the health problems it can cause?**
  - » **Get Vaccinated:**
  - » **Get screened for cervical cancer:** Routine scanning for women aged between 21 to 65 years old can prevent cervical cancer.
  - » **For Sexually Active people**: Use condoms:
    - But HPV can infect areas that are not covered by condoms - so condoms may not give full protection against getting HPV
    - Be in mutually monogamous relationship

- **Can I be treated for HPV or health problems caused by HPV?**
  - » **No treatment for virus itself**, but **there are treatments for health problems associated**

8) CERVICAL CANCER

- Nine out of 10 women who die of cervical cancer live in low and middle-income countries, according to WHO.

- **Details:**
  - » The low- and middle-income countries have low rate of vaccination against the HPV, which causes the cancer.
    - Most HPV vaccination consignments go to wealthier nations, driving a gap in access similar to the inequitable distribution of vaccines against the COVID-19.
    - Vaccines haven't been introduced in 80 countries and these countries record 2/3rd the incidences of cervical cancer.
    - Globally, just 13% of girls between nine and fourteen years were vaccinated against HPV in 2020. This was a reduction from 15% girls in 2019.

- **4th HPV Vaccine:**
  - » In Oct 2021, WHO has given approval to **Ceolin**, manufactured by Xiamen Innovax Biotech Co Ltd to bridge the gap.

9) DENGUE

- **Dengue fever,** also known as break bone fever, is a **mosquito borne tropical disease** caused by the dengue virus.
  - » **Dengue Virus (DENV)** in one of the five serotypes is the cause of Dengue fever. It is a mosquito borne single positive stranded RNA virus of the family **Flaviviridae; genus Flavivirus**.
  - » **Dengue hemorrhagic Fever (DHF)** is a specific syndrome that tends to affect children under 10 years of age. It causes abdominal pain, hemorrhage (bleeding), and circulatory collapse (shock).
- **Possible to get dengue multiple times**
- **Symptoms:** Severe joint and muscle pain, swollen lymph nodes, headache, fever, exhaustion, and rash. The presence of fever, rash, and headache (**the dengue "triad**") is characteristics of dengue fever.

- **Geographical Region:** Prevalent throughout the tropics and subtropics.
- **Transmission**
  - » The virus is contracted from the bite of a **striped Aedes aegypti** mosquito that has previously bitten an infected person. The virus is not contagious and cannot spread from person to person directly. There must be person to mosquito to another person pathway.
- **Treatment**: Symptomatic
- **Prevention**: Prevent mosquito bite
- **Vaccine:**
  - » Since there are around 5 serotypes of dengue virus known, vaccine making is difficult. It's because different vaccine is needed against each serotype.
  - » A vaccine against dengue, **DENGVAXIA**, from Sanofi Pasteur is approved in several countries and shows efficacies ranging from 42% to 78% against four serotypes of the virus.
  - » In **India**, Zydus Cadilla has been developing a DNA vaccine against dengue

10) ZIKA FEVER / ZIKA DISEASE

- **About Zika Virus**
  - » Zika virus (ZIKV) is a member of the Flaviviridae virus family and the Flavivirus genus, transmitted by daytime active Aedes mosquitoes, such as A. aegypti, A. Africanus, A. furcifer etc. Virus can also get transferred during sexual contacts, across the placenta (affecting unborn child). A mother already infected with Zika virus near the time of delivery can pass on virus to the newborn around the time of birth, but this is rare.
  - » Zika virus is related to dengue, yellow fever, Japanese Encephalitis, and West Nile virus. The illness it causes is similar to mild form of dengue fever, is treated by rest, and cannot yet be prevented by drugs or vaccine.

- **Earliest discovery**
  - » Virus was first isolated in 1947 from a rhesus macaque monkey that had been placed in a cage in the Zika Forest of Uganda, near Lake Victoria, by the scientists of yellow fever research institute.

- **Spread among Humans:**
  - » For the first 60 years after detection, only **14 human cases** have been reported from Tropical Africa and Asia (including India in 1952-53).
  - » The **first ever outbreak (185 cases) of Zika** virus was reported in 2007 in the **island of Yap (**a federated state in **Micronesia**) in the **Pacific**.
  - » In 2015 to Mexico, Central America, the Caribbean, and South Africa, where the Zika outbreak has reached pandemic levels.
    - The outbreak was associated with higher incidences of microcephaly as well as GB syndrome.

- **Symptoms and treatment**
  - » Common symptoms include mild headaches, **maculopapular rash**, fever, joint pains etc.
    - Thus far, Zika fever has been a relatively mild disease of limited scope, with only one in five persons developing symptoms, with no fatalities, but is true potential as a viral agent is unknown.

» As of 2022, **no WHO approved vaccine or preventing drug is available**. Symptoms can be treated.

- **Zika's link with Microcephaly and GB Syndrome**
  - » **Microcephaly** is a condition where a baby has a head size much smaller than other babies of the same age and sex. According to WHO this condition may be caused in newborn by mother to child Zika virus transmission.
  - » **GBS (Guillain-Barre Syndrome)** is a rapid onset of muscle weakness as a result of damage to the peripheral nervous system. In a French Polynesian epidemic, 73 cases of GBS and other neurological conditions occurred in a population of 270,000, which may be complications of Zika virus.

11) JAPANESE ENCEPHALITIS

- It's a viral fever that affects the brain and is considered **extremely dangerous for children**, and it also has a high "mortality and morbidity rate".

- **About JE Virus**
  - » Japanese Encephalitis virus (JEV) is a flavivirus. It is the main cause of viral encephalitis in many countries of Asia with an estimated 68,000 clinical cases every year.
  - » **Symptoms** of JE includes sudden onset of fever, vomiting, headache, neck stiffness, and seizures.

- **Transmissions**
  - » The virus is maintained in a **cycle between mosquitoes and vertebrate hosts, primary pigs, and wading birds**. Humans are incidental or dead-end hosts because they don't develop high enough concentration of JE virus in their bloodstream to infect feeding mosquitoes.
    - **So It is not transmitted from human to human**
  - » JE virus transmission often occurs in primarily rural agricultural areas, often associated with rice production and flooding irrigation.
  - » **Transmitted by** the bite of **Culex tritaeniorhynchus, and Culex vishnui mosquitoes.**

- **Management Control and Prevention**
  - » **Vaccination**: In the **mission Indradhanush** - JE vaccination was included in May 2016.
  - » **Controlling mosquitoes**
  - » **Pigs act as a carrier** for the virus - so it is also important to control mosquito population around the pig domestication areas.

- **Treatment**
  - » No specific treatments: Symptomatic care

12) ACUTE ENCEPHALITIS SYNDROME (AES)

- **What is AES?**
  - » AES is a c**omplex syndrome that affects central nervous system**, mostly in children and young adults. It starts with fever, then hampers neurological functions causing mental disorientation, seizure, confusion, delirium, coma etc.

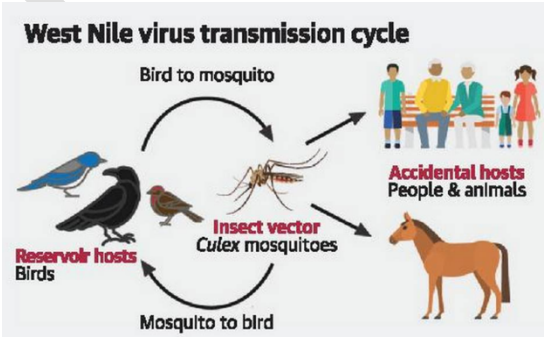
» **Causes**: It may be caused by **virus, bacteria, fungi, and a range of agents**. Japanese Encephalitis (JE) is the most common cause of AES in India. But the syndrome is also caused by scrub typhus, dengue, mumps, measles, even Nipah or Zika virus.

- **Relation between Hypoglycemia, children, and AES**
  - » Some researchers have claimed that there is an increasing correlation between death due to AES and hypoglycaemia. So, **AES may affect undernourished children more**.
- **Any relation between Litchi and AES**
  - » **More research** needs to be done in this aspect.
    - Some toxin/virus/bacteria found in Litchi **may** be responsible for AES.
    - Unripe fruit contains **toxins** hypoglycin A and methylenecycloprophyglycine (MCPG) which cause vomiting if ingested in large quantities
  - » **Note:** AES is called "Chamki Bukhar" in Bihar

- **Prevention**
  - » **Preventing Mosquito bite**
  - » **Drink plenty of water** and **ensuring proper nutrition** flushes out toxins which may be causing AES from the body.
  - » **Properly washing fruits** before consuming them properly.

13) WEST NILE VIRUS

- **About the Virus**
  - » It is a member of flavivirus genus and Flaviviridae family.
  - » It was **first isolated** in a woman in the West Nile District of Uganda in 1937. It was also identified in birds (including crows) starting 1953 and have also been found to be pathogenic for them (birds).
  - » The WNV Is commonly found in Africa, Europe, the Middle east, North America and West Asia.



- **Human Infection** is most often the result of bites from infected mosquitoes. Mosquitoes get infected by feeding on infected birds, which circulate the virus in their blood for a few days. It may also be transmitted through contact with other infected animals, their bloods or other tissues. There are also reports about few transmissions through organ transplant, blood transfusion, mother to child etc.

14) CHIKUNGUNYA

- **Basics about Chikungunya:**
  - » **Virus:** Chikungunya is a viral disease caused by an **RNA virus** that belongs to the **aphavirus genus** of the Togaviridae family.
  - » **Vector:** The bites of infected female mosquitoes, most commonly, **Aedes Aegypti and Aedes Albopictus**.
  - » **Symptoms:** Fever, severe joint pain, muscle pain, nausea, fatigue and rash.
  - » **Shares clinical signs with dengue** - They can be misdiagnosed with dengue.
  - » **Diagnosis**: **RT-PCR** (testing serum or plasma for detection of virus or viral nucleic acid)>

» **Treatment**: No cure available, treatment is mostly symptomatic.
» **People at risk**: People living in the proximity of mosquito breeding sites.
» **Prevention and Control -> Prevent Mosquitoes and Mosquito bites**
» **Less dangerous than dengue** -> rarely leads to fatalities. However, it does affect patients severely, leaving them with pain in the joints and swelling.

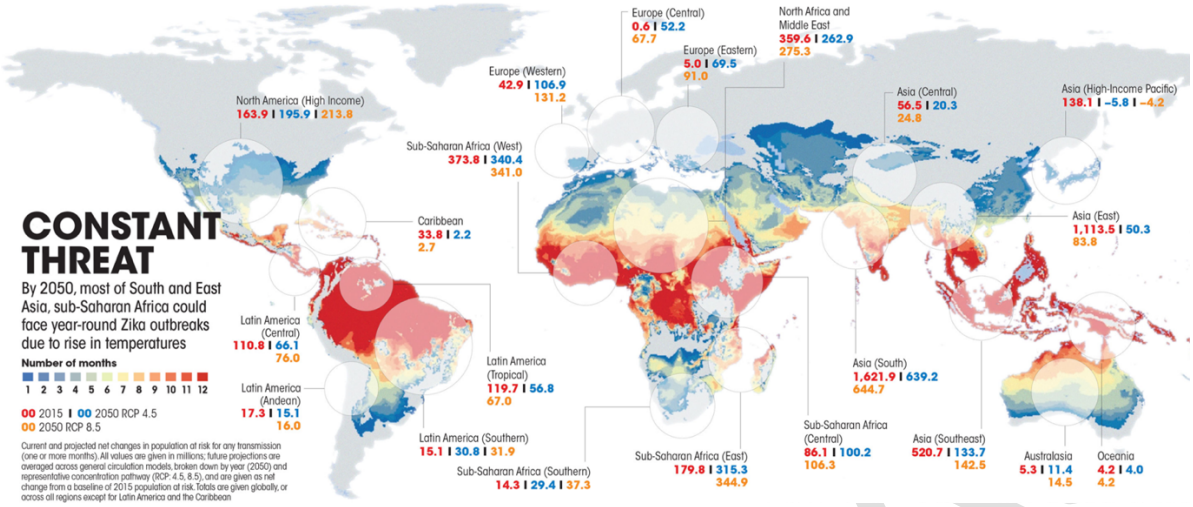
- **India and Chikungunya:**
  » India has become an endemic reservoir for the virus with persistent global transmission from the country.

- **Vaccine Efforts:**
  » **BBV87:**
    - A multi-country Phase-II/III clinical trial of a vaccine led by the **International Vaccine Institute (IVI)** in partnership with Bharat Biotech International Ltd (BBIL) began in **Costa Rica** in Aug 2021.
    - The vaccine is called **BBV87.** It is an **inactivated whole virion vaccine** based on a strain derived from an East, Central and South African genotype.

- **Vaccine: No**
- **Treatment:** Symptomatic
- **Prevention**: Mosquito control.

