

SCIENCE & TECHNOLOGY



Previous Year Question Analysis
2021-2023

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PREFACE

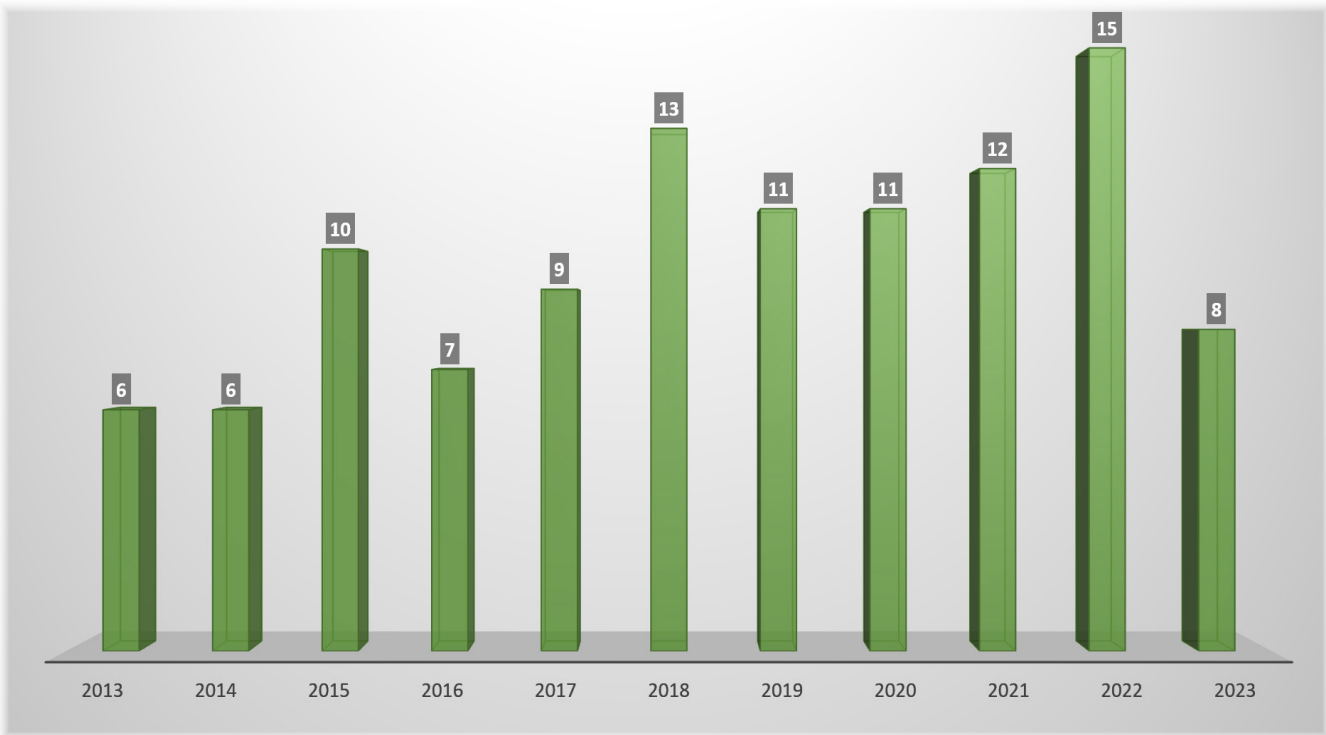
FORTUNE IAS ACADEMY is presenting an in-depth analysis of past year's questions (from 2021 to 2023) and providing comprehensive explanations of the key terms and concepts essential for prelims preparation.

TREND ANALYSIS

AI



The following graph examines the pattern of questions from Science and Technology spanning from 2013 to 2023:



Topic wise analysis of previous year questions:

TOPICS/ YEARS	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Information and Communication Technology (ICT)			1	1	1	2	2	1		2	
General Science	4	2	1	1	1	4		1	5	6	1
Technological inventions		1	3		1	2	2	4	1	3	2
Space and related technologies		1	1	2	1	2	1	1		1	1
Biotechnology	2		1	1	2	1	2	3	1	1	
Nuclear technology				1							
Defence Technology		1									1
Government initiatives					1						
Key terms			1	1	2	2	2	1	4	2	3
Diseases and pathogens		1	1				2		1		
Others			1								

STRATEGIC ANALYSIS AI



THE QUESTIONS FROM THE PAST THREE YEARS ARE DIVIDED INTO FOUR CATEGORIES:

Factual questions

It demands basic facts from static sources like NCERT, class notes, and other standard materials.

Current affairs questions

Current affairs questions demands general awareness about current events of National and International importance.

Conceptual questions

Such questions require knowledge of fundamental concepts along with conceptual clarity.

Application questions

It demands application of factual and conceptual knowledge to current events.

THE QUESTIONS ARE CLASSIFIED BASED ON ITS DIFFICULTY LEVEL:

EASY

The questions which can be answered from basics (NCERTs, and class notes) and does not need deep knowledge. Such questions are typically cracked by aspirants.

MODERATE

Moderate questions require decent level of conceptual clarity along with cognitive analysis. It can be solved through constant practice and revision.

HARD

Hard questions demand deeper understanding of concepts with critical thinking skills. Most of the aspirants leave such questions due to its increased difficulty.

2021-PRELIMS PREVIOUS YEAR QUESTIONS

Type of the questions: Factual

1. With reference to recent developments regarding 'Recombinant Vector Vaccines', consider the following statements:

- 1) Genetic engineering is applied in the development of these vaccines.
- 2) Bacteria and viruses are used as vectors.

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

Difficulty level: Moderate

EXPLANATION

Genetic Engineering

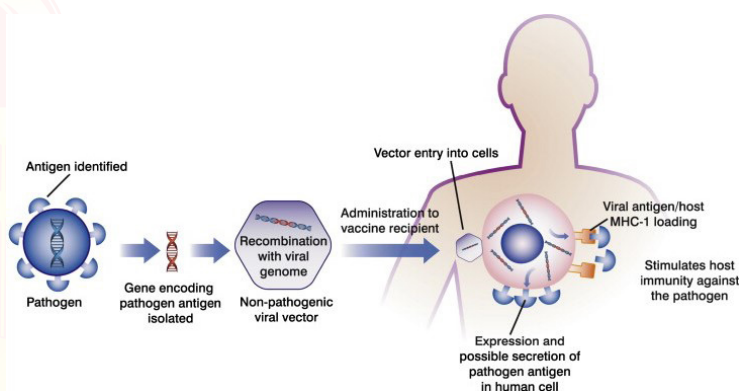
- Genetic engineering (genetic modification) is a process that uses laboratory-based technologies to **alter the DNA makeup of an organism**.
- This may involve **changing** a single base pair, **deleting** a region of DNA or **adding** a new segment of DNA.
- Genetic engineering is applied in the **development of recombinant vector vaccines**.

Recombinant Vector Vaccines

- Recombinant vector vaccines are a type of vaccine which **uses a modified or "recombinant" virus or bacteria** to deliver laboratory-made antigens to an organism, protecting it from diseases.
- In other terms, recombinant vector vaccines are **live replicating viruses** that are engineered to carry extra genes derived from a pathogen and these extra genes produce proteins against which we want to generate immunity.
- These vaccines are designed to be safer, more efficient and more effective than traditional vaccines.

- These vaccines are used to protect against-
 - » Hib (Haemophilus influenzae type b) disease
 - » Hepatitis B
 - » Whooping cough
 - » HPV(Human papillomavirus)

✖ A **vector** is a DNA molecule that is used to carry a foreign DNA into the host cell. It has the ability to self replicate and integrate into the host cell.



RELATED PYQs

- Q1. The Genetic Engineering Appraisal Committee is constituted under the
- a) Food Safety and Standards Act, 2006
 - b) Geographical Indications of Goods (Registration and Protection) Act, 1999
 - c) Environment (Protection) Act, 1986
 - d) Wildlife (Protection) Act, 1972

[2015]

- Q2. What is the importance of using Pneumococcal Conjugate Vaccines in India?
1. These vaccines are effective against pneumonia as well as meningitis and sepsis.
 2. Dependence on antibiotics that are not effective against drug-resistant bacteria can be reduced.
 3. These vaccines have no side effects and cause no allergic reactions.

Select the correct answer using the code given below:

- a) 1 only
- b) 1 and 2 only
- c) 3 only
- d) 1, 2 and 3

[2020]

2. In the context of hereditary diseases, consider the following statements:

- 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

Difficulty level: Hard

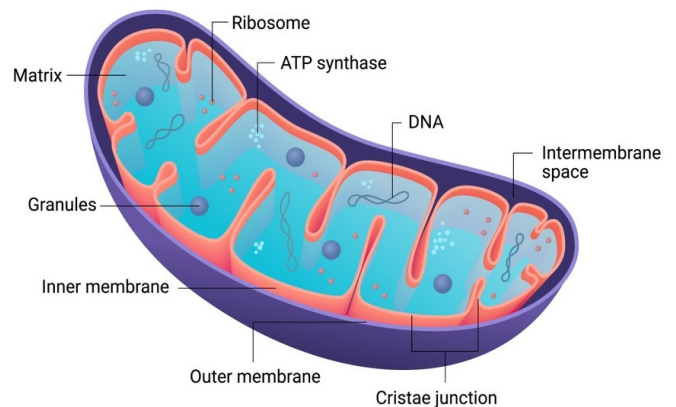
EXPLANATION

Mitochondrial diseases (mitochondrial disorder)

- Mitochondrial diseases, also known as mitochondrial disorders, refer to a group of conditions that affect the mitochondria.
- Mitochondria are **organelles found in the cytoplasm of eukaryotic cells**, responsible for producing **adenosine triphosphate (ATP)**, the primary energy molecule utilized by the cell. These tiny compartments are present in almost every cell of the body and are known as '**the powerhouse of the cell**' due to their main function of energy production.
- A common factor among mitochondrial diseases is that the mitochondria are unable to completely burn food and oxygen to generate energy, which is essential for normal cell function.
- It's often **hereditary** (an inherited medical condition caused by a DNA abnormality).
- In sexual reproduction, mitochondria are **normally inherited exclusively from the mother**. Because sperm contains a very low number of mitochondria and mitochondrial genes.
- Therefore, a child inherits mitochondrial diseases entirely from mother and not from father.
- These can cause a vast array of **health concerns**, including fatigue, weakness, metabolic strokes, developmental or cognitive disabilities, kidney failure, and more.