15) MOSQUITOES ARE EMERGING AS BIG ISSUE

- **Details**
  » ***Aedes Aegypti*** is native to sub-Saharan Africa, and in its native environment it lives in tree holes and small pools of water and bites non-human primates. These mosquitoes may have first moved to nearby human settlements during droughts when the tree holes dried up. During **trans-Atlantic slave trade**, the mosquitoes moved out of Africa. The first case of Yellow fever reported outside Africa in Yucatan, Central America in 1648.
  » ***Aedes albopictus*** is native to tropical SE Asia, where it was originally a forest species that fed on wild animals. During 1980s it spread to islands in the Indian and Pacific Oceans and then during the 1980s extended its range across temperate regions in Europe, Africa and the Americas.
  » A modelling study published in ***Nature Communications*** on May 1, 2020, shows that the **world became about 1.5% more suitable per decade** for the development of ***A aegypti*** during 1950-2000.
  » **Another study showed that by 2050, 49% of the World's population** will live in places where *A aegypti and A albopictus* are present if greenhouse gas emissions continue at the current rates.



- **Climate change is increasing vector population:**
  - » Mosquitoes are now able to breed throughout the year.
  - » Breeding behaviours of mosquitoes have also changed over the years. Now, they can lay eggs in dirty waters too. There is evidence that Aedes mosquitoes can breed in brackish water too.
  - » Artificial lights have increased the feeding period of Aedes mosquitoes.

- **Other factors**
  - » *Aedes aegypti* has also developed resistance to common insecticide permethrin.

16) WORLD MOSQUITOE PROGRAM (WMP)

- **Intro**
  - » WMP is a not-for profit initiative that works to protect the global community from mosquito-borne diseases such as Zika, Dengue, Chikungunya.
  - » Pioneered by Australian researchers, the WMP **uses safe and natural bacteria called Wolbachia** to reduce the ability of mosquitoes to transmit these viruses.
  - » WMP was first launched in Australia in 2011 and has expanded rapidly since then.

- **About Wolbachia**
  - » Wolbachia is a natural bacteria present in upto 60% of insect species, including some mosquitoes. It is one of the most common parasitic microbes and is possibly the most common reproductive parasite in the biosphere.
  - » However, they are naturally not found in Aedes aegypti mosquito.
- **WMP** research has shown that when introduced in Aedes aegypti mosquito, **Wolbachia can help reduce the transmission** of these virus in people. When introduced into this mosquito's cells, this parasite competes successfully against other parasites such as the viruses that cause dengue, chikungunya, yellow fever, Zika etc. Thus, it can be used to fight life-threatening diseases.
  - In a study in Djakarta, the number of cases saw a decline of 77% in the number of cases and a decline of 86% in hospitalizations due to dengue.

  - » Video link: World Mosquito Program - Our Wolbachia method

17) KYASANUR FOREST DISEASE (KFD) / MONKEY FEVER

- **Introduction**
  - » KFD is caused by KFDV, a member of virus family **Flaviviridae**. It was first identified in 1957 when it was isolated from a sick monkey in Kyasanur Forest in Karnataka state India.
  - » Since then, about 400-500 cases are reported every year from the state.
- **Reservoirs for Virus**
  - » **Hard Ticks** (Hemaphysalis spinigera) are the reservoir of the KFD virus and once infected, remain so for life.
  - » **Monkeys, shrews**, and **Rodents** are common hosts for KFDV after being bitten by an infected tick.
- **KFDV can cause epizootics** with high fatality in primates.

- **Transmission**
  - » Infected tick bite or contact with an infected animal (monkey, shrew etc.). No person-to-person transmission has been known so far.
  - » Transmission from other infected animals like goats, cows etc is extremely rare.
- **Symptoms**
  - » Chills, fever, headache, muscle pain, low platelet, low RBCs and WBCS.

- **Treatment:** No specific treatment -> hospitalization and support therapy like hydration and usual precautions is important.
- **Vaccine**: Yes; Used in endemic areas of India.
- **Distribution** Historically limited to western and central district of Kar, India. However, some samples have also been found from Tamil Nadu and Kerala.

18) INFLUENZA

A) INFLUENZA A VIRUS

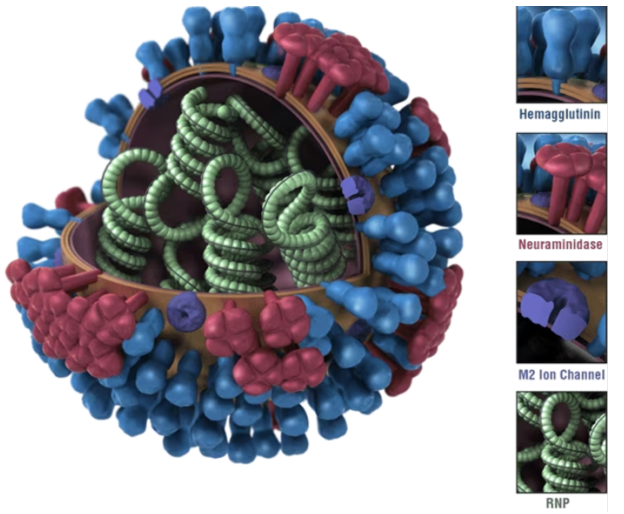
There are four types of Influenza viruses: A, B, C, and D. Influenza A and B viruses cause seasonal epidemics of diseases.

Influenza A viruses are the only influenza viruses known to cause flu pandemics (i.e. global epidemics of flu diseases)

Influenza A virus is the only species of the genus *Alphainfluenzavirus*. It is an RNA virus.

Influenza A viruses are divided into subtypes based on **two proteins** on the surface of the virus: hemagglutinin (H) and neuraminidase (N).

- There are 18 hemagglutinin subtypes (H1 - H18) and 11 different neuraminidase subtypes (N1 - N11)



More than **130 influenza A subtype combinations** have been identified in nature, primarily from birds, there are potentially many more influenza A subtypes combinations given the propensity of virus **"reassortment".** **Reassortment** is a process by which influenza viruses swap gene segments. It can occur when two influenza viruses infect a host at the same time and swap genetic information.	

- **The influenza A** virus subtypes that have been confirmed in humans, ordered by the number of known human pandemic deaths, are:
  - » **H1N1** caused Spanish Flu in 1918 and the 2009 swine flu pandemic.
    - A variant of H1N1 was responsible for the Spanish Flu pandemic that killed some 50 million to 100 million people worldwide in 1918 and 1919.
  - » **H2N2** caused "Asian Flu" in the late 1950s.
  - » **H3N2** caused Hongkong Flu" in the late 1960s.

B) SWINE FLU

- **Swine Flu** is a respiratory disease caused by **influenza A viruses** that infects respiratory tract of pigs and result in barking cough, decreased appetite, nasal secretion, and restless behavior; the virus **can be transmitted to human.**

- **The first case** of **influenza A H1N1** was reported in Mexico in **April 2009**. Since then, this infection has affected almost all the countries of the world.
  - » **The Virus**
    - Most common virus causing swine flu is H1N1 but the flu virus can sometimes also come from other subtypes such as **H1N2, H3N1, and H3N2**. Since 2017, H3N2 is becoming a dominant strain.
  - » **Cross Species infections** (swine to humans, humans to swine) etc. have **mostly remained local and haven't caused national or worldwide infections** in either pig or humans.
  - » **Transmission to humans**:
    - Most common way for humans to catch swine flu is through **contact with an infected pig** (not through properly cooked pork)
    - Swine flu is transmitted from **person to person** by inhalation or ingestion of droplets containing virus from people sneezing or coughing**.**
  - » **Symptoms**
    - **Similar to most influenza infections**: - fever, cough, nasal secretion, fatigue and headache.
  - » **Prevention and cure**
    - **Vaccination** is the best way to prevent or reduce the chances of becoming infected with influenza virus.

- Two antiviral agents, **zanamivir (Relenza)** and **oseltamivir (Tamiflu),** have been reported to help prevent or reduce the effects of swine flu if taken within 48 hours of the onset of symptoms.

C) AVIAN INFLUENZA: BIRD FLU

- **Intro**
  - Bird flu (Avian Influenza) is caused by influenza A viruses.
    - Only viruses of the **H5 and H7 subtypes** are known to cause the **highly pathogenic form of the bird diseases**.
      - Most avian influenza virus don't infect humans; however, some such as A(H5N1) and A(H7N9), have caused serious infections in people.
    - Recently, China reported that **H10N3** has also infected humans.

- **There are several subtypes of Avian Influenza**
  - **AH5N1** is the most common virus causing bird flu, or avian influenza. It is largely restricted to birds, and often fatal **(high pathogenicity)** to them. it can sometimes cross over to other animals, as well as human.
    - According to WHO, the H5N1 was first discovered in humans in 1997 and has killed almost 60% of those infected. Though, it is not known to transmit easily among humans, the risk remains.
  - **A-H7N9**: It was reported in China in 2013. An outbreak of H7N9 strain killed around 300 people in 2016 and 2017.

- **Risk Factors for human infections**
  - The primary risk factor for human infection appears to be direct or indirect exposure to infected live or dead poultry or contaminated environments, such as live bird markets.

- **Impacts**
  - Outbreaks of AI in poultry may raise global public health concerns due to their effect on poultry population, their potential to cause serious disease in people and their pandemic potential.
  - Can impact local and global economies and international trade.

- **Note**
  - There is no evidence to suggest that the virus can be transmitted to humans through properly prepared poultry or eggs.

D) THE EUROPEAN UNION IS EXPERIENCING THE LARGEST BIRD FLU OUTBREAK IN EUROPE: REPORT BY EUROPEAN FOOD SAFETY AUTHORITY (EFSA) (2022 AND 2023)

More than 50 million birds culled between Oct 2021 to Sep 2022

E) FIRST CASE OF AVIAN FLU FOUND IN ANTARCTIC REGION (OCT 2023)

- Avian flu has been detected for the first time in Antarctic region and has raised concerns for birds and mammals which feed on these bids.
- **Which type?**
  - Highly Pathogenic Avian Influenza (HPAI) was detected in brown skua (a predatory seabird) populations on Bird Island, South Georgia, making it the first known case in the Antarctic region.
- **Risk Assessment:**
  - Sea-Gulls and Skuas are the most threatened avian group. They are followed by bird's prey such as hawks and carcasses, terns and shorebirds.
  - Among marine mammals, fur seals and sea lions are reportedly most vulnerable, followed by southern elephant seals and dolphins.

19) NIPAH

A) NIPAH

- **Why in news**?
  - » There has been an outbreak of the deadly Nipah virus in Kerala which have infected five people and killed two of them (Sep 2023)

- **Introduction**
  - » According to WHO Nipah Virus (NiV) infection is a **newly emerging zoonosis** (a disease that can be transmitted from animals to humans) that can infect both humans and animals.
    - It is classified as a **"highly pathogenic paramyxovirus"** and handling it requires the highest grade of facilities called **BS-4**.
  - » The natural host of the virus are **fruit bats** of the Pteropodidae family, Pteropus genus. Humans are generally infected by fruit bat or pigs. Human to human transmission is also known including in the hospital setting.

- **First identification**
  - » First identified during the outbreak of disease that took place in **Kampung Sungai Nipah**, Malaysia in 1998. In this case pigs were intermediate hosts. Since, then there have been several outbreaks even without intermediate hosts.
  - » In India it was first detected in Siliguri in 2001 and Nadia in 2007. This was a spillover of the outbreak in Bangladesh.
  - » Later in 2018, 19, 21 and again in 2023 it appeared in Kerala.
    - **Why?**
      - Kerala has several fruit plantations that host several species of bats.
      - Better health facilities in Kerala may be leading to better detection, surveillance etc., whereas in other states the cases may go undetected.

- **Symptoms** of NiV can be **neurological, respiratory and pulmonary**. They include:
  - i. **Encephalitis (brain swelling) due to Inflammation of the brain**
  - ii. Confusion, disorientation and even persistent drowsiness
  - iii. Headache, fever, nausea and dizziness (flu like symptoms)

- **Fatality:** Around **40-70% depending on the local capability** for epidemiological surveillance and clinical management.

- **Prevention** (Avoid date palm sap; avoid close contact with NiV Patient; avoid direct contact with pigs/bats in endemic area)

- **Treatment / Vaccine**
  - » **Intensive Support care (no treatment or vaccine is available)**

According to NCDC (National Centre for Disease Control), **Ribavirin,** an antiviral, may have a role in reducing mortality among patients with encephalitis caused by NIPAH virus disease.

B) WHY ZOONOTIC DISEASES ARE INFECTING HUMANS MORE AND MORE

- » **Dramatic increase in population and mobility ->** Environmental changes, Deforestation etc. -> increase human contact with pathogens.
- » **Increased demand for animal protein**
  - Livestock production is moving closer to towns in the form of poultry farms etc.
- » **Rise in intense and unsustainable farming**
- » **Increased use and exploitation of wildlife**
- » **Unsustainable utilization of natural resources**
- » **Many Indian villages are located within or around forests**
  - Thus, significant number of people interact with forests in their day-to-day lives
- » **Global Warming**
  - Increases the population of insects like ticks that harbour and transfer the virus
- » **Poor Preparation in terms of infra and human resource**
  - Zoonotic diseases become more problematic in countries where health infrastructure is poor (e.g., Ebola in Africa, Zika in South America, Nipah in Asia etc.)
- » **Lack of awareness** especially in rural areas also

20) HEPATITIS

- **About Hepatitis**
  - Hepatitis refers to **inflammatory condition of liver**. It's commonly caused by **viral infections**, but there can be **other causes too** (e.g., auto-immune hepatitis that occurs as a secondary result of medication, drugs, toxins etc.)

- **5 Types of Viral Hepatitis**
  - Hepatitis A, B, C, D, and E.
    - A different virus is responsible for each of these types.
  - » **Hepatitis A** by Hepatitis A Virus (HAV)
    - Transmitted by consuming food or water contaminated by faeces from a person infected with hepatitis A.
  - » **Hepatitis B** (HBV) is transmitted through contact with infectious body fluids, such as **blood, vaginal secretion, semen** etc.
  - » **Hepatitis C** (HCV) is transmitted through direct contact with infected blood fluids typically through injection drug use and sexual contact.

        - Injecting drug use is a major contributor to the number of people newly infected with Hepatitis C globally.
    - » **Hepatitis D** (HDV), also called Delta Hepatitis is transmitted through direct contact with infected blood.
    - » **Hepatitis E** (HEV), is mostly found in areas with poor sanitation and typically results from injecting fecal matter that contaminates the water supply.

- **Hepatitis B and C** are responsible for more than 96% of cases.
    - » Vaccine for Hepatitis B is available
    - » Vaccine for Hepatitis C is not available

- **National Viral Hepatitis Control Program** (launched in July 2018)
    - » By MoH&FW
    - » It is aimed at **eliminating the deadly condition by 2030**.
    - » It has been launched in collaboration with WHO.
    - » Under the program, government will be providing **free drugs and diagnosis** for Hepatitis **B and C**.
    - » **Key strategies under the program include** - Preventive and promotive intervention through awareness generation; safe injection practices; sanitation and hygiene; safe drinking water; infection control and immunization; collaboration and coordination among different ministries; access to testing and management; building capacities at district, state, and national levels.

- **World Hepatitis Day - 28th July**
    - » Aims at raising awareness of hepatitis (A,B,C,D,E) and encourage prevention, diagnosis and treatment.
    - » World Hepatitis Day is one of the 8 global public health campaigns marked by WHO, along with World Health Day (7th April), World Blood Donor Day (14th June), World Immunization Week (last week of April), World Tuberculosis Day (24th March), World No tobacco day (31st May), World Malaria Day (25th April), and World Aids Day (1st December)

21) NOROVIRUS

- **Norovirus:**
    - » Norovirus is thought to be the **most common cause of acute gastroenteritis** (diarrhea and vomiting illness) around the world. It spreads easily through food and drink and can have a big impact on people's health.
    - » Noroviruses also are **sometimes called food poisoning** because they can be transmitted through contaminated food. They aren't always the result of food contamination.

    - » **Transmission of Norovirus:**
        - Having direct contact with an infected person.
        - Consuming contaminated food or water or touching contaminated surface.

    - » **Symptoms:** Diarrhea, Vomiting, Nausea, and Stomach Pain.

    - » **Prevention:**

- **General Hygiene:** Regular hand wash; rinse fruits and vegetables etc.

» **Treatment**: Not available - generally goes away on its own within 1 to 3 days.

12. NON- VIRAL DISEASES

1) MALARIA

- **Cause of Malaria**: It is caused by plasmodium pathogens.
  - » There are five human malaria parasites: Plasmodium falciparum (deadliest of the five) and Plasmodium vivax are the most common causes. The list also includes P. ovale, P. malarie, and P. knowlesi.
  - » **Mosquitoes** inject **sporozoite (Spore-like) stage** of the parasite into the skin when they bite, and the sporozoites travel to the liver. The parasite multiply in liver, and then infect the red blood cells.
- **Mosquito Vector**: Female **Anopheles** Mosquito (e.g. A. gambiae, A. culicifacies, A. fluviatilis etc.)
- **Note**: Malaria is the largest parasitic killer in the world.
- **Key Interventions to control Malaria**:
  - » Prompt and effective treatment with **artemisinin-based combination therapies.**
  - » **Reducing Mosquitoes** and Mosquito bites (**female Anopheles Mosquito** (e.g. A. gambiae, A. culicifacies, A. fluviatilis etc.)

A) DEVELOPMENT OF DRUG RESISTANCE:

A study from Africa has found that P. falciparum has developed resistance to the primary drug used to treat the disease i.e. Artemisinin and Artemisinin based combination therapies.

- Resistance was earlier shown in Asia, but experts are more worried about the development of resistance in Africa as it has 90% of the world's Malaria cases

B) 2023 WORLD MALARIA REPORT – PUBLISHED BY WHO (DEC 2023)

- **India**:
  - » In 2022, India accounted for 66% of the cases in the WHO South-East Asia region. This region accounted for only 2% of the global cases.
    - ▫ Plasmodium vivax was responsible for almost 46% of all cases in the region.
- **WHO Africa region** accounts for around 95% of the cases.
- **Crucial milestone of the WHO Global Technical Strategy for Malaria 2016-2030** have been missed in 2020.
- **Key factors** impacting fight against Malaria:
  - » Covid-19 disruptions; Drug and Pesticide Resistance; Humanitarian Crisis; climate change response; delays in program implementation.

C) GLOBAL TECHNICAL STRATEGY FOR MALARIA 2016-2030: WHO

- Aimed at dramatically lowering the global malaria burden over the 15 year period

D) VACCINATIONS

As of Dec 2023, RTS/AS01 and R21/Matrix-M vaccines are recommended by WHO to prevent malaria in Children. Malaria vaccines should be provided to children in a schedule of 4 doses from around 5 months

of age. These malaria vaccines act against P. falciparum, the deadliest malaria parasite globally and the most prevalent in Africa.

RTS,S

- The WHO has recommended widespread use of the **RTS,S/AS01 (RTS,S) malaria vaccine** (Commercial name: Mosquirix) among Children in regions of moderate to high ***P. falciparum*** *malaria transmission*.

- **RTS, S** has been developed by PATH Malaria Vaccine Initiative (MVI) and GlaxoSmithKline (GSK) with support from Bill and Melinda Gates foundation.
  - » It is a **recombinant vaccine**. It consists of the **P.*falciparum circumsporozoite* protein (CSP)** from the pre-erythrocytic stage (i.e. the CSP is secreted at the sporozoite stage of this plasmodium). The CSP antigen causes the production of antibodies capable of preventing the invasion of hepatocytes and additionally elicits a cellular response enabling the destruction of infected hepatocytes.
  - » **Note:** Mosquito bites transfer the CSP and **sporozites** into the human bloodstream, and the CSP nudges the parasite towards the liver, where it enters liver cells, matures and proliferates. The release of **mature merozites** marks the onset of the symptoms of malaria

R21 MALARIA VACCINE

- **Why in news?**
  - » A malaria vaccine manufactured by the biotechnology company Serum Institute of Technology of India and University of Oxford have passed the next round of regulatory approval by the WHO (Dec 2023)
    - R21/Matrix-M meets the WHO standards for vaccine quality, safety, and efficacy.

- **Details about the vaccine**:
  - » R21 is a modified form of a vaccine called RTS,S or Mosquirix.
  - » Vaccine is highly effective and can reduce malaria cases by 75% over a year.
  - » It is the second malaria shot approved by WHO, following the **RTS,S/AS01 on**e, which was approved in July 2022.
  - » R21 is designed to be both more potent and cheaper to produce than Mosquirix. .
    - **Note1:** R21 and Mosquirix both target the malaria parasite in the sporozoite phase of its life cycle - the phase in which it enters the human body from its mosquitoe host. The vaccines include a protein (Circumsporozoite Protein (CSP)) secreted by the parasite at that stage, in the hope of stimulating an antibody response against it. R21 includes a higher concentration of these proteins.
    - **Note2:** Each of the vaccine is administered with a chemical called an adjuvant, which boosts immune responses to the inoculation. But the Adjuvant used with R21 is easier to make than that used with Mosquirix, raising hopes that it cold be cheaper as well.

- **WHO's Approval:**
  - WHO has added the vaccine to the WHO's list of prequalified vaccines.

- This was also recommended for use for the prevention of malaria in Children by the global health agency on 2nd Oct 2023.

- **How is a vaccine added in the WHO list of pre-qualified vaccine?**
  - If a vaccine has undergone through evaluation of relevant data, testing of samples and WHO inspection of relevant manufacturing sites - and the outcome is positive - it is included in the WHO list of Prequalified Vaccines.
  - Pre-qualification is also a pre-requisite for vaccine procurement by UNICEF and fuding support for development y Gavi, the Vaccine alliance.

E) MALARIA'S COMBACK IN USA

- **USA** has recorded its first homegrown malaria cases in decades. In the year 2023, 9 indigenous cases have been reported (7 in Florida, one in Texas, and one in Maryland)
- **How?**
  - » ***Anopheles* mosquitoe**s capable of carrying malaria are still very much present in the USA they've just had very few opportunities to transmit the parasite because there are so few infected people to feed on.
    - **Experts believe that** a person infected with Malaria traveled to the USA from a malaria-endemic area and was bitten by a local *Anopheles mosquito,* which picked up the parasite and then bit someone else, passing on the parasite.
  - » **Climate change** is making environment more suitable for Malaria. Higher temperature also enhance the growth rate and transmissibility of the parasites responsible for malaria. Higher rainfall and sea level rise may also make the situation more suitable for malaria.

2) IMPORTANT INTERNATIONAL INITIATIVES RELATED TO MALARIA

A) E-2025 INITIATIVE

- Under this initiative WHO has identified 25 countries, including 3 from Africa, with the **potential to eradicate malaria by 2025**.
  - » The WHO will provide specialized support and technical guidance to these countries under the initiative.

- The initiative is built on the foundation of the E-2020 initiative. The **countries were identified by WHO across four key criterias**:

1. The generation of government endorsed elimination plan
2. Meeting a defined threshold of Malaria case reductions in recent years
3. A designated government agency for Malaria elimination and the capacity to confirm 100% of suspected malaria cases in a laboratory
4. Selected by the Malaria Elimination Oversight Committee

- **Countries selected for the E-2025 initiative:**

Automatically Nominated	Newly Added
1- Mexico 2- Costa Rica 3- Ecuador 4- Suriname 5- Belize 6- Cabo Verde 7- Saudi Arabia 8- Islamic Republic of Iran 9- Nepal 10- Bhutan 11- Republic of Korea 12- Malaysia 13- Comoros 14- Bostwana 15- Eswatini 16- South Africa 17- Timor-Leste	1- Panama 2- Vanuatu 3- Honduras 4- Thailand 5- Guatemala 6- Dominican Republic 7- Sao Tome And Principe 8- Democratic People's Republic of Korea

B) CHINA CERTIFIED MALARIA FREE AFTER 70 YEARS OF FLIGHT: WHO (JUNE 2021)

- In 1940s, China used to report 30 million cases annually. Now, it has gone for four consecutie years without an indigenous case.
- **Requirement of WHO's Malaria Free status**: 3 Consecutive years of zero indigenous cases. The country must also present rigorous evidence and demonstrate the capacity to prevent transmission re-emergence.
- **China** has become the 40th territory to be certified malaria free. The other recent countries to get Malaria free status include - El Salvador (2021), Algeria and Argentina (2019), and Paraguay and Uzbekistan (2018).
    - China is also the first country in WHO's Western Pacific region to be awarded a malaria-free certification in more than three decades. The only others with certified status are Australia (1981), Singapore (1982) and Brunei (1987).
- **Key initiatives by China** which has made this possible?
    - Discovery of Artemisinin in 1970s -> most effective anti-malarial drug.
    - Among the first countries to test the use of insecticide treated net to prevent Malaria and China distributed millions of nets

C) MAJOR NATIONAL INITIATIVES

- **National Framework for Malaria Elimination** (2016-2030)
    - Released by MoH&FW and aims to make India Malaria free by 2030.

3) KALA AZAR (VISCERAL LEISHMANIASIS, BLACK FEVER, AND DUMDUM FEVER)

- **As per WHO**, there are three main forms of Leishmaniases of which Kala-azar is the most serious form.

- **Basics of Kala Azar (Black Fever)**
  - **Parasite:** Protozoan parasite called '**leishmania donovani**'. (Genus: Leishmania)
  - **Vector:** female Sand fly.
    - The parasite is spread to humans by bites from infected female sand flies.
  - **Second largest parasite killer** in the world (after malaria)
  - It is one of the most neglected Tropical Diseases (NTD).
  - The parasite migrates to the internal organs such as liver, spleen (hence visceral), and bone marrow, and, if **left untreated, will almost always result in the death** of the host.
  - **Other factors:**
    - The disease affects some of the poorest people in the world and is linked to malnutrition, population displacement, poor housing, a weak immune system and a lack of financial resources.
    - It is also linked to environmental changes such as deforestation etc.
  - **Symptoms**: Irregular fever, weight loss, anaemia, and swelling of the spleen and liver.
  - **Only infects humans** (no other animal known to harbour the infection in Asia), and **humans are considered the only reservoir of the parasite**.
  - **Treatment:** Anti-leishmanial medicines are available for treatment. Vector control is another aspect.