- There isn't a cure, but treatment can prevent life-threatening complications.

MITOCHONDRIA



- **Mitochondrial replacement techniques (MRT)** are novel procedures designed to **prevent the maternal transmission of mitochondrial DNA (mtDNA) diseases**.
- In this therapy, healthy mitochondria from a donated egg are combined with the nuclear DNA from the mother and father to establish an embryo that should only have healthy mitochondrial DNA. **It can be done either before or after in vitro fertilisation of the egg.**

3. In a pressure cooker, the temperature at which the food is cooked depends mainly upon which of the following?

- 1) Area of the hole in the lid
- 2) Temperature of the flame
- 3) Weight of the lid

Select the correct answer using the code given below:

- a) 1 and 2 only
- b) 2 and 3 only
- c) 1 and 3 only ✓
- d) 1, 2 and 3

Difficulty level: Easy

EXPLANATION

- A pressure cooker is a sealed chamber that **traps the steam generated** as its contents are heated.
- As steam builds, pressure increases, driving the boiling point of water past 212°F (100°C).

- In general, this **higher temperature shortens cooking times and, due to a lack of evaporation, extracts flavour more efficiently** from foods.
- The working of a pressure cooker can be explained by “**ideal gas law**”, which describes the behaviour of most gases under given conditions.
- In a pressure cooker, the temperature at which the food is cooked depends mainly upon:
 - » **Area of the hole in the lid**
 - » **Weight of the lid**
- Here, the temperature at which the food is cooked is **not dependent on the temperature of the flame.**

4. Consider the following:

- 1) Bacteria
- 2) Fungi
- 3) Virus

Which of the above can be cultured in artificial/synthetic medium?

- a) 1 and 2 only ✓
- b) 2 and 3 only
- c) 1 and 3 only
- d) 1, 2 and 3

Difficulty level: Easy

EXPLANATION

- Culture media (or Growth media) is a gel or liquid that **contains nutrients and is used to grow bacteria or microorganisms.**
- Culturing mediums can be classified into two-**natural and synthetic mediums.**
 - i) Natural media includes **natural biological fluids such as plasma and serum**, which can be used for a wide variety of cell and tissue cultures.
 - ii) Synthetic media (or artificial media) are those created using a variety of **organic and inorganic compounds.**
- **Bacteria and Fungi can be cultured in artificial mediums.**
- **Viruses can't be cultured in artificial mediums, because they requires a living host cell for replication.**

RELATED PYQs

Q1. Which of the following statements is/are correct?

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

[2016]

5. Consider the following statements:

- 1) **Adenoviruses have single-stranded DNA genomes whereas retroviruses have double-stranded DNA genomes.**
- 2) **Common cold is sometime caused by an adenovirus whereas AIDS is caused by a retrovirus.**

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

Difficulty level: Moderate

EXPLANATION

Adenovirus

- Adenoviruses are a group of viruses that **utilize DNA as their genetic material** and commonly **infect both humans and animals.** Their genome **comprises double-stranded DNA.**
- Adenoviruses predominantly lead to **respiratory and eye infections**, with some cases contributing to the **common cold.** In children, adenovirus infection accounts for up to 10% of respiratory infections.
- **Transmission** of adenoviruses mainly **occurs through droplets, the faecal-oral route, and contaminated objects (fomites).**
- Preventive measures include the use of masks, practicing hand hygiene, avoiding close contact and sharing of objects, following respiratory etiquettes, and isolating oneself during illness.

Retrovirus

- A retrovirus is a type of virus that **utilizes RNA** as its genetic material. Its genome **consists of single-stranded RNA**.
- Upon infecting a cell, a retrovirus employs an enzyme known as **reverse transcriptase** to convert its **RNA into DNA**. Subsequently, the retrovirus integrates its viral DNA into the host cell's DNA, facilitating its replication.
- One well-known example of a retrovirus is **HIV**, the virus responsible for **causing AIDS**.

6. Water can dissolve more substances than any other liquid because

- a) it is dipolar in nature ✓
- b) it is a good conductor of heat
- c) it has high value of specific heat
- d) it is an oxide of hydrogen

Difficulty level: Easy

EXPLANATION

- Water is the primary component of the Earth's **hydrosphere** as well as the fluid of all known living species.
- Water is recognised as **“universal solvent”**, because it does dissolve more substances than any other liquid. The structure of water molecules contributes to this.

Structure of water molecule

- It is a molecule made up of **one oxygen and two hydrogen atoms**. (The chemical formula of water is **H₂O**.)
- In a water molecule, the electrons are localised around the oxygen atom since it is much more electronegative than the hydrogen atom.
- It gives a **slight negative charge in the region of the oxygen atom and a slight positive charge near the hydrogen atom**. This is called a **dipole**.
- The **charge differences cause water molecules to be attracted to each other** (the relatively positive areas being attracted to the relatively negative areas) and **to other polar molecules**.

- Hence, water can dissolve more substances than any other liquid.

(Dipolar- bond or molecule whose ends have opposite charges.)

7. Bisphenol A (BPA), a cause of concern, is a structural/key component in the manufacturing of which of the following kind of plastics?

- 1) Low- density polyethylene
- 2) Polycarbonate ✓
- 3) Polyethylene terephthalate
- 4) Polyvinyl chloride

Difficulty level: Hard

EXPLANATION

Bisphenol A (BPA)

- BPA is a chemical produced in large quantities for primarily use in the production of **polycarbonate plastics**.
- It is **hydrophobic** (water repelling), found in various products including **shatterproof windows, eyewear, water bottles, and epoxy resins** that coat some metal food cans, bottle tops, and water supply pipes.
- Safe in low doses, but **prolonged exposure** is suspected of **affecting the health of children** and leads to **high blood pressure**.
- It is an **endocrine disruptor** which can interfere with **secretion of natural hormones**, contribute to **fertility problems, breast and prostate cancer**, and damage **human immune system**.

Polycarbonate (PC)

- A group of **thermoplastic** polymers containing carbonate groups in their chemical structure.
- They are **transparent, light weight, strong, tough, easily molded, protection from UV radiations and thermoformed**.
- PC do not have a unique **resin identification code (RIC)** and are identified as **“other”**, 7 on the RIC List.

Low density polyethylene (LDPE)

- Polyethylene(PE) is an **organic thermoplastic** polymer.
- It is **not reactive at room temperature** except to strong oxidisers.

- It has **weak intermolecular forces**, **lower tensile strength** and **higher elasticity**.
- When **exposed to consistent sunlight**, LDPE **produces** significant amount of **greenhouse gases: methane and ethylene**.

Polyethylene terephthalate (PET or PETE)

- PET is a **condensation polymer** of **ethylene glycol** and **terephthalic acid**.
- It is a **thermoplastic synthetic** polymer resin of polyester family.
- PET is very **moisture tolerant**, has **excellent chemical resistance** and **not biodegradable**. Its **burning** leads to **emission of carbon dioxide (CO₂)**.
- It is **used in fibres for clothing**, **containers for liquids** and **thermoforming for manufacturing**.
- It's fibres can be **blended with wool and cotton fibres** to reinforce their properties.
- **Bottles made of it can be recycled into other products**.

Polyvinyl chloride (PVC)

- PVC made from **vinyl chloride polymerisation**.
- It **resists water and fire** and used in raincoats, wires, pipes etc.
- It is **tough, lightweight** and **abrasion-resistant** and are **self-extinguishing due to high chlorine content**.
- PVC **resistant towards all inorganic chemicals** and excellent material for **insulation**.

8. Which one of the following is a reason why astronomical distances are measured in light-years?
- 1) Distances among stellar bodies do not change.
 - 2) Gravity of stellar bodies does not change.
 - 3) Light always travels in straight line.
 - 4) Speed of light is always same. ✓

Difficulty level: Moderate

EXPLANATION

Light-year

- Light-year is a measurement of distance in space.

- A light-year is the distance a beam of light travels in a single earth year. It is equal to approximately 6 trillion miles (approx. 9.5 trillion kilometres).

[Earth year- Time takes for Earth to orbit all the way around the Sun one time. An earth year is actually about 365 days, plus approximately 6 hours.]

Why are astronomical distances measured in light-years?

Distances are huge

- Light-years are a large unit of measurement that can accommodate the vast distances between celestial objects. For example, a star that is eight light-years away would take light eight years to travel to Earth.

Light speed is constant

- The **speed of light is constant or same throughout the universe**, and is known to a high degree of precision. In a vacuum, light travels at 670,616,629 mph (1,079,252,849 km/h).

Light-years are regular

- Light-years are regular, meaning they do not change with time.

Light-years are a uniform function of brightness

- There is a relationship between the period and brightness of light, so once the period is known, the brightness can be inferred.

Type of the questions: Current Affairs

1. Bollgard I and Bollgard II technologies are mentioned in the context of
- 1) clonal propagation of crop plants
 - 2) developing genetically modified crop plants ✓
 - 3) production of plant growth substances
 - 4) production of biofertilizers

Difficulty level: Easy

Relevance: Fears over farmers cultivating unauthorised and illegal genetically-modified cottonseed called Bollgard-III or 'Bt-3', haunts the seed industry.