- **Cases of Visceral Leishmaniasis or Kala Azar in India (Jan 2023)**
  - **Kala Azar** cases in India fell to 834 in 2022 from 44,533 in 2007 - a 98.7% decline: Union health Ministry.
  - After missing deadlines thrice, **India is poised to achieve the elimination target for visceral leishmaniasis or Kala Azar this year** with no block in the country reporting more than 1 case per 10,000 people. (Dec 2023)
    - India needs to sustain the momentum over the next 3 years in order to receive the WHO certification.
  - India contributes to 11.5% of total cases reported globally.
  - 89% of the cases were reported from eight countries - Brazil, Eritrea, Ethiopia, India, Kenya, Somalia, South Sudan and Sudan.

- **In October** 2023, **Bangladesh became the first country in the world** to be officially validated by the WHO for elimination of Kala Azar as a public health problem

- **National Kala Azar Elimination Program (NKEP)**
  - Though the initial 2015 deadline has been missed, the numbers have been brought down significantly.
  - **Key steps taken:**

- **India** has also expanded **vector control interventions**:
  - **Indoor residual spraying** to control the population of sandflies.
- Since sandflies have developed resistance to DDT, the NVBDCP introduced a synthetic pyrethroid for indoor residual spraying in 2015.
- **Reducing Crevices in 'Kuccha' walls** to reduce breeding areas.
- **ASHA (**Accredited Social Health Activist) network was tasked with ensuring that people with PKDL complete treatment.

- **Note:**
  - Since 2003, National Vector Borne Disease Control Programme (NVBDCP) is in charge of coordinating with endemic states to eliminate disease.
    - NVBDCP now funds consultants at state and district level and Kala-Azar Technical Supervisors (KTS) at the State's blocks (or clusters of village panchayats) to conduct surveillance.

- **International efforts to control Kala Azar**
  - An initiative was launched by **WHO** to eliminate VL as a public health problem from SE **Asia region by 2020.** The deadline has now been extended to 2023.

POST KALA-AZAR DERMAL LEISHMANIASIS (PKDL)

» It is a complication of Kala-Azar, in which the disease-causing protozoan invades the patient's skin cells. These cases act as reservoirs of the pathogens.

» **PKDL treatment is a bigger problem**
  - **Diagnostic is difficult**
    - PKDL cannot be diagnosed by the trademark rapid diagnostic kits. So, a skin snip examination is required. But not all PHCs are equipped with such tools.

» **Longer dose and greater quantity of drugs**
  - PKDL requires a longer dose and greater quantity of drugs then primary Kala Azar.

» **Why treating PKDL is important?**
  - It is not life threatening but can act as a source for Kala Azar infection to others.

A) OTHER TWO FORM OF LEISHMANIASIS

CUTANEOUS LEISHMANIASIS (CL)

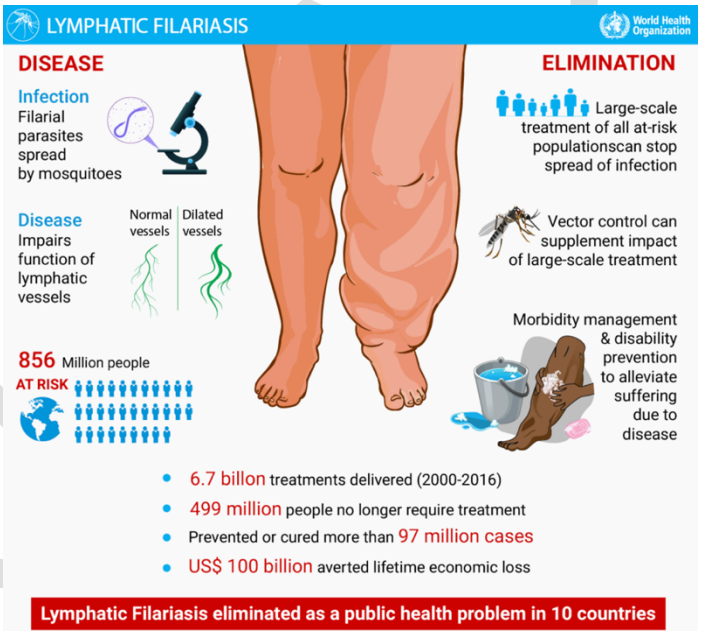
- It is the most common form of leishmaniasis.
- It is caused by 15 different species of the protozoan parasite *Leishmania*, transmitted by infected female sandflies.
- They are not life threatening, but can cause skin lesions, mainly ulcers, on exposed parts of the body, leaving life-long scars and serious disability or stigma.
  - » About 95% of CL cases occur in the Americas, the Mediterranean basin, the Middle East and Central Asia.

MUCOCUTANEOUS LEISHMANIASIS

It leads to partial or destruction of mucous membranes of the nose, mouth, and throat. More than 90% of the cases come from Bolivia, Brazil, Peru, and Ethiopia.

4) FILARIASIS

- **Basics:**
  - » It is a parasitic disease caused by infection with r**oundworm**s of the **Filarioidea** type.
  - » **Lymphatic Filariasis** impairs the lymphatic system and can lead to the **abnormal enlargement of the body parts,** causing pain, severe disability, and social stigma. It is also known as **elephantiasis** and is a Neglected Tropical Disease.



- **Vectors: Mosquitoes** are infected with micro-filariae (immature larvae) when biting an infected host. This larva matures in the mosquitoe and when the mosquitoes bite people, people are infected with mature parasite larvae. The larvae then migrate into lymphatic vessels where they develop into adult worms.
  - » It may be transmitted by different types of mosquitoes including the **Culex Mosquito**.
- The disease is prevalent in more than 50 countries.

5) NEUROCYSTICERCOSIS

- **Details**
  - » Neurocysticercosis (NCC) is caused when a human consumes meat from (or is indirectly in contact with) - a **pig** infected with **tapeworm**.
    - The eggs of tapeworms invade muscles of the human body to make cysts. Sometimes these cysts get into human brains, triggering epileptic seizures, headaches, difficulty with balance and excess fluid around the brain.
  - » A study published in the ***Nature journal*** in 2021 reported higher prevalence (42.2%) of NCC among patients with active epilepsy in the tea gardens of Assam. These findings were in sync with the older findings that NCC was one of the leading causes of seizures in developing countries, particularly in areas without proper sanitation and where pig rearing was widespread.

6) TUBERCULOSIS

- **Introduction**
  - » TB is an infectious **bacterial disease** caused by bacillus Mycobacterium tuberculosis, which most commonly affects the lungs (pulmonary TB) but can affect other sites as well (extra pulmonary TB)

- **Symptoms:**
  - » Healthy people -> often no symptoms (immune system wall off the bacteria)
  - » **Symptoms** of **active TB of the lung** include coughing (sometimes with sputum or blood), chest pains, weakness, weight loss, fever, night sweats etc.

- **Diagnosis**
  - » **Sputum Smear Microscopy** - used since more than 100 years.
  - » **Rapid Molecular Test** - developed recently - uses polymerase chain reaction (**PCR**)
  - » **Culture Methods** - needs developed laboratory capacity.

- **Treatment**
  - » The effective drug treatments were **first developed in the 1940s**.
    - The most effective first-line anti-TB drug, **rifampicin,** became available in the 1960s.
    - The currently recommended treatment for new cases of drug-susceptible TB is a **six month regimen of four first line drugs**: **rifampicin, isoniazid, ethambutol and pyrazinamide.** Treatment success rates of 85% or more for new cases are regularly reported to WHO by its member states.
  - » Additionally**, social determinants** of TB such as under-nutrition, overcrowding and poor ventilation in slums and **clinical risk factors** such as diabetes mellitus, smoking etc. should be addressed simultaneously.

  - ▪ Treatment for **Multi drug resistant TB (MDR-TB),** defined as **resistance to isoniazid, rifampicin** (the two most powerful anti TB drugs) is longer, and requires more expensive and more toxic drugs. For most patients with MDR-TB, the current regimens recommended by WHO last 20 months, and treatment success rates are much lower.

- **Vaccine**
  - » Not yet (BCG is not effective in tropical countries)

- **Steps Taken**
  - i. **For Detection**
    - **National Policy of Mandatory Reporting** of detected cases since 2012
    - Launch of **Nikshay Platform** - a nation wide web-based and case-based reporting system that facilitates reporting of detected cases by care providers in public and private hospitals.

  - ii. **National Strategic Plan for Tuberculosis Elimination (2017-2025)**

- **Goal**
  - » Achieving rapid decline in the burden of TB, morbidity and mortality while working towards elimination of TB by 2025
  - **100% case finding by 2020**
  - **Elimination of TB 2025** (< 1 per 1,00,000 population)

- **Updated MDR-TB Recommendations from WHO** (Aug 2018)
  - **Replace all injectable with oral regime** for MDR-TB patients.
    - Injectables have been found to be less effective
  - **Prioritize newer drugs** like **Bedaquiline** in the fully oral regime.
    - Data has shown that newer drugs show greater success in treatment and lower mortality rate.

- **24 March: World Tuberculosis Day**

- **New Vaccines and Medicines**
  - i. New BCG based TB vaccine, VPM1002 has shown promise in animal and small-scale human trials. It is to be supplied by Pune based Serum Institute of India.
  - **ii.** **Bedaquiline** - a new drug for drug resistant TB - launched by Union Health Ministry on 24th March 2016 (Worth TB Day)

A) WHO'S GLOBAL TB REPORT

7) LEPROSY

- **Introduction**
  - » Leprosy, also known as Hansen's disease, is a chronic infectious disease caused by ***Mycobacterium leprae***. It is one of the oldest diseases known to humans and despite advances in all spheres of medical science, continues to be a public health challenge in India.
  - » The disease mainly affects the skin, the peripheral nerves, mucosal surfaces of the upper respiratory tract and the eyes. The deadening of hands and feet leaves patients prone to kinds of disabling injuries that have become stigmatizing symbol of leprosy.
  - » Leprosy is known to occur at **all ages**. Leprosy is a leading cause of permanent physical disability.
  - » It is included under the list of Neglected Tropical Diseases of WHO.
  - » India, Indonesia and Brazil constitute around 81% of the cases with India contributing to more than 50% of the cases.
- **Transmission**
  - » The exact mechanism of transmission of leprosy is not known.
  - » Till recently, most widely held belief was that the disease was transmitted by **contact** between cases of leprosy and healthy persons.
  - » More recently, possibility of transmission by **respiratory route** is gaining ground. There are other possibilities like transmission through insects which can't be ruled out.
- **Treatment**
  - » Leprosy is **curable** with combination of drugs known as **multidrug therapy (MDT)** (to prevent drug resistance)

» Treatment, before nerve damage occurs, is the most effective way of preventing disability due to leprosy.

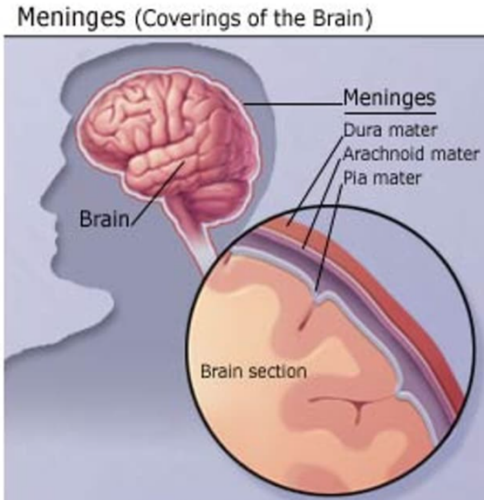
- **Leprosy Situation in India**
  - India currently accounts for 60% of the total new leprosy cases in the world. Though, technically, WHO declared India leprosy free in 2005(<1 case per 10,000 population), the disease is still widespread in the region where poverty and stigma have kept patients hidden and untreated.
    - **Bihar, Jharkhand, Odisha, West Bengal, Madhya Pradesh, Chhattisgarh, Odisha and Maharashtra** account for 76% of the new leprosy cases.
  - Further, another worrying trend is that Leprosy is **impacting the marginalized population** more. For e.g. an analysis by ORF indicates that Adivasis account for 18.8% of India's new cases and this percentage has been increasing over the last decade.

- **Steps taken by India towards eradicating Leprosy:**
  a. **National Leprosy Eradication Program (NLEP)**, running since 1983 - a centrally sponsored health scheme of MoH&FW, GoI.
     - NLEP is aimed at eradicating the disease from the country. India was able to eliminate leprosy (bring the number of cases to less than 1 per 10,000 population) by 2005, but complete eradication has not taken place yet.
  b. **Sparsh Leprosy Awareness Campaign (SLAC)** under NLEP was launched in 2017.
  c. **Personal Laws (Amendment) Act, 2019** is aimed at removing leprosy as a ground for divorce in India family laws.
     - The act amends five acts - The Divorce Act, 1869, the Dissolution of Muslim Marriage Act, 1939, the Special Marriage Act, 1954, the Hindu Marriage Act, 1955, and the Hindu Adoption and Maintenance Act, 1956 - on provisions related to marriage, divorce, and separation of Hindu and Muslim couples.

8) MENINGITIS (BOTH VIRAL AND BACTERIAL REASONS)

- **What is Meningitis?**
  » It is inflammation of the meninges (three membranes that cover the brain and spinal cord). It occurs when fluid surrounding the meninges becomes infected.

- **Causes:** Viral and bacterial infections; Cancer; chemical irritation; fungi; and drug allergies.
  » **Bacterial Meningitis**: It is an extremely serious illness. It can be caused by several bacterias including *Streptococcus pneumoniae (pneumococcus), Neisseria meningitidis* (meningococcus) etc.
    - **Meningococcal meningitis** (caused by the Neisseria meningitidis bacteria), is associated with high fatality rate. It primarily affects small children (though can infect everyone) and can cause severe brain damage if left untreated. It holds the potential to cause large epidemics as it has the **potential to transfer from person to person through respiratory droplets**.
      - This is vaccine preventable.



- *Haemophilus influenzae type b* (Hib) was a common cause of meningitis in babies and young children until the Hib vaccine became available for infants.

» **Viral Meningitis** is more common but generally less serious than bacterial meningitis.
» **Fungal Meningitis** is very rare. Generally, people with weak immune system are vulnerable to it.
» **Parasitic and Amoebic meningitis** are also rare.
» **Noninfectious meningitis** is caused by diseases like cancer or in case of injury due to accident, surgery or reactions to medications.

- **Contagious?**
  » Some viral and bacterial meningitis are contagious. They can be transmitted by coughing, sneezing, or close contact.

- **Symptoms:** In the beginning the viral and bacterial meningitis have similar symptoms. However, bacterial meningitis symptoms are usually more severe. These symptoms also vary depending on your age.

- **Regions most affected**: Meningitis epidemics have occurred in the last decade in all regions of the world. But it is most common in the '**Meningitis Belt**', which spans 26 countries across sub-Saharan Africa.

- **Vaccines**:
  » Several vaccines protect against meningitis, including meningococcal, Haemophilus Influenza type b and Pneumococcal vaccines.

- **"The Global Roadmap to Defeat Meningitis by 2030" by WHO** (Sep 2021)
  » It aims to eliminate the epidemic of bacterial meningitis - the deadliest form of the disease - and to reduce deaths by 70 percent and halve the number of cases.

  » Focus on urgently expanding access to existing tools like vaccines, spearheading new research to prevent, detect, and treat the various causes of the disease and improving the rehabilitation for the affected.

13. NEGLECTED TROPICAL DISEASES (NTDS)

- **WHO Definition:**
  - NTDs are a diverse group of **20 conditions** that are **mainly prevalent in tropical areas**, where they mostly affect i**mpoverished communities** and disproportionately affect women and Children.
    - The epidemiology of NTDs is complex and often related to environmental conditions.
    - They are caused by variety of **pathogens** - viruses, bacteria, protozoa, and parasitic worms (helminths).

- **Which are the diseases included in NTDs**:

- Buruli Ulcer, Chagas Disease, Dengue & Chikungunya, dracunculiasis (Guinea-worm disease), echinococcosis, foodborne trematodiases, human African trypanosomiasis (sleeping sickness), leishmaniasis, leprosy (Hansen's disease), lymphatic filariasis, mycetoma, chromoblastomycosis and other deep mycoses, onchocerciasis (river blindness), podoconiosis, rabies, scabies, and other ectoparasitoses, schistosomiasis, soil-transmitted helminthiases, snakebite envenoming, taeniasis/cysticercosis, trachoma, and yaws and other endemic treponematoses.

- **Note:**
  - '**Noma**' is the latest addition to WHO's list of neglected tropical diseases (Dec 2023)

- These diseases are **contrasted with the "big three" infectious diseases** (HIV/AIDS, tuberculosis, and malaria), which generally receive greater treatment and research funding.

- **Jan 30**: World **NTD Day**
  - In May 2021, the delegates at the 74th World Health Assembly unanimously adopted a proposal to declared Jan 30 as 'World NTD Day.

- **WHO's new roadmap for 2021-2030 calls for three strategic shifts to end NTDs:**
  - From measuring process to measuring impact.
  - From disease-specific planning and programming to collaborative work across sectors.
  - From externally driven agendas reliant to programmes that are country-owned and country-financed

A) INCLUSION OF NOMA ON THE WHO'S LIST OF NTD

It is a severe gangrenous disease of the mouth and face. It primarily affects young children (between the ages of 2 years to 6 years) in regions of extreme poverty.

It starts as an inflammation of gums, which, if not treated early, spreads quickly to destroy facial tissues and bones.

Cause: Evidence indicate that NOMA is caused by bacteria found in the mouth. There are multiple risk factors associated with the disease. It includes malnutrition, weakened immune system, infections, and extreme poverty. If the child is malnourished and has recently been sick with an infectious disease, such as measles or chickenpox, they are at more risk for developing noma.

It is not contagious but tends to strike when the body's immune system is weak.

Impact: It can be fatal and may also cause severe disfigurement for survivors.

Treatment: It involves antibiotics, advice and support on practices to improve oral hygiene with disinfectant mouth wash and nutritional supplements. In case of early diagnosis, proper wound healing without long-term consequences may take place. In severe cases, surgery may be necessary.

NOMA is sometimes called the '**Face of Poverty**' as it is a social marker of extreme poverty and malnutrition.

Significance of Including NOMA in the NTD's list:

- Amplify global awareness.
- Catalyze research, stimulate funding and boost efforts to control

Cases are mostly found in sub-Saharan Africa. Some cases are also reported from Americas and Asia. **Accurate estimation** of the number of noma cases is challenging due to rapid progression of the disease and the associated stigma.	the disease through multisectoral and multi-pronged approaches.

14. NON-COMMUNICABLE DISEASES

1) HYPERTENSION (HIGH BLOOD PRESSURE)

- **Why in news?**
  - » Who releases its first-ever report on global impact of high BP, states approximately four in every five not treated adequately (Sep 2023)

- **What is Blood Pressure?**
  - » **Blood pressure** is a measure of how much the blood moving through your arteries pushes against the vessel walls. According to medical standards, the reading on a doctor's BP monitor going above 140/90 accounts for **hypertension**. **High Blood Pressure (Hypertension) is a serious medical condition** that significantly increase the risks of heart, brain, kidney and other diseases**.**
  - » A large number of people who suffer from hypertension are unaware of this, therefore it is also sometimes referred as a **silent killer**.
  - » It is a condition that knows no boundaries affecting people of **every age** and **different socio-economic conditions.** It **can't be cured** but can be managed through lifestyle changes, medication, and regular monitoring.

- **WHO Report on Global Impact of High BP** (Sep 2023)
  - » Hypertension affects 1 in 3 adults worldwide and around 1/3rd of the adults with hypertension are unaware of their conditions. Nearly 4/5 people with hypertension are inadequately treated. Scaling up coverage can avert 76 million deaths between 2023-2050.

- The number of people living with hypertension (blood pressure of 140/90 mmHg or higher or taking medication for hypertension) doubled between 1990 and 2019, from 650 million to 1.3 billion.

- **Hypertension Situation in India**:
  - » **As per a paper published in *The Lancet:***
    - Hyper Tension is the **most important risk factor for death and disability in India**.
      - Less than 1/4th of hypertensive patients in India had their blood pressure under control during 2016-2020.
    - There is a growing prevalence of hypertension amongst younger adults and those from lower socioeconomic backgrounds.
  - » **NFHS-5** reported a hypertension prevalence of 24% in men and 21% among women, an increase from 19% and 17% respectively from the previous round (NFHS-4)

- **Key Issues with Hypertension situation in India**:
  - **i. Lack of Awareness**: As per WHO, 1/3rd of the hypertension patients don't even know that they are suffering from hypertension.
  - **ii. Limited Access to healthcare services**
  - **iii. Inadequate adherence** to medication and lifestyle modifications

A) BENEFITS OF REDUCING SALT INTAKE (DEC 2022)

- Adding less salt to food -> Fewer heart attacks and strokes.
  - This was found to be true even in participants who were following DASH diet (Dietary Approaches to Stop Hypertension).
  - **DASH** is the best recommended diet to prevent cardiovascular events. It involves eating fruits, vegetables, lean meat, poultry, nuts, whole grains, and reducing intake of saturated fats, cholesterol, and sugar.
  - WHO recommends only 5 gm of salt per day.

- **Other key things to know:**
  - **Sodium** intake from processed and restaurant food contributes to high rates of high blood pressure, heart attack, and stroke. Reducing sodium intake could prevent thousands of deaths annually.
  - **How does salt raise blood pressure ->** Class discussion?

2) DIABETES AND INSULIN

A) WHAT IS DIABETES?

- A medical condition when person's blood sugar level is too high.
- It is classified in **two types**:
  - » **Type 1 diabetes:** This type of diabetes appears in childhood where **body can't make insulin or make insufficient Insulin, a** hormone that regulates blood sugar level. It helps glucose get into cell. This condition occurs because body's immune system attacks the cells in the pancreas that make insulin.
  - » **Type 2 diabetes:** The **body doesn't make enough insulin** or when **cells are not responding to insulin**. This type of diabetes is associated with **obesity** and can lead to blindness, strokes, heart disease and even death.

B) TYPE 1 DIABETES LEADING CAUSE OF DIABETES DEATHS IN THOSE BELOW 25, EASILY PREVENTABLE: STUDY PUBLISHED IN LANCET

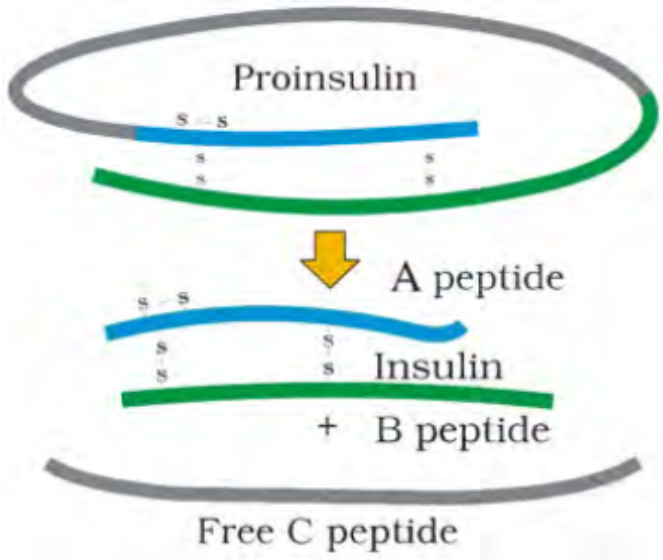
- » **Type 1** diabetes in those below 25 years accounted for at least **73.7% of the overall 16,300 diabetes deaths** in this age group in 2019. This is despite fatalities from this condition being largely curable.

- » The **death rate** varied based on the Socio-demographic index (SDI) of a country.
  - Countries on the higher end of the SDI spectrum recorded 0.13 deaths per 100,000 people.

- Countries on the low middle SDI spectrum recorded 0.6 deaths per 100,000 people.
- Countries on low SDI spectrum recorded a 0.71 per 100,000 population death rate.
    - Myanmar (1.93/1,00,000 population), Papua New Guinea (1.78 per 100,000 population) and Haiti (1.57 per 100,000 population) had the highest age-standardized death rates for diabetes.

C) INSULIN

- **Details**
    - » Insulin is a peptide hormone produced by pancreas. Inside the pancreas, the hormone insulin is made in **the beta cells**, which are part of islets of Langerhans. With each meal, beta cells release insulin to help the body use or store the blood sugar it gets from the food.
    - » In the beta cells, insulin is first created as a big molecule called "**proinsulin**". Proinsulin is broken into two pieces: Insulin and C-Peptides.
    - » **Note:** Insulin cannot be taken as pill as it would be broken down during digestion just like the protein in food. It must be injected into the fat under your skin for it to get into your blood.



- **Discovery of Insulin:**
    - » Insulin was discovered in 1921 by **Sir Frederick G Banting,** Charles H Best, and JJR Macleod at the University of Toronto in 1921 - after which it was purified by James B Collip for safer testing on humans. It was the **greatest medical breakthrough of the 20th century** and remains the go-to treatment for type-1 diabetes globally today.
        - **Note:** Back in the 19th century, those suffering from type-1 diabetes were rarely expected to live longer than a year or two after detection. This happens because type-1 diabetes is an autoimmune disease where the body destroys the cluster of cells in the pancreas
    - » In **Jan 1922**, Leonard Thompson was administered first dose. **Banting and Macleod** went on to win the **Nobel prize in Physiology** or Medicine on Oct 25, 1923.
    - » **Important Video:** 100 years of insulin use: How it was discovered and where we stand today

- **Situation today:**
    - » Globally, 15/1 lakh people suffer from type-1 diabetes. The international diabetes federation have estimated that 451 million adult suffered from diabetes worldwide in 2017. This would increase to 693 million by 2026 if not effective prevention methods are adopted.