EXPLANATION

Genetically modified crops

- GM crops are plants that have had their **DNA altered** using genetic engineering techniques.
- This process involves inserting one or more genes from a different species into the plant's genome **to confer certain advantageous traits** that aren't naturally present in the species.
- **Bt.Cotton is the only GM crop approved for commercial cultivation in India.**

Bollgard I and Bollgard II technologies

- They help in developing genetically modified crop plants.
- Both Bollgard I and Bollgard II **insect-protected cotton** are widely planted around the world as an **environmentally friendly way of controlling bollworms** (a moth larva that attacks the fruiting bodies of certain crops, especially cotton).
- Bt cotton (Bollgard I) with cry1Ac gene was the first GM crop to be commercialised in India in March 2002 and Bt cotton (Bollgard II) with **cry1Ac** and **cry2Ab** for insect resistance has also been commercialised.
- Bollgard I Bt cotton is based on single-gene technology followed by Bollgard II – double-gene technology, approved by the Genetic Engineering Approval Committee (GEAC).
- The combination of the cry2Ab and cry1Ac genes show promise for improved insect efficacy and an increased spectrum of control.
- These genetic modifications lead to **better boll retention, maximum yield, lower pesticides costs, and protection against insect resistance.**

RELATED PYQs

Q1. With reference to the Genetically Modified mustard (GM mustard) developed in India, consider the following statements:

1. GM mustard has the genes of a soil bacterium that give the plant the property of pest-resistance to a wide variety of pests.
2. GM mustard has the genes that allow the plant cross-pollination and hybridization.
3. GM mustard has been developed jointly by the IARI and Punjab Agricultural University.

Which of the statements given above is/are correct?

- a) 1 and 3 only
- b) 2 only
- c) 2 and 3 only
- d) 1, 2 and 3

[2018]

2. The term 'ACE2' is talked about in the context of
- 1) genes introduced in the genetically modified plants
 - 2) development of India's own satellite navigation system
 - 3) radio collars for wildlife tracking
 - 4) spread of viral diseases ✓

Difficulty level: Moderate

Relevance: This enzyme has been identified as the receptor for SARS-CoV-2.

EXPLANATION

Angiotensin-Converting Enzyme 2 (ACE2)

- It is a **protein on the surface of many cell types** and tissues including the lungs, heart, blood vessels, kidneys, liver and gastrointestinal tract.
- ACE2 is present in **epithelial cells**, which **line certain tissues** and **create protective barriers**.
- It generates small proteins- by cutting up the larger protein angiotensin.
- ACE2 is a **vital element in a biochemical pathway** that is critical to **regulating processes such as blood pressure, wound healing and inflammation**, called the **renin-angiotensin-aldosterone system (RAAS) pathway**.

ACE2 and viral diseases

- ACE2 **enhances viral infection**, through which it aggravates the underlying diseases.
- For example, this enzyme has been identified as the **receptor for SARS-CoV-2** (virus causes COVID-19).
- SARS-CoV-2 uses ACE2 to enter into the cells of its host. Thus, ACE2 acts as an entry point for coronavirus into the human body.
- Hence, ACE2 is discussed in the context of the spread of viral diseases.

3. 'Triclosan', considered harmful when exposed to high levels for a long time, is most likely present in which of the following?

- 1) Food preservatives
- 2) Fruit-ripening substances
- 3) Reused plastic containers
- 4) Toiletries ✓

Difficulty level: Hard

Relevance: IIT Hyderabad Bio Researchers reveal neurotoxic nature of Triclosan, antimicrobial chemical used in soaps and dental care products.

EXPLANATION

Triclosan

- It is an **antibacterial** and **antifungal** agent that slows or stops the growth of germs.
- Triclosan is an ingredient **added to many consumer products** intended to reduce or prevent bacterial contamination. It is added to some antibacterial soaps and body washes, toothpastes, and some cosmetics.
- It is **added to toothpaste to prevent gingivitis** (a mild form of gum disease).
- Studies have demonstrated that it may have the potential to adversely **affect bone mineral density** in cell lines of animals.
- Exposure to high doses of Triclosan leads to a decrease in the levels of some thyroid hormones, thus making Triclosan an **endocrine disruptor** (chemicals that may interfere with the body's endocrine system and produce adverse effects).

Additional information

Food preservatives

- Most commonly used preservatives are salts and edible oils. They are mainly sodium benzoate (anti-fungal properties), sodium metabisulphite (antioxidant), sodium bicarbonate or baking soda, tartaric acid, sodium sulphate.

Fruit-ripening substances

- It can be used to ripen fruits artificially and to provide fruits with the desired colour and taste within short time.
- Acetylene gas (C₂H₂), ethylene (C₂H₄), calcium carbide (alkaline in nature), ethephon (an insecticide).

Calcium carbide

- Highly reactive compound that releases acetylene gas.
- Use as an artificial fruit ripening agent is prohibited under the Food Safety and Standards (Prohibition and Restriction on Sales) Regulation, 2011.
- Use can lead to the formation of arsenic and phosphorus, which are poisonous in nature.

Type of the questions: Conceptual

1. With reference to street-lighting, how do sodium lamps differ from LED lamps?

- 1) Sodium lamps produce light in 360 degrees but it is not so in the case of LED lamps.
- 2) As street-lights, sodium lamps have longer life span than LED lamps.
- 3) The spectrum of visible light from sodium lamps is almost monochromatic while LED lamps offer significant colour advantages in street-lighting.

Select the correct answer using the code given below.

- a) 3 only
- b) 2 only
- c) 1 and 3 only ✓
- d) 1, 2 and 3

Difficulty level: Moderate

EXPLANATION

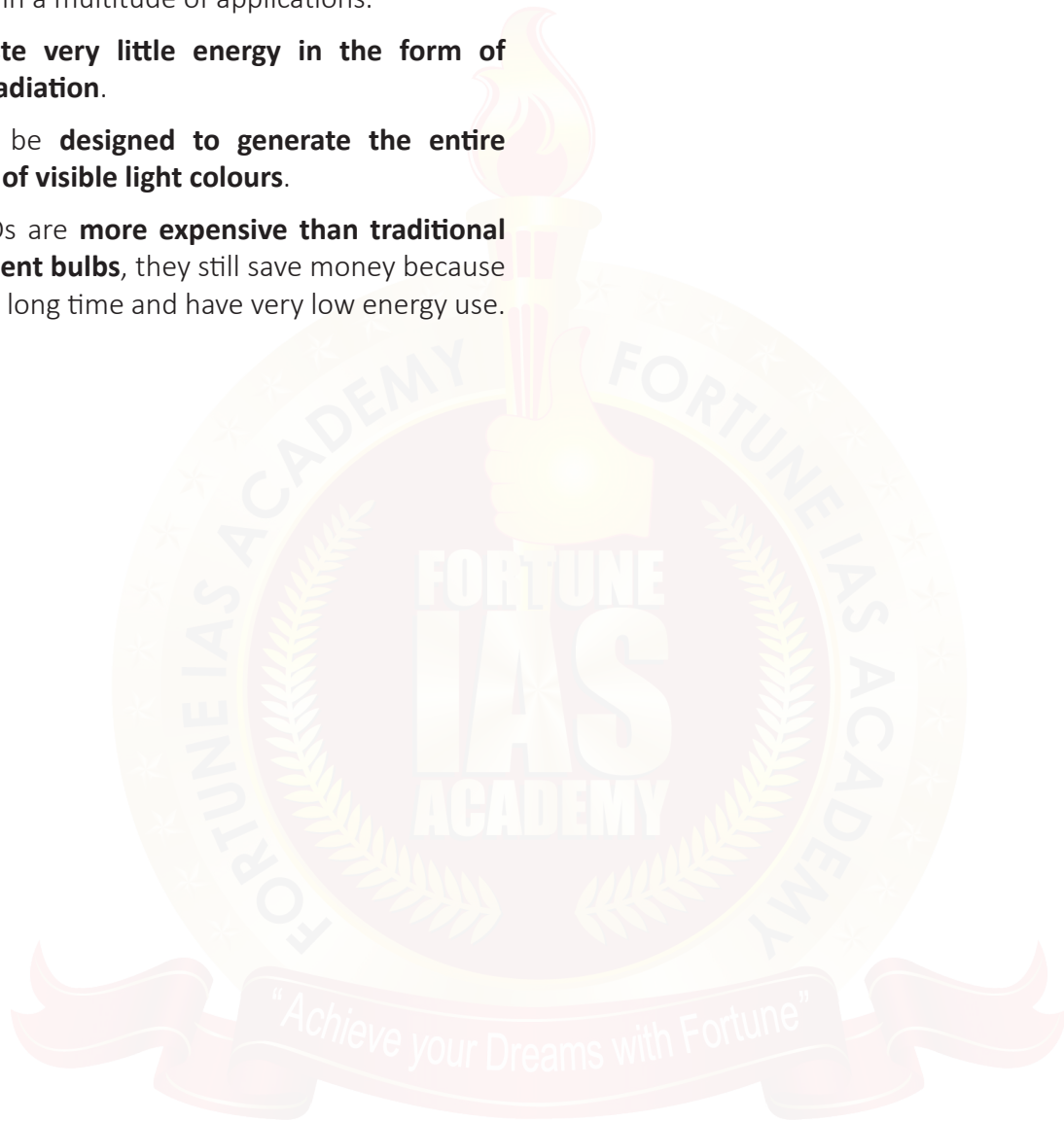
Sodium lamps

- Sodium vapour bulbs **contain metals that are evaporated into inert gas** within the glass casing.
- There are **two kinds of sodium lights: Low pressure (LPS) and High Pressure (HPS)**.
- The principal difference between low and high pressure sodium lights is the operating pressure inside the lamp.
- These lamps are mostly used for **street lighting** as well as **industrial uses**. The spectrum of visible light from sodium lamps is almost **monochromatic**, and is well known for their **warm yellow glow**.