D) NON SUGAR SWEETNERS

- **What are non-Sugar Sweeteners?**

» Non-Sugar Sweeteners (NSS) or Non-Nutritive Sweeteners (NNS) are **substances used in place of sweeteners that have sugar** (sucrose) or sugar alcohols. They have negligible or zero calories because, unlike sugar, they don't get broken down by the body into products that provide energy or calories.
» They are used as tabletop sweeteners as well as in food items marked as 'Sugar Free', 'Diet' etc.
» They are of primary **two types - i) Artificial, ii) Natural**
  - **Artificial:** These NSS are prepared in laboratories. Examples include Aspartame, Saccharine, Acesulfame-potassium, Sucralose, Neotame (derived from aspartame), Advantame (derived from aspartame) etc.
  - **Natural**: These are extracted from plants (e.g. Stavia, Thaumatin, Monk Fruit etc.)
» All the six artificial NSS and 3 natural NSS are approved by the US Food and Drug Administration. India's FSSAI has also approved all of them (except Advantame, and Monk Fruit).

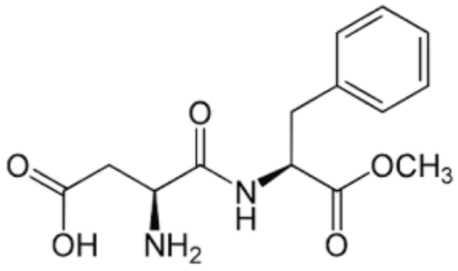
- **Why are they used?**
  » **TO reduce consumption of sugar** (which has led to global rise in diabetes and obesity).

- **Market**:
  » As per a report by global market consultancy The Business Research Company the market for these NSS was worth $**20 billion in 2022** and it is expected to reach about $30 billion by 2027.

- **Criticisms:**
  i. **Little Evidence to substantiate the benefits of NSS** in controlling diabetes and obesity.
  ii. **Growing body of research** says that these NSS may lead to **cardiovascular diseases, cancers, and type-2 diabetes**.
    - For e.g. WHO in its July 2023 guidelines have classified Aspartame as "**possibly carcinogenic o humans"**.

D) PRELIMS FACTS: ASPARTAME:

Aspartame is an artificial sweetener which was invented in 1965 and has been in use in USA since early 1980s.
It is a compound of carbon, hydrogen, nitrogen, and oxygen with chemical formula **$C_{14}H_{18}N_2O_5$**.
It is among the most popular sugar substitute used in the world.
Several Studies have highlighted problems associated with Aspartame:
- The **WHO** analyzed some 1,300 studies, and cited the following three, to declare aspartame "**possibly carcinogenic to humans)** -> European Journal of Nutrition, 2016; Cancer Epidemiology, 2022; Cancer Epidemiology, Biomarkers & Prevention, 2022;



- **WHO has placed aspartame in Group 2B**. This group consist of those substances which are possibly carcinogenic.

- **Details about various Groups:**

» **Group-1**: **Carcinogenic:** These substances have shown sufficient evidence in humans and animals to be treated as carcinogenic. It includes tobacco smoking, alcohol consumption, Solar Radiation, ionizing radiation.
» **Group-2A: Probably Carcinogenic**: Limited evidence in humans but sufficient evidence in animals. It includes insecticide DDT, Red Meat, Night Shift Work, Emission from high temperature frying etc.
» **Group-2B: Possibly Carcinogenic**: Limited evidence in humans or sufficient evidence in animals. It includes aspartame, gasoline engine exhaust, heavy metal lead;
» **Group-3: Not classified as carcinogen:** Inadequate evidence in humans an in animals. It include coffee, Mercury, Paracetamol, crude oil etc.

15. RARE GENETIC DISEASES

- **Introduction**
  » A rare disease is a **health condition of low prevalence that affects a small number of people** compared with other prevalent diseases in general population.
    ▫ They generally include **genetic diseases**, rare cancers, infectious tropical diseases, degenerative diseases etc.
  » The **most common rare diseases recorded in India** are Haemophilia, Thalassemia, sickle cell anaemia, primary immuno-deficiency in children, auto-immune diseases, Lysosomal storage disorders such as Pompe disease, Hirschsprung disease, Gacher's disease, Cystic fibrosis etc. These diseases may be impacting around 70 million people from India, 50% of which are children.

- **Why special focus is needed for rare diseases / Need of a separate policy on Rare Diseases**
  » **High cost of treatment** or no treatment -> not affordable for most of the citizens -> health insurance generally excludes rare diseases.
    • Available are primarily expensive because pharma companies are not interested in R&D as the number of patients for each disease is very less (**Orphan Drugs)**
    • **As per WHO**, only 5% of the identified rare diseases have treatment.
  » **Difficult to diagnose**.
  » **Early screening generally doesn't happe**n because of lack of awareness among primary care physicians, lack of adequate screening and diagnostic facilities etc. There are very few medical professionals who can deal with these diseases
  » Currently there is **inadequate insurance cover** and treating practitioners are lacking **management practices.**

1) NATIONAL POLICY FOR RARE DISEASES, 2021

- MoH&FW came up with the policy in March 2021.

- It aims to **lower the high cost of treatment** for rare diseases with **increased focus on indigenous research** with the help of a **National Consortium** to be set up by Department of Health Research, MoH&FW as convenor.

- It envisages creation of a national hospital based registry of rare diseases so that adequate data is available for definition of rare diseases and for R&D.

- It focuses on **early screening and prevention** through primary and secondary healthcare infrastructure such as H&W Centres and District Early Intervention Centres (DEICs) and through counselling of high risk parents.
    - Screening will also be supported by NIDAN Kendras set up by the DBT.
- The policy aims to strengthen **tertiary health care facilities for prevention and treatment of rare diseases** through designating 8 health facilities as **Centre of Excellence** and these CoEs will also be provided **one-time financial support of upto Rs 5 crores for upgradation of diagnostic facilities**.

- **Provision for financial support:** The policy was amended in May 2022. It now provides a financial **assistance of upto Rs 50 lakh** for treatment of rare diseases of all categories.

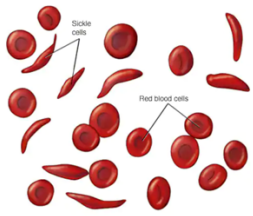
- The policy also envisages a **crowd funding mechanism** in which corporates and individuals will be encouraged to extend financial support through a robust IT platform for treatment of rare diseases.
    - Funds so collected will be utilized by CoEs for treatment of **all three categories of rare diseases a**s first charge and then the balance financial research could also be used for research.

- **Performance of the policy** (Critical Analysis) (Jan 2023)
    - LS MP Varun Gandhi have written to Union Health Minister and have said that more than 4,00 identified patients of rare diseases - mostly children - are yet to receive the Rs 50 lakh financial assistance for treatment guaranteed by the Union Government under the National Policy for Rare diseases, 2021.
        - More than 10 children who were awaiting treatment have already lost their lives.
    - The 10 CoEs constituted under the policy are yet to seek financial assistance (crowdfunding) for patients with rare diseases.

2) SOME RARE GENETIC DISEASES IN MORE DETAILS

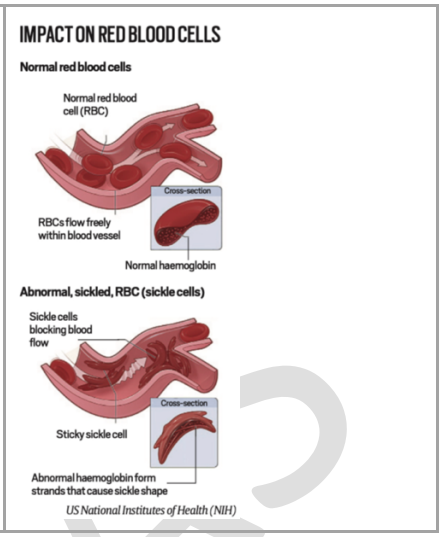
A) SICKLE CELL ANAEMIA

- **Why in news?**
    - » The first therapy based on gene editing technology Crispr-Cas9 for Sickle cell disease and thalassemia has been approved in UK (Nov 2023)

About Sickle Cell Anaemia: It is one of a group of inherited disorders known as Sickle Cell Diseases. It affects shape of the red blood cells which carry oxygen to all parts of the body. **RBCs are usually round and flexible** so that they move easily through the blood vessels. But, in sickle cell Anaemia, some of the RBCs are shaped like sickle and also become rigid and sticky. This slows or blocks blood flow.	

Note: Both Sickle Cell Anaemia and thalassemia are caused by **errors in the gene for haemoglobin**, a protein in the red blood cells that carry oxygen to organs and tissues.

Symptoms: Anaemia -> fatigue; Episodes of extreme pain called pain crises; Swelling of hands and feet; delayed growth and puberty; Vision problems etc.



THE UK DRUG REGULATOR, IN A LANDMARK BREAKTHROUGH, IN NOV 2023 APPROVED A GENE THERAPY FOR THE CURE OF SICKLE CELL DISEASE AND THALASSEMIA.

- This therapy is called **Casgevy**. It is the first licensed therapy in the world based on gene editing technology CRISPR-CAS9. This therapy edits the faulty gene that leads to these blood disorder, potentially curing person for life.

- **How does the therapy work?**
  - » The therapy uses the patient's own blood stem cells, which are precisely edited using Crispr-Cas9. A gene called BCL11A, which is crucial for switching from foetal to adult is targeted in the therapy.
  - » Foetal haemoglobin, which is naturally present in everyone at birth, doesn't carry the same abnormalities as adult haemoglobin. The therapy uses the body's own mechanisms to start producing more of this foetal haemoglobin, alleviating the symptoms of the two conditions.

- **How is the therapy prepared and given**:
  - » **Casgevy** is one time treatment for which the doctor has to first collect blood stem cells from the bone marrow using a process called apheresis - used to filter out the blood for different components. The cells are then sent to the manufacturing site where it takes about six months for them to be edited and tested.
  - » **Then the edited cells are then transplanted**. Before this doctor gives a conditioning medicine for a few days to clear the bone marrow of other cells that will be replaced by modified cells.
  - » **The patient has to stay in hospital for at least one month** so that the edited cells take up the residence in bone marrow and start making RBCs with normal haemoglobin.

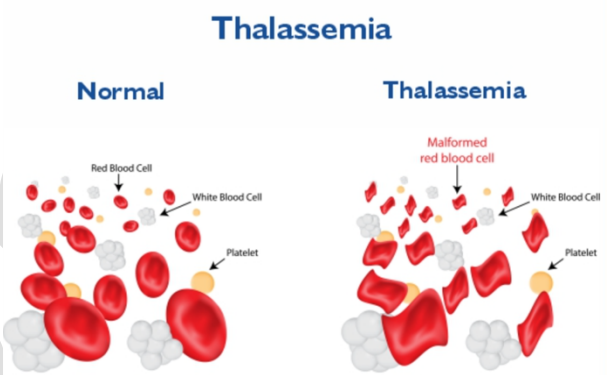
- **Side effects** from the treatment are similar to those associated with autologous stem cell transplants, including nausea, fatigue, fever and increased risk of infection.

- **Key challenges of the treatment:**
  - » **Very Costly**: it is estimated that the therapy will cause around $2 million per patient, which is in line with other gene therapies.

» **Absence of local manufacturing technology**: This means that the harvested blood stem cells have to be sent across countries.
» **Preventing the misuse of CRISPR-CAS9**:

- **Situation in India**:
  - An estimated 30,000 - 40,000 children in India are born with this disorder every year. Thus, India has one of the highest burdens of sickle cell anaemia in the world.
- **Steps taken by India:**
  - In Budget 2023-24, a **Mission to Eliminate Sickle Cell Anaemia by 2047** was announced. It entails awareness creation, universal screening of 7 crore people in the age group of 0-40 years in affected tribal areas, and counselling through collaborative efforts.

B) THALASSEMIA:



- Thalassemia is an inherited blood disorder in which the body makes an **abnormal form of hemoglobin**.
  - If both of your parents are carriers of thalassemia, you have a greater chance of inheriting a more serious form of disease.
- The disorder results in excessive destruction of RBCs, which leads to anemia.
- **Treatment Option**
  - Blood Transfusion
  - Bone Marrow transplantation
  - Medication and supplements
  - Possible surgery to remove spleen or gallbladder.
- **Situation in India**
  - India is the **thalassemia capital of the world with 40 million carriers** (highest in the world) and over 1,00,000 patients (Majors) under blood transfusion every month. It is the most common genetic blood disorder that is prevalent in India.
  - People suffering from the disease are unknowingly transferring on this genetic disorder to their children.
- Around 10,000 births of Thalassemia major are taking place every year.
  - Most of the thalassemia treatment takes place in private sector with out-of-pocket expenses.
  - The 2021 policy and associated benefits haven't been operationalized yet.
- **World Thalassemia Day**
  - It is observed on May 8 every year to commemorate Thalassemia victims and to encourage those who struggle to live with the disease.
  - The day was created by Thalassemia International Federation (TIF) in 1994.
  - **Theme for 2023**: "Strengthening Education to Bridge the Thalassemia Care gap"

C) HUNTER SYNDROME OR MPS-II

1. It is a very rare inherited, genetic disorder caused by a missing or malfunctioning **enzyme** iduronate 2-sulfatase. This enzyme's job is to break down certain molecules (large sugar molecules called glycosaminoglycans), and without enough of this enzyme, the molecule build up in harmful amounts.
2. The buildup of massive amounts of these harmful substances eventually causes permanent, progressive damage affecting appearance, mental development, organ function and physical disabilities.
3. The condition is one type of a group of **inherited metabolic disorders** called **mucopolysaccharidoses (MPSs)**. Hunter syndrome is also known as MPS II.
4. **Cure:** There is no cure for hunter syndrome. Treatment involves managing symptoms and complications.
5. **It mainly affects males**.
    - It is caused by a defective X chromosome. For females, even if one X chromosome is defective, the other may provide the correct gene. But males have only one X chromosome and hence the defective X chromosome would lead to Hunter Syndrome.