- Sodium vapour lights are **omnidirectional**. Omnidirectional lights **produce light in 360 degrees**.

LED Lamps

- LED stands for **light emitting diode**.
- LEDs have an extremely **long lifespan** and relative to every other lighting technology.
- They are “**directional**” light sources, which means they emit light in a specific direction. That means LEDs are able to use light and energy more efficiently in a multitude of applications.
- They **waste very little energy in the form of infrared radiation**.
- LEDs can be **designed to generate the entire spectrum of visible light colours**.
- While LEDs are **more expensive than traditional incandescent bulbs**, they still save money because they last a long time and have very low energy use.



2022-PRELIMS PREVIOUS YEAR QUESTIONS

Type of the questions: Factual

1. Consider the following communication technologies :

- 1) Closed-circuit Television
- 2) Radio Frequency Identification
- 3) Wireless Local Area Network

Which of the above are considered Short-Range devices/technologies?

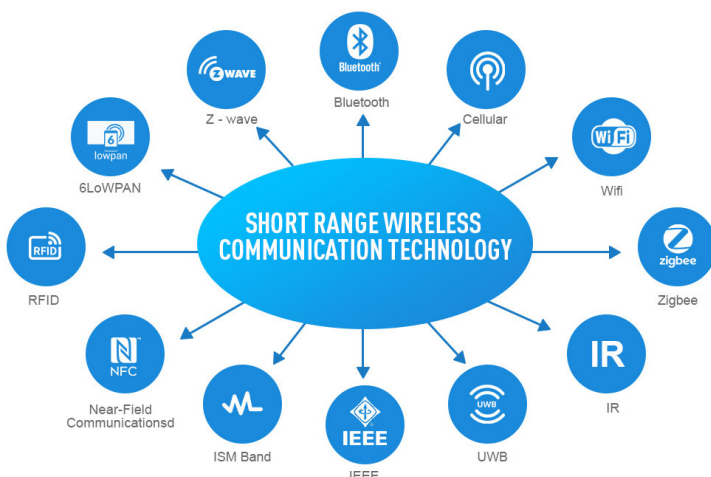
- a) 1 and 2 only
- b) 2 and 3 only
- c) 1 and 3 only
- d) 1, 2 and 3 ✓

Difficulty level: Moderate

EXPLANATION

Short-Range devices/technologies

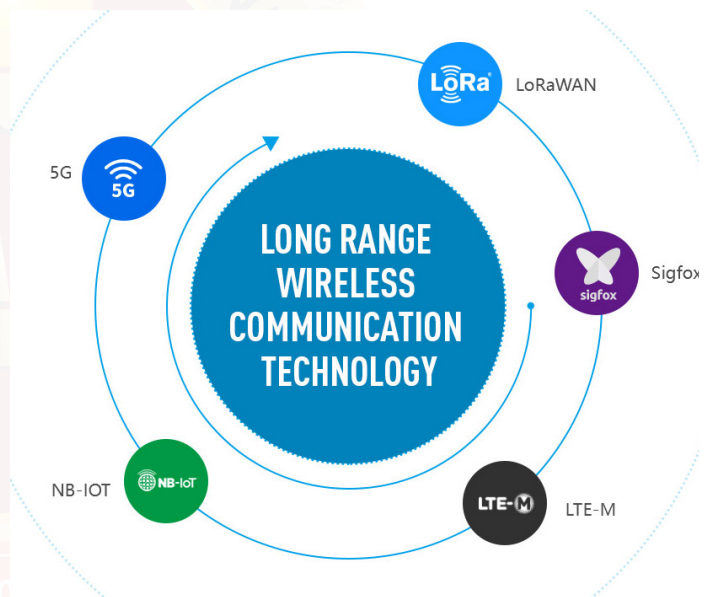
- Short Range Devices (SRD) are **wireless devices that transmit low power levels** and operate over distances of up to a few hundred metres.
- They have a **low effective radiated power (ERP)** to typically **25-100mW** and thus **do not interfere with other radio services**.
- The frequencies used by these devices are called **SRD frequencies**.
- SRD wireless technologies include **Bluetooth, Wi-Fi, near-field communication (NFC), and ultra-wideband (UWB)**.



- They are used for power metres & other remote instrumentation, **RFID applications, radio-control models, fire & security alarms, Closed-circuit television (CCTV), wireless local area networks, remote control** etc.
- In most cases, these devices can operate licence-free, however there are few exceptions.

Long-Range devices/technologies

- Long-range wireless technology **connects devices over vast distances**, far beyond typical Wi-Fi, enabling seamless communication in remote areas.
- Wireless technology typically **transmits data at high speeds** and allows users to **connect distances of up to 40 miles** (approximately 64 km).
- Due to the high speed of long-range wireless, **more data can be transferred in shorter amounts of time**.



- In wireless technology, **computer data is converted into radio waves and travels through the air**. A wireless router picks up these waves and translates them back into data.
- This process is similar to the technology used by **cell phones, walkie-talkies, and other two-way communication devices**.

2. Consider the following statements in respect of probiotics :

- 1) Probiotics are made of both bacteria and yeast.
- 2) The organisms in probiotics are found in food 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

Difficulty level: Easy

EXPLANATION

Probiotics

- Probiotics are defined as, “**live microorganisms** that, when administered in adequate amounts, confer a **health benefit on the host**”.
- These microorganisms, which consist mainly of **bacteria** but also include **yeasts**, are **naturally present in fermented foods**, may be added to other food products, and are available as **dietary supplements**.
- They are intended to **maintain or improve the “good” bacteria in the body that naturally occur in our gut**.

Adding probiotics in diet may offer many health benefits like:

- Improve digestive health (eg: digestion of milk sugars)
 - Reduce depression
 - Promote heart health
 - Boost immunity
- **Yogurt** is one of the best sources of probiotics. Other sources include buttermilk, sauerkraut, kombucha, some types of cheese, fermented soybeans etc.
 - Probiotics should not be confused with **prebiotics, which are typically complex carbohydrates** (such as inulin and other fructo-oligosaccharides) **that microorganisms in the gastrointestinal tract use as metabolic fuel**.

- Commercial products containing **both prebiotic sugars and probiotic organisms** are often called **synbiotics**.

3. Which of the following are nitrogen-fixing plants?

- 1) Alfalfa
- 2) Amaranth
- 3) Chickpea
- 4) Clover
- 5) Purslane (Kulfa)
- 6) Spinach

Select the correct answer using the code given below:

- a) 1, 3 and 4 only ✓
- b) 1, 3, 5 and 6 only
- c) 2, 4, 5 and 6 only
- d) 1, 2, 4, 5 and 6

Difficulty level: Moderate

EXPLANATION

Nitrogen fixation

- Fixation **converts nitrogen in the atmosphere into forms that plants can absorb** through their root systems.
- Most **nitrogen fixation occurs naturally**, in the soil, **by bacteria**.
- Some bacteria attach to plant roots and have a **symbiotic relationship** (beneficial for both the plant and the bacteria) with the plant.
 - » Eg: **Rhizobium, Azotobacter, Cyanobacteria** etc.
- The bacteria get energy through photosynthesis and, in return, they fix nitrogen into a form the plant needs.
- The fixed nitrogen is then carried to other parts of the plant and is used to form plant tissues, so the plant can grow.

Nitrogen-fixing plants

- The symbiotic nitrogen-fixing bacteria invade the root hairs of host plants, where they multiply and stimulate the formation of root nodules.
- Within the nodules, **the bacteria convert free nitrogen to ammonia**, which the host plant utilises for its development.

Examples of nitrogen-fixing plants:

- Alfafa
- Beans
- Clovers
- Peas (eg: chickpea)
- Soybeans

- Amaranth, Purslane (Kulfa), Spinach are not nitrogen-fixing plants.

Amaranth

- Amaranth is a member of the amaranthaceae family.
- It is cultivated for use as cereals, vegetables, or ornamentals, and a few species are considered weeds.
- The main biological compounds found in amaranth are proteins, fats, carbohydrates, vitamins, and minerals.

Purslane (Kulfa)

- Purslane is a common “weed” that produces an edible leafy, green vegetable.
- It is one of the **most nutrient-dense foods** on earth.
- Widely distributed around the globe and is popular as a potherb in many areas of Europe, Asia, and the Mediterranean region.
- It is a rich source of potassium, magnesium, calcium and omega-3 fatty acid.

Spinach

- Spinach is a leafy green flowering plant native to central and western asia.
- It is good for health due to its rich nutrient content, including vitamins, minerals, and antioxidants.

1. Consider the following :

- 1) Aarogya Setu
- 2) CoWIN
- 3) DigiLocker
- 4) DIKSHA

Which of the above are built on top of open-source digital platforms?

- a) 1 and 2 only
- b) 2, 3 and 4 only
- c) 1, 3 and 4 only
- d) 1, 2, 3 and 4 ✓

Difficulty level: Moderate

Relevance: The Prime Minister, Shri Narendra Modi addressed the CoWin Global Conclave as India offered the CoWIN platform as a digital public good to the world to combat COVID-19.