D) HAEMOPHILIA A AND HAEMOPHILIA B (ALREADY DISCUSSED WITH BIOTECHNOLOGY)

16. OTHER DISEASES

1) DEMENTIA

- **Details**
    - **What is dementia?**
        - It is the loss of cognitive functioning - thinking, remembering, and reasoning - to such an extent that it interferes with a person's daily life and activities.
        - Dementia is more common as people grow older (about 1/3rd of all the people aged 85 or older may have some form of dementia) but it is **not a normal part of aging**. Many people live in 90s and beyond without any sign of dementia.
        - There are **different forms of dementia** including **Alzheimer's disease** which is responsible for 70% of the cases.
    - **Situation in India**:
        - According to a 2020 report published by the Alzheimer's and Related Disorder Society of India, there are 5 million people in India living with dementia.
    - **Cause:** When healthy neurons, or nerve cells, in the brain stop working; sometimes genetic mutation may also be responsible.
        - The exact causes of Alzheimer's are still **unknown**, but a classical feature of the disease is the build up of **two proteins** in the brain: **beta amyloid and tau**.

- In people with Alzheimer's, **beta-amyloid i**s usually found in large quantities outside of neurons (brain cells), and tau "tangles" are found inside axons, the long, slender projection of neurons.

- **Three genes** have been linked to Alzheimer's disease in the young: **amyloid precursor protein (APP)**, **presenilin 1 (PSEN1)** and **presenilin 2 (PSEN2)**.
  - These genes are involved in producing a protein fragment called **beta-amyloid peptide,** a precursor to the previously mentioned beta-amyloid. I**f the gene is faulty,** it can lead to an abnormal build-up (plaques) of beta-amyloid in the brain – a hallmark of Alzheimer's disease and a target for treatments such as the recently approved drug lecanemab.
- People only need one of APP, PSEN1 or PSEN2 to be faulty to develop **Alzheimer's disease**.

- **Prevention of Dementia:**
  - **No proven prevention**
  - In general, leading a healthy lifestyle may help reduce the risk factors that have been associated with these diseases.

- **A 19-year-old** from China is the youngest person to be diagnosed with Alzheimer's disease - the cause is a mystery (Feb 2023)
  - Nearly, all cases of Alzheimer's disease in people younger than 30 are due to inherited faulty genes. In fact, the previous youngest case - a 21-year-old - had a genetic cause.
  - But, in this case, genetic cause was ruled out.

- **Lecanemab** gains FDA approval for early Alzheimer Disease (Jan 2023)
  - This is a treatment that may moderately slow mild cognitive decline and reduce **amyloid-B-**plaques in the patients with early Alzheimer disease. It gained accelerated approval from the US FDA.

17. MITOCHONDRIAL DISEASE

- **Introduction**
  - » Mitochondrial disease is a group of disorders **caused by dysfunctional mitochondria**, the organelles that generate energy for the cell.
  - » It is an **inherited chronic illness** that can be present at birth or develop later in life. It causes debilitating physical, developmental, and cognitive disabilities with symptoms including poor growth; loss of muscle coordination; muscle weakness and pain; seizures; vision and/or hearing loss; gastrointestinal issues; learning disabilities; and organ failures. About 1 in 2000 people have this disease in USA. It's **progressive and there is no cure**.
  - » There are many forms of mitochondrial disease, and it is inherited in a number of ways.

- **What causes Mitochondrial diseases?**
  - » For **many patients**, mitochondrial disease is an **inherited genetic condition**. Some percentage of patients acquire symptoms due to other factors, including mitochondrial toxins.
  - » The types of inherited mitochondrial diseases inherited include:
    - **DNA inheritance** (DNA contained in the nucleus of the cell). Also called autosomal inheritance

- **MtDNA Inheritance (DNA** contained in mitochondria)
  - There is **100% chance of trait occurring in other siblings, since all mitochondria are inherited from mother**, although symptoms might be more or less severe.
  - Note: Mitochondrial DNA is separate from DNA found in the cell nucleus and does not affect human characteristics such as hair or eye color, appearance or personality traits.

» **Other causes**

- Diseases specifically from deletions of large parts of mitochondrial DNA molecule are usually sporadic without affecting other family members.
- Medicine or other **toxic substances** can trigger mitochondrial disease.

- **Treatment**

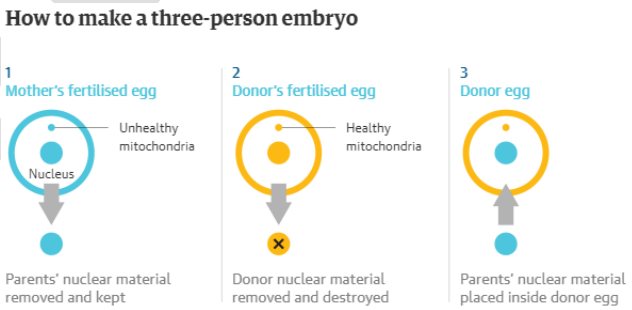
» The goal is to improve symptoms and slow the progression of diseases.

- Use vitamin therapy.
- Conserve energy
- Pace activities
- Maintain an ambient environmental temperature.
- Avoid exposure to illness.
- Ensure adequate nutrition and hydration.

- **Three Parent Babies**

» In 2015, Britain became the first country in the world to allow a three-parent baby to prevent some inherited incurable diseases.

» It is considered only hope for women who carry defective mitochondria to have healthy children. It is designed to help couples with mitochondrial disease, incurable condition passed down the maternal line that affect around one in 6500 children worldwide.



» The treatment is known as "three-parent" in vitro fertilization (IVF) because the babies, born from genetically modified embryos, would **have DNA from mother, a father and from a female donor**.

▪ **In 2018,** UK doctors selected first women to have 'three person babies'.

- They carried genetic mutations which caused rare genetic disease.

18. ANTI-MICROBIAL RESISTANCE

- **Why in news?**

» **Genes fuel antibiotic resistance in Yemen Cholera Epidemic** (Sep 2023)

▫ The Cholera outbreak in Yemen, which began in 2016, is the largest in modern history and anti-biotic resistance has become widespread among *V. cholerae* bacteria since 2018.

- A study has found the **presence of a new plasmid** - a small, circular DNA molecule - in V. *cholerae* from late 2018 to the bacterial strain behind the epidemic. This plasmid introduced genes encoding resistance to multiple clinically used antibiotics, including macrolides (such as azithromycin).

- **Introduction:**
  - » Antibiotic resistance occurs when an antibiotic has lost its ability to effectively control or kill bacterial growth; in other words, the bacteria become "resistant" and continue to multiply in the presence of therapeutic levels of antibiotic.

- Why do bacteria become resistant to antibiotic?
  - » **Natural Phenomena**: **Evolution** - Selective pressure for the survival of resistant strains of bacteria.
  - » **Human Action:** Current higher levels of antibiotic resistant bacteria are attributed to the **overuse and abuse of antibiotics**.

- **How do bacteria become resistant?**
  - » Some bacteria are naturally resistant to certain type of antibiotics.
  - » However, bacteria may also become resistant in two ways:
    - By Genetic Mutation
    - By acquiring resistance from another bacterium.

- **Why Anti-biotic resistance is more prevalent in India: Key Factors**
  - » **India is the largest consumer of anti-microbials globally** and the use of **last resort anti-microbials** like **cephalosporins** is soaring.
    - **Easy availability and overuse** of anti-biotics is the most important factor: Over the Counter Availability; Irrational Use; over-prescription by doctors
  - » **Poor Health Sector** -> improper treatment -> Development of anti-biotic resistance
    - Further, exposure to subtherapeutic levels of anti-microbials or non-adherence to prescribed medications has also been cited as a driver of AMR
    - E.g.: in case of TB
  - » Increasing and completely unregulated use of antibiotic **in Agriculture, live stocks and Poultry** sector.
    - Amount of antibiotics used in the farm animal and food industry is three to four times more than those used by humans.
    - For instance, Colistin is extensively used in veterinary practices as a growth promoter. This leads to generation of colistin-resistant bacteria in poultry and fresh water fish.
  - » **Poor Sanitation conditions ->** More diseases -> More use of medicines -> More AMR development
  - » Unchecked **discharge of effluents by the pharmaceutical industrie**s -> high concentration of pharmaceutical substances are found in surface and ground water systems near production facilities -> anti-biotics cause development of anti-microbial resistance in environment.

- **Impact of increasing anti-microbial resistance**
  - » **Damage to Public Health:**

        - In 2019, drug-resistant superbugs killed about **1.27 million people** globally - a toll more than HIV/AIDs or malaria - and according to the UN estimates, the number could reach 10 million by 2050.
        - Demands **complicated treatment pattern, with longer stay in hospitals** -> increase in cost of treatment.
        - Stronger antibiotics which are used after the first line of drugs fail generally have toxic side effects
        - Resistance also emerging for second line of drugs (e.g. XDR-TB emerging)
        - Without functional anti-microbials to treat bacterial and fungal infections, even the most common surgical procedures, as well as cancer chemotherapy, will become fraught with the risk of untreatable infections.
        - All this is compounded by the fact that **no new class of anti-biotics have made it to the market** in the last three decades, largely on account of inadequate incentives for their development and production.
    - **Economic damages** due to AMR can be equivalent to what 2008-09 economic shocks resulted into: UN Report
    - **Environmental Damages**
        - Extensive amount of anti-biotics lead to development of AMR in some micro-organisms. It impacts the microbial biodiversity and thus the environmental balance needed.

- **Steps that government has taken**:
    - **National Policy** for Containment of Antimicrobial Resistance, 2011
    - Guidelines for appropriate antibiotic usage which have revised Schedule H drugs to make over-the-counter availability of certain antibiotics nearly impossible
    - Programs such as Red Line Campaign
    - Sanitation campaigns such as Swatch Bharat Mission etc.
    - National Surveillance system for AMR (April 2017)
    - **National Action Plan on Antimicrobial Resistance (April 2017):** Focused on enhancing awareness, strengthening surveillance, improving rational use, promoting research and supporting neighboring countries.

19. SMOKING/DRINKING ETC.

1) SPURIOUS LIQUOR/ HOOCH TRAGEDIES/ METHYL ALCOHOL

- **Why do spurious drinks become poisonous sometime?**
    - **Excess Methanol:** Illicit brewing is unscientific, hooch brewers inadvertently mix excessive amounts of methanol in their liquor every once in a while, leading to mass death.
    - **Why is Methyl Alcohol (Methanol) used**?
        - It is similar in appearance and test to Ethyl Alcohol
        - It is easily available.
            - In Industry it is used as antifreeze, solvent, fuel, and ethanol denaturant.
    - The potential lethal dose of methanol is variable, adverse effects has reportedly occurred at 30 ml. The toxicity of methyl alcohol manifests as permanent blindness or ultimately death due to respiratory failure.
    - **Why is Methanol poisonous?**

- Due to accumulation of formic acid, a metabolite of methanol metabolism.

- **Why do people go for this kind of drink?**
  - » **Cheap Price:**
  - » **Availability**
  - » **Strong effect**

- **Other reasons Spurious liquor prosper-> Corruption**

20. INTERNATIONAL INITIATIVES

2) THE LANCET

- **Details about the Lancet:**
  - » The Lancet is a weekly peer-reviewed general medical journal and one of the oldest of its kind. It is also world's highest-impact academic journal. It was founded in 1823.
  - » It publishes original research articles, review articles, editorials, book reviews etc.
  - » The journal has editorial offices in London, New York City, and Beijing.

- **The Lancet announced a new commission on Dec 15, 2022,** to address **public health threats**.
  - » The scope of work by *The Lancet Commission on 21st-Century Global Health Threats* includes demographic changes and inverted population pyramids, high body mass index, anti-microbial resistance, eroding sexual and reproductive rights for women, food security, and fraying multilateralism.
  - » In 2024, the body will release its report after detailed study of 2 years.