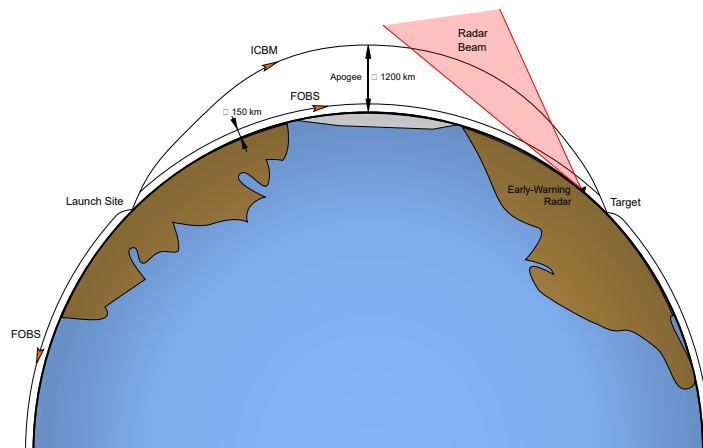
EXPLANATION

Open-source digital platforms

- An open source platform is any platform that **allows access to its source code to any other users** or developers.
- Here, **the general public can inspect, modify, and enhance source code.**
- Open source software aims to **allow equal access to anyone and everyone.**
- It is developed in a **decentralised** and **collaborative** way, relying on peer review, and community production.
 - » **Some examples: Aarogya Setu, CoWIN, DigiLocker, Aadhar,GSTN and DIKSHA.**

- **Aarogya Setu** - It is an Indian COVID-19 “**contact tracing, syndromic mapping and self-assessment**” digital service, primarily a mobile app, developed by the **National Informatics Centre** under the **Ministry of Electronics and Information Technology.**
- **CoWIN portal** - Indian government web portal for **COVID-19 vaccination registration**, owned and operated by India’s **Ministry of Health and Family Welfare.**

- **DigiLocker** - DigiLocker is a flagship initiative of **Ministry of Electronics & IT (MeitY)** under **Digital India Programme**. It aims at '**Digital Empowerment**' of citizens by providing access to **authentic digital documents to citizen's digital document wallet**.
- **DIKSHA** (Digital Infrastructure for Knowledge Sharing) is a national platform for **school education**, an initiative of **National Council for Educational Research and Training (NCERT)**, under the aegis of the **Ministry of Education**. Launched in 2017.



2. Which one of the following statements best reflects the idea behind the “Fractional Orbital Bombardment System” often talked about in media?

- A hypersonic missile is launched into space to counter the asteroid approaching the Earth and explode it in space
- A spacecraft lands on another planet after making several orbital motions
- A missile is put into a stable orbit around the Earth and deorbits over a target on the Earth ✓
- A spacecraft moves along a comet with the same speed and places a probe on its surface

Difficulty level: Hard

Relevance: Reports of China testing a new missile system, known as Fractional Orbital Bombardment System (FOBS), have fuelled concerns.

EXPLANATION

Fractional Orbital Bombardment System (FOBS)

- The Fractional Orbital Bombardment System (FOBS) was a concept related to **space-based nuclear weapons delivery** that originated during the Cold War and was associated with the **Soviet Union**.
- The idea behind FOBS was to **place nuclear warheads in orbit around the Earth and deorbit them to strike targets on the Earth's surface**.
- Unlike traditional **intercontinental ballistic missiles (ICBMs)** that follow a predictable ballistic trajectory, **FOBS weapons could approach their targets from unexpected directions**, making them potentially **more challenging** to defend against.

Salient Features

- A most important feature is its **capability to attack from any direction** and **hide the target destination** until the payload is dropped.
- It has **no fixed trajectory**, as it can **use thrusters to change**.
- It has **no range limit** and can be **targeted at any point on the Earth**.

3. Which one of the following is the context in which the term “qubit” is mentioned?

- Cloud Services
- Quantum Computing ✓
- Visible Light Communication Technologies
- Wireless Communication Technologies

Difficulty level: Easy

Relevance: Google builds "Qubit Game" to teach students quantum computing.

EXPLANATION

Qubit

- A quantum bit, or qubit, serves as the **fundamental unit of information in quantum computing**, counterpart to the bit (binary digit) in classical computing.
- Unlike classical bits, which can only exist in one of two states (0 or 1), qubits can exist in a **superposition** of states, representing **both 0 and 1 simultaneously**.

- Qubits have the unique **capability of performing multiple calculations simultaneously**, potentially making quantum computing significantly more powerful than traditional computing for specific tasks.
- Furthermore, qubits can be interconnected through a special phenomenon known as **entanglement**. Even when they are physically distant, the state of **one qubit depends on the state of the other**. This characteristic contributes to the efficiency of quantum circuits in performing complex tasks.

4. In the context of vaccines manufactured to prevent COVID-19 pandemic, consider the following statements :

- 1) The Serum Institute of India produced COVID-19 vaccine named Covishield using mRNA platform.
- 2) Sputnik V vaccine is manufactured using vector based platform.
- 3) COVAXIN is an inactivated pathogen based vaccine.

Which of the statements given above are correct?

- a) 1 and 2 only
- b) 2 and 3 only ✓
- c) 1 and 3 only
- d) 1, 2 and 3

Difficulty level: Moderate

Relevance: These vaccines were manufactured to prevent COVID-19 spread.

EXPLANATION

Covishield

- It is a **recombinant, replication-deficient chimpanzee adenovirus vector** encoding the SARS-CoV-2 Spike (S) glycoprotein.
- Manufactured by **Serum Institute of India Pvt Ltd**.
- It has been prepared using the **viral vector platform**.
- A chimpanzee adenovirus – ChAdOx1 – has been modified to enable it to carry the COVID-19 spike protein into the cells of humans.
- Well, this cold virus is basically incapable of infecting the receiver but can very well **teach the immune system** to prepare a mechanism against such viruses.

- The exact technology was used to prepare vaccines for viruses like **Ebola**.

Sputnik V

- Sputnik V is the **world's first registered vaccine** based on a well-studied **human adenovirus vector platform**.
- Developed by the **Gamaleya Research Institute of Epidemiology and Microbiology in Russia**.
- The vaccine is named after the first Soviet space satellite.
- Sputnik V is one of the three vaccines in the world with **efficacy of over 90%**.
- It was the first coronavirus vaccine to use a heterogenous boosting approach based on 2 different vectors for 2 vaccine shots.

COVAXIN

- COVAXIN is **India's first indigenous COVID-19 Vaccine by Bharat Biotech** is developed in collaboration with the Indian Council of Medical Research (ICMR) - National Institute of Virology (NIV).
- The vaccine is **developed using Whole-Virion Inactivated Vero Cell** derived platform technology.
- **Inactivated vaccines contain dead virus, do not replicate** and are therefore unlikely to revert and cause pathological effects.

5. Consider the following statements:

DNA Barcoding can be a tool to:

- 1) assess the age of a plant or animal.
- 2) distinguish among species that look alike.
- 3) identify undesirable animal or plant materials in processed foods.

Which of the statements given above is/are correct?

- a) 1 only
- b) 3 only
- c) 1 and 2
- d) 2 and 3 ✓

Difficulty level: Moderate

Relevance: Delhi University researchers discover new species of frog in Western Ghats using DNA Barcoding.

EXPLANATION

DNA Barcoding

- DNA barcoding is a **method of specimen identification using short, standardized segments of DNA**. Every species has its own barcode, just as every person has their own fingerprint.
- The goal of DNA barcoding is to provide a quick and accurate method for species identification, especially when traditional methods may be difficult or impractical

Applications:

- » Identification of species
- » Environmental monitoring - identification of invasive species, parasites and their carriers.
- » Food and Pharmaceutical industries - to prevent adulteration and mislabeling of food products
- » Delimiting cryptic species
- » Pest and disease control
- » Forensics

Researchers using **carbon dating technique** for assessing age of a plant animal species. Also, DNA barcoding is not known to be used for the assessment of age of living organisms.

Type of the questions: Conceptual

1. With reference to Web 3.0, consider the following statements :

- 1) Web 3.0 technology enables people to control their own data.
- 2) In Web 3.0 world, there can be blockchain based social networks.
- 3) Web 3.0 operated by users collectively rather than a corporation.

Which of the statements given above are correct?

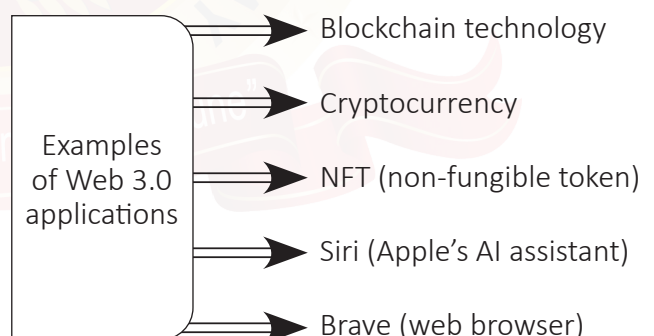
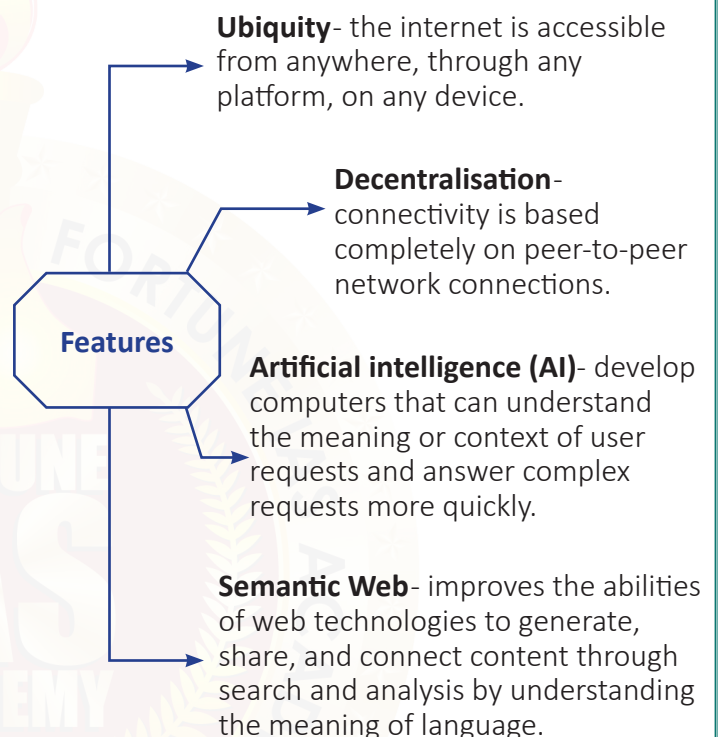
- a) 1 and 2 only
- b) 2 and 3 only
- c) 1 and 3 only
- d) 1, 2 and 3 ✓

Difficulty level: Moderate

EXPLANATION

Web 3.0

- Web 3.0, or Web 3, represents the **third generation of the World Wide Web**. It encompasses a set of values and technical applications that define a new era for the internet.
- Web 3.0 is characterized by **decentralization**, openness to everyone (with a bottom-up design), and is built on top of **blockchain technologies**.
- This third iteration of the web is defined by open technologies such as blockchain and immersive experiences like the **metaverse**.