21. FOOD SAFETY

1) LAWS AND INSTITUTIONS

A) FOOD SAFETY AND STANDARDS ACT, 2006

- Came into force in 2011.
- **Key Provisions**
  - i. **Consolidation of existing mechanisms**
    - The FSS Act consolidated a number of food legislations, rules, orders etc and established a single law for all matters relating to food safety and standards.
    - It subsumes acts like Prevention of Food Adulteration Act, 1954, The Fruit Product Order, 1955 etc.
  - ii. **Classification into standardized and non-standardized**
    - **Standardized Food products** - Standards are prescribed and do not require product approval prior to manufacture, sale distribution, or import. The first time manufacturer or importer only requires an FSSAI license to begin a food business.
    - **Non-standardized food products** - don't have standards as their safety parameters are either not known or either not yet ascertained.

iii. **Statutory Authority: Food Safety and Standards Authority of India (FSSAI) and State Food Safety Authorities**
   - FSSAI is the apex body for food quality regulation in the country. It is responsible for setting standards and regulate, manufacture, storage, distribution, sale and import of food items to ensure food safety.

iv. **Commissioner of Food Safety of state**
   - Appointed by respective state governments.
   - For efficient implementation of the Food Safety Act and various rules and regulations regarding food safety
   - Commissioner also responsible for appointing Food Safety Officers for various local areas

v. **Graded Punishment and penalties** for contravention of the Act

vi. **Adjudicating and Appellate Tribunal**

B) FOOD SAFETY AND IPC

- **Section 272 of IPC** prescribed punishment for adulteration of food or drink **intended for sale**.
- **Section 273 of IPC** punishes sale of noxious food or drink.
  - These two sections provides for imprisonment (upto six months) and/or fine (upto 1,000 rupees)

C) STATE FOOD SAFETY INDEX (FSI)

- **Details**
  - SFSI is an index developed by FSSAI. It aims to measure the performance of states and UTs on selected parameters of food safety.
  - It is aimed at **encouraging states and Uts to improve their performance** and work towards establishing a proper od safety ecosystem in their jurisdiction.
  - It is an annual report which has been released since 2018-19.
  - **Key Parameters used**:
    - **Human Resources and Institutional Data (20%)**:
    - **Compliance (30%)**
    - **Food Testing - Infrastructure and Surveillance** (20%):
    - **Training and Capacity Building** (10%)
    - **Consumer Empowerment** (20%)

22. MAKING MEDICINES AFFORDABLE

1) GENERIC MEDICINES:

- **Why in news recently?**
  - On Aug 2023, the National Medical Council (NMC) directed all doctors to prescribe only generic names and not brand names which led to protest. Following the Indian Medical Association's protest, the NMC has withdrawn the order on 'generic prescribing' since Aug 23, 2023.
    - **Why the protest?**

- Doctors trust certain brands
- The control over which brands to take will go to chemist shops.

- **What is a generic drug?**
  - Generic drug is a **low cost version of pharmaceutical drug** that is equivalent to a brand-name product in dosage, strength, route of administration, quality, performance and intended use.
  - They usually enter market after patent protection of the original drug expires.

- **Note:** Broadly Medicines can be of three types:
  - **Branded**: These are still on patent
  - **Branded Generic**: Off-Patent and Generic, but nonetheless produced by a reputed company, with a brand.
  - **Generic**: Off Patent, and unbranded.

- **Advantages**
  1. **Affordable healthcare**
  2. **Breaks the doctor-pharma nexus**
     - **Reduce unnecessary prescription**
  3. **Promotes domestic pharma companies**.
  4. **Difficult for quacks to function**

- **Limitations**
  1. **Quality concerns**
  2. **Erode doctor-patient relationship**
  3. **Low profit margins for retailers**
  4. **Shortage**
  5. **Difficult for common person to understand**, especially the multiple salt names in a FDC.
  6. **May discourage big pharma companies to launch their new medicines in India**

2) JAN AUSHADHI KENDRAS

- **Intro:**
  - » **Pradhan Mantri Bhartiya Janaushadhi Pariyojna (PMBJP)** was launched by Department of Pharmaceuticals, Ministry of Chemical and Fertilizers, Government of India as a direct market intervention scheme in 2008.

- It aims to make quality generic medicines available to all at affordable prices through Jan Aushadhi Stores (JAS) opened in each district of the states.
  - » First Jan Aushadhi Store (JAS) was opened at Amritsar Civil Hospital in 2008.

- Other key focus of the scheme is to create awareness and demand for generic medicine.

- **Incentives given:**
  - » The scheme provides an excellent opportunity of self-employment with suitable and regular earnings.

» An incentive of **Rs 5,00,000** is provided to the Jan Aushadhi Kendras as financial assistance and one-time additional incentive of Rs 1 lakh (as reimbursement for IT and infra expenditure) is provided to Jan Aushadhi Kendra opened in **North-Eastern India**, Himalayan state, island territories, and backward areas identified by NITI Aayog as aspirational districts or if opened by women entrepreneurship, Ex-Serviceman, Divyangs, SCs and STs.

- As of Jan 2023, **9,000 Jan Aushadhi Kendras** are functional across the country.
  - » The government has set up a target to increase the number of Jan Aushadhi Kendras to 10,000 by March 2024.
    - It offers 1759 medicines, and 280 surgical devices covering all major therapeutic groups.

PYQs:	
1	Living organisms require at least 27 elements, of which 15 are metals. Among these, those required in major quantities include: [Prelims 1995] (a) Potassium, manganese, molybdenum and calcium (b) Potassium, molybdenum, copper and calcium (c) Potassium, Sodium, Magnesium, and Calcium (d) Sodium, Magnesium, Copper and manganese
2	Which of the following hormones contains iodine? [1995] (a) Thyroxine (b) Testosterone (c) Insulin (d) Adrenaline
3	Which of the following are associated with *Diabetes mellitus,* a common disease in adults? [1996] 1. Higher sugar level in blood 2. Lowe sugar level in blood 3. Lower insulin level in blood 4. Higher insulin level in blood Select the correct answer by using the codes given below: A. 2 and 4 B. 1 and 2 C. 2 and 3 D. 1 and 3
4	Consider the following statements: [1996] AIDS is transmitted 1. By sexual intercourse 2. By Blood Transfusion 3. By Mosquito and other blood sucking insects 4. Across the placenta Select the correct answer using codes provided below: A. 1, 2 and 3 B. 1, 2 and 4

	C. 1, 3 and 4 D. 1 and 3
5	Which of the following leads to malnourishment? [1996] 1. Overnutrition 2. Undernutrition 3. Imbalance nutrition Select the correct answer using the codes given below: A. 2 only B. 2 and 3 only C. 1 and 3 only D. 1, 2 and 3
6	Antigen is a substance which: [1997] (a) lowers body temperature (b) destroys harmful bacteria (c) triggers the immune response (d) is used as an antidot to poison
7	Consumption of fish is considered to be healthy when compared to flesh of other animals because fish contains: [1997] (a) polyunsaturated fatty acids (b) saturated fatty acids (c) essential vitamins (d) more carbohydrates and proteins
8	Match List-1 with List-II and select the answer using the codes given below: [1998] List-1 / List-2 A - Malaria / 1 Fungi B - Polio / 2 Bacteria C - TB / 3 Virus D - Ringworm / 4 Protozoan (a) A-4, B-3, C-2, D-1 (b) A-4, B-3, C-1, D-2 (c) A-3, B-4, C-1, D-2 (d) D-3, B-4, C-2, D-1
9	Haemophilia is a genetic disorder which leads to: [1998] A. Decrease in haemoglobin level B. Rheumatic Heart Disease C. Decrease in WBC D. Non-clotting of blood

10	Assertion (A): Unsaturated fats are more reactive compared to saturated fats Reason (R): Unsaturated fats have only single bonds in their structure (A) Both A and R are true and R is the correct explanation of A (B) Both A and R are individually true but R is not the correct explanation of A (C) A is true but R is false (D) A is false but R is true
11	Consider the following statements about probiotic food: [2008] 1. Probiotic food contains live bacteria which are considered beneficial to health 2. Probiotic food help in maintaining gut flora Which of the statements given above is/are correct? A. 1 only B. 2 only C. Both 1 and 2 D. Neither 1 nor 2
12	Regular intake of fresh fruits and vegetables is recommended in the diet since they are good source of anti-oxidants. How do antioxidants help a person maintain health and promote longevity? [Prelims 2011] A. They activate the enzymes necessary for vitamin synthesis in the body and help prevent vitamin deficiency B. They prevent excessive oxidation of Carbohydrates, fats and proteins in the body and avoid unnecessary wastage of energy C. They neutralize the free radicals produced in the body during metabolism D. They activate certain genes in the cells of the body and help delay the ageing process
13	Which of the following is/are correct? [2013] 1. Viruses lack enzymes necessary for the generation of energy 2. Viruses can be cultured in the synthetic medium 3. Viruses are transmitted from one organism to another by biological vectors only Select the correct answer using the codes given below: A. 1 only B. 2 and 3 only C. 1 and 3 only D. 1, 2 and 3
14	Consider the following minerals [Prelims 2013] 1. Calcium 2. Iron 3. Sodium

	Which of the minerals given above is/are required by human body for the contraction of muscles? A. 1 only B. 2 and 3 only C. 1 and 3 only D. 1, 2 and 3
15	Which of the following diseases can be transmitted from one person to another through tattooing? [Prelims 2013] 1. Chikungunya 2. Hepatitis B 3. HIV-AIDS Select the correct answer using the codes given below: A. 1 only B. 2 and 3 only C. 1 and 3 only D. 1, 2 and 3
16	Consider the following diseases: [Prelims 2014] 1. Diptheria 2. Chickenpox 3. Smallpox Which of the above diseases has/have been eradicated in India? A. 1 and 2 only B. 3 only C. 1, 2 and 3 D. None
17	H1N1 virus is sometimes mentioned in news with reference to which one of the following diseases? [Prelims 2015] A. AIDS B. Bird Flu C. Dengue D. Swine Flu
18	Which of the following statements is/are correct? (2016 Pre) Viruses can infect 1. bacteria 2. fungi 3. plants Select the correct answer using the code given below. (a) 1 and 2 only (b) 3 only (c) 1 and 3 only (d) 1, 2 and 3

19	'Mission Indradhanush' launched by the Government of India pertains to (Pre 2016) (a) immunization of children and pregnant women (b) construction of smart cities across the country (c) India's own search for the Earth-like planets in outer space (d) New Educational Policy
20	Consider the following statements: (Pre 2017) 1. In tropical regions, Zika virus disease is transmitted by the same mosquito that transmits dengue. 2. Sexual transmission of Zika virus disease is possible. Which of the statements given above is/are correct? (a) 1 only (b) 2 only (c) Both 1 and 2 (d) Neither 1 nor 2
21	Which of the following statements is not correct? (Pre 2019) (a) Hepatitis B virus is transmitted much like HIV. (b) Hepatitis B, unlike Hepatitis C, does not have a vaccine. (c) Globally, the number of people infected with Hepatitis B and C viruses are several times more than those infected with HIV. (d) Some of those infected with Hepatitis B and C viruses do not show the symptoms for many years.
22	Which of the followings are the reasons for the occurrence of multi-drug resistance in microbial pathogens in India? [Prelims 2019] 1. Genetic predisposition of some people. 2. Taking incorrect doses of antibiotics to cure diseases. 3. Using antibiotics in livestock farming. 4. Multiple chronic diseases in some people. Select the correct answer using the code given below. (a) 1 and 2 (b) 2 and 3 only (c) 1,3 and 4 (d) 2,3 and 4
23	A company market food products advertises that its items don't contain trans-fats. What does this campaign signify to customers? [Prelims 2021] 1. The food products are not made out of hydrogenated oils 2. The food products are not made out of animal fats 3. The oil used are not likely to damage the cardiovascular health of consumers Which of the statements given above is/are correct? A. 1 only B. 2 and 3 only C. 1 and 3 only D. 1, 2 and 3
24	The term ACE2 is talked about in the context of (Prelims 2021): A. genes introduced in the genetically modified plants B. development of India's own satellite navigation system

	C. radio collars for wildlife tracking D. spread of viral diseases
25	In the context of hereditary diseases, consider the following statements: [Prelims 2021] 1. Passing on mitochondrial diseases, from parent to child can be prevented by mitochondrial replacement therapy either before or after in vitro fertilization of egg 2. A child inherits mitochondrial diseases entirely from mother and not from father Which of the statements given above is/are correct? A. 1 only B. 2 only C. Both 1 and 2 D. Neither 1 nor 2
26	Consider the following statements in respect of probiotics: [Prelims 2022] 1. Probiotics are made of both bacteria and yeast. 2. The organisms in probiotics are found in foods we ingest but they do not naturally occur in our gut. 3. Probiotics help in the digestion of milk sugars. Which of the statements given above is/are correct? A. 1 only B. 2 only C. 1 and 3 D. 2 and 3
27	'Wolbachia method' is sometimes talked about with reference to which one of the following? (a) Controlling the viral disease spread by mosquitoes (b) Converting crop residues into packing material (c) Producing biodegradable plastics (d) Producing biochar from thermochemical conversion of biomass