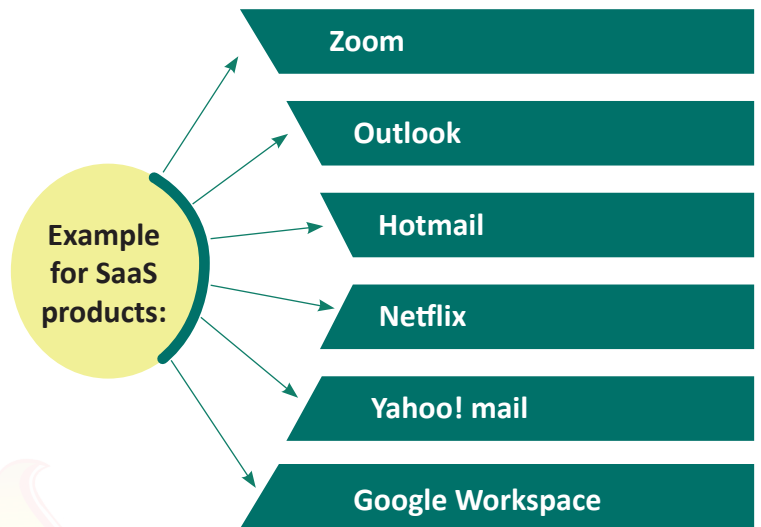
Web 1.0 (first generation of the World Wide Web)

- Text-based or **read-only** web.
- It was the foundation of the web, and it consisted of static text and images with no interactivity.

- Passive experience.
- **Eg:** Britannica Online, personal websites etc.

Web 2.0 (second generation of the World Wide Web)

- It is a **participatory** or social web.
- Defined by interaction and social media.
- **Two-way flow of information:** created spaces for sharing and interactivity.
- **Eg:** Amazon, Google, Facebook, P2P gaming sites etc.



2. With reference to “Software as a Service (SaaS)”, consider the following statements :

- 1) SaaS buyers can customise the user interface and can change data fields.
- 2) SaaS users can access their data through their mobile devices.
- 3) Outlook, Hotmail and Yahoo! Mail are forms of SaaS.

Which of the statements given above are correct?

- a) 1 and 2 only
- b) 2 and 3 only
- c) 1 and 3 only
- d) 1, 2 and 3 ✓

Difficulty level: Moderate

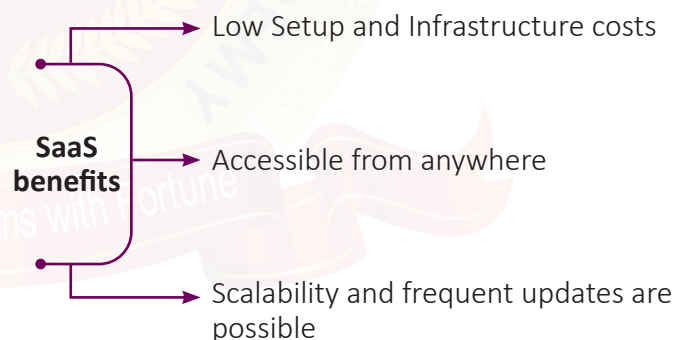
EXPLANATION

Software as a service (SaaS)

- Software as a service (SaaS) is a model where a **cloud provider hosts applications** and makes them **available to users over the internet**.
- It is a way of delivering applications over the Internet-as a service instead of downloading it. Instead of installing and maintaining software, you simply access it via the Internet, freeing yourself from complex software and hardware management.
- SaaS applications are sometimes called **Web-based software, on-demand software, or noted software**.
- SaaS applications run on a SaaS provider’s servers. The **provider manages access to the application, including security, availability, and performance**.

Characteristics

- **SaaS Multi-Tenant Architecture:** All SaaS vendor clients and applications share a single, common infrastructure and code base that is centrally maintained.
- **Easy customisation:** SaaS buyers **can customise the user interface and can change data fields**.
- **Better access from Network devices:** SaaS users **can access their data through their mobile devices** and ensure many users can see the same information simultaneously.



3. With reference to polyethylene terephthalate, the use of which is so widespread in our daily lives, consider the following statements :

- 1) Its fibres can be blended with wool and cotton fibres to reinforce their properties.
- 2) Containers made of it can be used to store any alcoholic beverage.
- 3) Bottles made of it can be recycled into other products.
- 4) Articles made of it can be easily disposed of by incineration without causing greenhouse gas emissions.

Which of the statements given above are correct?

- a) 1 and 3 ✓
- b) 2 and 4
- c) 1 and 4
- d) 2 and 3

Difficulty level: Moderate

EXPLANATION

Polyethylene Terephthalate (PET or PETE)

- It is a **synthetic fibre** and a member of the polyester family of polymers.
- PET is produced by the **polymerisation of ethylene glycol and terephthalic acid**.
- When heated together under the influence of a chemical catalyst, ethylene glycol and terephthalic acid produce PET in the form of molten, viscous mass that can be spun directly to fibres or solidified for later processing as a plastic.
- **Its fibres can be blended with other fibres such as rayon, wool, and cotton, to reinforce their inherent properties.**
- **The polymer finds use in packaging, fabrics, electronics, and the textile industry.**
- A PET bottle or a PET plastic container **can be easily recycled to new PET bottles** or PET plastic containers.
- **Storing alcohol in plastic containers made of it, is highly discouraged.** Because, the leaching effects of plastic and plastic chemical substances (such as ethylene glycol) have the tendency to leach considerably into alcohol stored if the temperature goes up during storage.

- **Incineration** is a thermal waste treatment technique - a controlled combustion process with the primary objective of volume reduction and energy recovery from the waste stream.
- **Incineration is not a preferred method of disposal because it can result in the emission of dioxins and other atmospheric pollutants**, and it contributes to global warming.

4. Consider the following statements:

- 1) **Other than those made by humans, nanoparticles do not exist in nature.**
- 2) **Nanoparticles of some metallic oxides are used in the manufacture of some cosmetics.**
- 3) **Nanoparticles of some commercial products which enter the environment are unsafe for humans.**

Which of the statements given above is/are correct?

- a) 1 only
- b) 3 only
- c) 1 and 2
- d) 2 and 3 ✓

Difficulty level: Moderate

EXPLANATION

Nanoparticles

- These are materials with overall **dimensions in the nanoscale**, ie, **under 100 nm**. They are also referred to as “**zero-dimensional**” nanomaterials.
- Nanoparticles have a number of properties that distinguish them from bulk materials simply by virtue of their **size**, such as **chemical reactivity, energy absorption**, and **biological mobility**.
- **Naturally occurring nanoparticles (NNPs) are often present in all spheres of the Earth** (ie. in the atmosphere, hydrosphere, lithosphere and even in the biosphere), irrespective of human activities.
- **Nanoparticles of some metallic oxides (like titanium dioxide, zinc oxide and silica) used as UV filters in sunscreen and other cosmetics.**

Applications:

- **Modern medicine** - enables analysis and therapies, medical imaging and drug/gene therapy.
- **Optical imaging** - eg: Quantum dots (QDs) are nanoparticles composed of inorganic semiconductor molecules.
- **Paints, fabrics, and personal and health care products.**

Environmental concerns of nanoparticles

The impact of nanomaterials on the environment and on public health has received considerable attention in recent years.

- ✘ **Pollution**- Nanomaterials reaching in the land have the potential to contaminate soil, and migrate into surface and ground waters.
- ✘ **Diseases and allergic reactions**- inhalation and exposure of nanoparticles.
- ✘ **Destroying the natural food chain** in water bodies.

Type of the questions: Application

1. Consider the following statements :

- 1) Biofilms can form on medical implants within human tissues.
- 2) Biofilms can form on food and food processing surfaces.
- 3) Biofilms can exhibit antibiotic resistance.

Which of the statements given above are correct?

- a) 1 and 2 only
- b) 2 and 3 only
- c) 1 and 3 only
- d) 1, 2 and 3 ✓

Difficulty level: Moderate

Relevance: IIT Guwahati recently signed an MOU with the South Dakota Mines to advance research into 2D materials, and biofilms.

EXPLANATION

Biofilm

- A biofilm is an **assemblage of microbial cells that is irreversibly associated** (not removed by gentle rinsing) with a surface and **enclosed in a matrix** of primarily polysaccharide material.
- Biofilms may **form on a wide variety of surfaces, including living tissues, indwelling medical devices, industrial or potable water system piping, or natural aquatic systems.**
- A **combination of several pathogens** can synergistically **interact to form biofilms in the food industry. In food-processing environments, bacteria are able to exist as multispecies biofilms,** from where both spoilage and pathogenic bacteria can contaminate food.
- Bacterial biofilms cause **chronic infections** because they show **increased tolerance to antibiotics** and disinfectant chemicals as well as resisting phagocytosis and other components of the body's defence system. It depends upon factors such as biofilm composition, architecture, the stage of biofilm development, and growth conditions.

2. If a major solar storm (solar flare) reaches the Earth, which of the following are the possible effects on the Earth?

- 1) GPS and navigation systems could fail.
- 2) Tsunamis could occur at equatorial regions.
- 3) Power grids could be damaged.
- 4) Intense auroras could occur over much of the Earth.
- 5) Forest fires could take place over much of the planet.
- 6) Orbits of the satellites could be disturbed.
- 7) Shortwave radio communication of the aircraft flying over polar regions could be interrupted.

Select the correct answer using the code given below:

- a) 1, 2, 4 and 5 only
- b) 2, 3, 5, 6 and 7 only
- c) 1, 3, 4, 6 and 7 only ✓
- d) 1, 2, 3, 4, 5, 6 and 7

Difficulty level: Moderate

Relevance: On 2 March 2022, a solar flare exploded from the Sun. It was rated as M-class, the fourth highest out of five categories for solar flare intensity.

EXPLANATION

Solar Storm (Solar flare)

- A solar flare is a **tremendous explosion on the Sun** that happens when energy stored in 'twisted' magnetic fields (usually above sunspots) is suddenly released.
- Scientists classify solar flares according to their brightness in the x-ray wavelengths. **There are three categories:**
 - i. X-class** flares are **big**; they are major events that can trigger radio blackouts around the whole world and long-lasting radiation storms in the upper atmosphere.
 - ii. M-class** flares are **medium-sized**; they generally cause brief radio blackouts that affect Earth's polar regions. Minor radiation storms sometimes follow an M-class flare.
 - iii. C-class** flares; compared to X- and M-class events, C-class flares are **small** with few noticeable consequences here on Earth.

Effects of solar flare on earth

- They directly affect the ionosphere and radio communications at the earth
 - Intense spectacular auroras
 - Disrupt radio signals and navigation systems
 - Create drag for low-orbiting satellites
 - Harm power grids
 - Corrosion of oil and gas pipelines
- **They cannot generate tsunamis directly.** (For a tsunami to be unleashed on Earth, there has to be an earthquake rumbling below the ocean floor that displaces water and generates a colossal, ultra-fast wave through the entire water column.)
 - According to a study published on PubMed, **some particular forest fires could be associated with solar winds striking the planet. But it can't take place much over the planet.**

3. Which one of the following statements best describes the role of B cells and T cells in the human body?

- a) They protect the environmental allergens.
- b) They alleviate the body's pain and inflammation.
- c) They act as immunosuppressants in the body.
- d) They protect the body from the diseases caused by pathogens. ✓

Difficulty level: Easy

Relevance: CAR T- cell therapy has been in news with reference to cancer treatment.

EXPLANATION

- A lymphocyte is a type of **white blood cell** that is part of the **immune system**.

There are two main types of lymphocytes: B cells and T cells.

B- cells

- B-cells are an important part of our body's immune system.
- They **produce antibodies that destroy antigens** or the pathogen associated with a particular antigen.
- B-cells can also **remember specific antigens** so your immune system can launch an **effective defense** if the pathogen ever enters your body again.

There are two main types of B-cells: plasma cells and memory cells.

Plasma cells:

- Plasma cells **release antibodies** in response to antigens.
- Once a B-cell becomes a mature plasma cell, it can release up to 2,000 antibodies per second.
- Plasma cells are also called plasmacytes or effector cells.
- They have a **shorter lifespan** than memory cells.

Memory cells:

- Memory cells **remember particular antigens** so, if they appear in your body in the future, your immune system can mount a defense quickly.

- While plasma cells fight bodily invaders by producing antibodies, memory cells help your immune system fight in the future.
- For example, **most vaccines work because they expose your immune system to antigens that your memory cells remember.** If an invader appears, your body can mount an attack quickly.

T cells

- T-cells protect you by **destroying harmful pathogens** and by sending signals that help control your immune system's response to threats.

There are two main types of T-cells: Cytotoxic and Helper T-cells

Cytotoxic T-cells:

- Cytotoxic T-cells are also called **CD8+** cells because they have a CD8 receptor on their membranes.
- These cells get their name from "cyto," which means cell, and "toxic," which means poisonous or harmful.
- Cytotoxic T-cells **kill cells infected with viruses** and bacteria, and they also destroy tumor cells.

Helper T-cells:

- Helper T-cells are also called **CD4+** cells because they have a CD4 receptor on their membranes.
- Unlike cytotoxic T-cells, helper T-cells **don't kill cells directly.** Instead, they **send signals that tell other cells in your immune system** how to coordinate an attack against invaders.
- Helper T-cells signal cytotoxic T-cells, B-cells and another type of white blood cell called a **macrophage.**

Type of the questions: Factual

1. Consider the following statements :

- 1) Ballistic missiles are jet-propelled at subsonic speeds throughout their flights, while cruise missiles are rocket-powered only in the initial phase of flight.
- 2) Agni-V is a medium-range supersonic cruise missile, while BrahMos is a solid-fuelled intercontinental ballistic missile.

Which of the statements given above is/are correct?

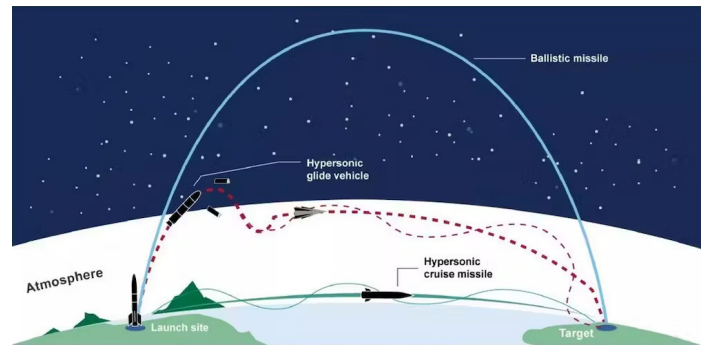
- a) 1 only
- b) 2 only
- c) Both 1 and 2
- d) Neither 1 nor 2 ✓

Difficulty level: Moderate

EXPLANATION

Ballistic Missiles

- Ballistic missile, a **rocket-propelled self-guided** strategic-weapons system that **follows a ballistic trajectory** to deliver a payload from its launch site to a predetermined target.
- They can **carry conventional high explosives** as well as chemical, biological, or nuclear munitions.
- Ballistic Missiles **can be launched from aircraft, ships, and submarines** in addition to **land-based silos and mobile platforms**.
- A ballistic missile generally **does not have onboard motors to make last minute corrections**, meaning engineers must get the burnout time and speed, launch angle and direction correct during the boost phase to ensure they hit their target.
- For example, **Prithvi I, Prithvi II, Agni I, Agni II and Dhanush** ballistic missiles are currently operational in the Indian defence forces.



Cruise Missiles

- A cruise missile is an **unmanned self-propelled** (till the time of impact) **guided vehicle** that sustains flight through **aerodynamic lift** for most of its flight path and whose primary mission is to place an ordnance or special payload on a target.
- They **fly within the earth's atmosphere and use jet engine technology**.
- Unlike ballistic missiles, cruise missiles **do not follow a ballistic trajectory**.
- They are **able to avoid detection by flying at very low altitudes**.

Depending upon the speed cruise missiles are classified as:

Subsonic cruise missile

- It travels at a speed of around **0.8 Mach** (less than that of sound).
- Eg: American Tomahawk cruise missile

Supersonic cruise missile

- Speed : **2-3 Mach**
- The combination of supersonic speed and warhead mass provides high kinetic energy ensuring tremendous lethal effect.
- **BRAHMOS** is the only known versatile supersonic cruise missile system which is in service.

Hypersonic cruise missile

- Speed: more than **5 Mach**
- BrahMos Aerospace is in the process of developing a hypersonic cruise missile, BRAHMOS-II, which would fly at a speed greater than 5 Mach.

RELATED PYQs

Q1. Which reference to Agni-IV Missile, which of the following statements is/are correct?

1. It is a surface-to-surface missile.
2. It is fuelled by liquid propellant only.
3. It can deliver one-tonne nuclear warheads about 7500 km away.

Select the correct answer using the code given below.

- 1 only
- 2 and 3 only
- 1 and 3 only
- 1, 2 and 3

2. Consider the following statements:

- 1) Carbon fibres are used in the manufacture of components used in automobiles and aircrafts.
- 2) Carbon fibres once used cannot be recycled.

Which of the statements given above is/are correct?

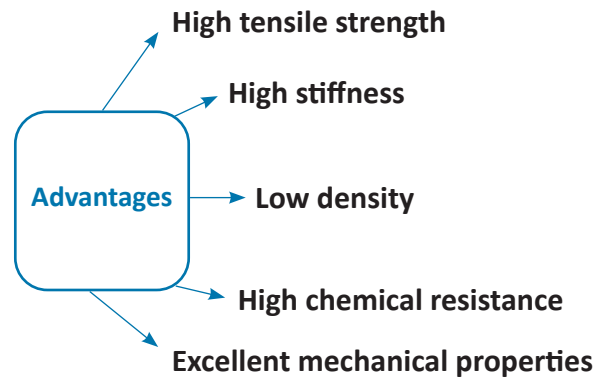
- 1 only ✓
- 2 only
- Both 1 and 2
- Neither 1 nor 2

Difficulty level: Easy

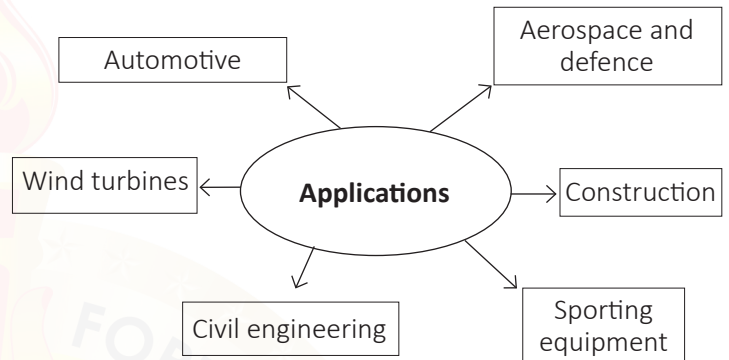
EXPLANATION

Carbon Fibres

- Carbon fibres can be defined as **fibres with a carbon content of 90% or above**.
- They are produced by **thermal conversion of organic fibres with a lower carbon content**.
- Most carbon fibres (about 90%) are made from the **polyacrylonitrile (PAN) process**.
- A small amount (about 10%) are **manufactured from rayon or the petroleum pitch process**.
- **Carbon nanotube**, one of the form of carbon fiber, is considered the strongest material available.



[2014]



- Carbon fibre is **recyclable**.
- It can be recycled using mechanical, thermal, or chemical methods.
- However, the properties of this recycled material are expected to be worse than those of virgin carbon fibre.
- The incorporation of polymers, nanoparticles and other hybrid materials could enhance the overall properties of recycled carbon fibre waste.

3. Consider the following pairs :

- 1) Cepheids : Giant clouds of dust and gas in space
- 2) Nebulae : Stars which brighten and dim periodically
- 3) Pulsars : Neutron stars that are formed when massive stars run out of fuel and collapse

How many of the above pairs are correctly matched?

- 1) Only one ✓
- 2) Only two
- 3) All three
- 4) None

Difficulty level: Hard

Type of the questions: Current Affairs

EXPLANATION

Cepheids

- Cepheids, also called Cepheid Variables, are **stars which brighten and dim periodically**.
- This behaviour allows them to be used as cosmic yardsticks out to distances of a few tens of millions of light-years.
- The brighter the Cepheid, the longer the period (the time they take to brighten, dim and brighten again).

Nebulae

- A nebula is a **giant cloud of dust and gas in space**.
- Some nebulae (more than one nebula) come from the gas and dust thrown out by the explosion of a dying star, such as a supernova.
- Other nebulae are regions where new stars are beginning to form. For this reason, some nebulae are called "**star nurseries**".

Pulsars

- Pulsars are **rotating neutron stars** observed to have pulses of radiation at very regular intervals that typically range from milliseconds to seconds.
- Pulsars have very **strong magnetic fields** which funnel jets of particles out along the two magnetic poles. These accelerated particles produce very **powerful beams of light**.
- Most **neutron stars are observed as pulsars**.
- Neutron stars - They are **formed when a massive star runs out of fuel and collapses**. The very central region of the star- the core- collapses, crushing together every proton and electron into a neutron. If the core of the collapsing star is between about 1 and 3 solar masses, these newly-created neutrons can stop the collapse, leaving behind a neutron star.

1. Consider the following actions :

- 1) **Detection of air crash/collision which results in the deployment of airbags almost instantaneously**
- 2) **Detection of accidental free fall of laptop toward the ground which results in the immediate turning off of the hard drive**
- 3) **Detection of the tilt of the smartphone which results in the rotation of display between portrait and landscape mode**

In how many of the above actions is the function of accelerometer required?

- a) Only one
- b) Only two
- c) All three ✓
- d) None

Difficulty level: Moderate

Relevance: Amazon launched the 5th gen of Echo Dot in India with improved audio, motion detection, temperature sensor, and tap gesture controls. It has an accelerometer.

EXPLANATION

Accelerometer

- It is a device that **measures the vibration, or acceleration of motion, of a structure**.
- An accelerometer **works by utilising an electromechanical sensor that is designed to measure either static or dynamic acceleration**.
- **Working principle-** It converts mechanical energy into electrical energy.

These sensors are used in a variety of ways:

- » **Vehicles-** Accelerometers are used to trigger airbags. Here, sensors send a signal when they experience a sudden shock.
- » **Laptops-** Accelerometers in laptops protect the hard drive from damage. If the laptop were to fall while in use, the accelerometer would detect the fall and immediately turn off the hard drive to avoid hitting the reading heads into the hard drive platter.

- » **Smartphone**- They help the phone know whether it undergoes acceleration in any direction, and it's the reason why your phone's display switches on when you flip it.
- » **Industries**- Accelerometers help engineers understand a machine's stability and enable them to monitor for any unwanted forces/vibrations.
- » **Drones** - They help drones stabilise their orientation mid flight.

- Additionally, there are two regional systems. They are designed to provide accurate position information service to users in a limited area.
- **Countries having its own navigation systems (or Regional Navigation Systems)**
 - » **Indian Regional Navigation Satellite System (IRNSS) or NavIC - India**
 - » **Quasi-Zenith Satellite System (QZSS) - Japan**

2. Which one of the following countries has its own Satellite Navigation System?

- a) Australia
- b) Canada
- c) Israel
- d) Japan ✓

Difficulty level: Hard

Relevance: To bolster NavIC's adoption, ISRO had launched second-generation Navigation Satellites in May 2023.

EXPLANATION

Satellite Navigation Systems (SNS)

- Satellite Navigation System is a system of **artificial satellites capable of providing geo specific positioning everywhere in the world.**
- It is the system of **offering real-time location service using navigation satellites to the users in air, sea, ground, or space.**
- Satellite Navigation is based on a global network of satellites that **transmit radio signals from medium earth orbit.**

Satellite Navigation Systems with Global coverage

- **Global Positioning System (GPS) - United States**
- **GLONASS - Russian Federation**
- **Galileo - European Union**
- **BeiDou - China**

RELATED PYQs

Q1. In which of the following activities are Indian Remote Sensing (IRS) satellites used?

1. Assessment of crop productivity
2. Locating ground water resources
3. Mineral exploration
4. Telecommunications
5. Traffic studies

Select the correct answer using the code given below

- a) 1, 2 and 3 only
- b) 4 and 5 only
- c) 1 and 2 only
- d) 1, 2, 3, 4 and 5

[2015]

Q2. With reference to the Indian Regional Navigation Satellite System (IRNSS), consider the following statements:

1. IRNSS has three satellites in geostationary and four satellites in geosynchronous orbits.
2. IRNSS covers entire India and about 5500 sq. km beyond its borders.
3. India will have its own satellite navigation system with full global coverage by the middle of 2019.

Which of the statements given above is/are correct?

- a) 1 only
- b) 1 and 2 only
- c) 2 and 3 only
- d) None

[2018]

3. 'Wolbachia method' is sometimes talked about with reference to which one of the following?

- Controlling the viral diseases spread by mosquitoes ✓
- Converting crop residues into packing material
- Producing biodegradable plastics
- Producing biochar from thermo- chemical conversion of biomass

Difficulty level: Moderate

Relevance: World Mosquito Program (WMP) announced that it will release modified mosquitoes - which carries a Wolbachia bacterium- in Brazil aims to halt Dengue.

EXPLANATION

How mosquitoes spread disease?

- Mosquitoes **do not naturally carry viruses** - they can only get them from infected people.
- Mosquitoes **pick up viruses by biting infected people**. When they bite again, they can transmit the virus to the next person.
- Since only female mosquitoes bite humans, only female mosquitoes can transmit viruses.

Some mosquito-borne diseases :

Mosquito	Transmitting viruses of
Aedes aegypti mosquito	Dengue, zika, chikungunya, yellow fever
Anopheles mosquito	Malaria
Culex mosquito	Japanese encephalitis, west Nile fever

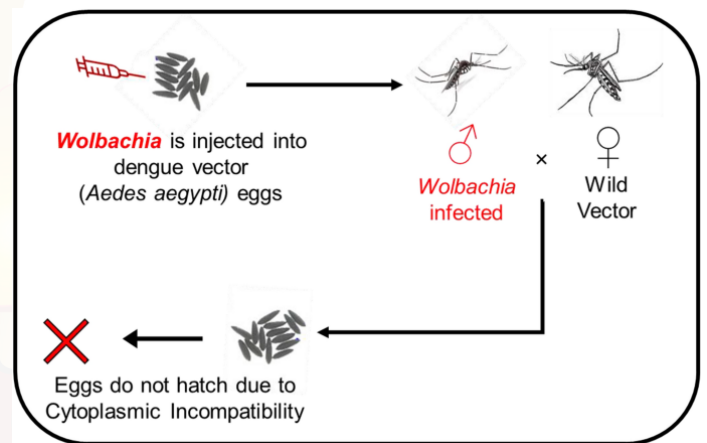
- Dengue fever is now considered the most critical mosquito-borne viral disease in the world, according to the World Health Organisation.

What is Wolbachia?

- These are **extremely common bacteria that occur naturally in 50 percent** of insect species, including some mosquitoes, fruit flies, butterflies etc.
- It manipulates its host reproduction in many ways.
- Wolbachia is safe for humans and the environment.**
- Aedes aegypti mosquitoes don't normally carry Wolbachia, however many other mosquitoes do.

Wolbachia Method

- The **World Mosquito Program's** natural and self-sustaining Wolbachia technique **aims to prevent spread of mosquito-borne diseases**.
- Wolbachia strains can **invade and sustain themselves in mosquito populations**, reduce adult lifespan, affect mosquito reproduction and interfere with pathogen replication.
- For example:** When Aedes Aegypti mosquitoes carry natural bacteria called Wolbachia, they reduce the mosquitoes' ability to transmit viruses like dengue, chikungunya and yellow fever.
- This method **does not suppress mosquito populations or involve genetic modification (GM)**, as the genetic material of the mosquito is not altered.



4. 'Aerial metagenomics' best refers to which one of the following situations?

- Collecting DNA samples from air in a habitat at one go ✓
- Understanding the genetic makeup of avian species of a habitat
- Using air-borne devices to collect blood animals samples from moving
- Sending drones to inaccessible areas to collect plant and animal samples from land surfaces and water bodies

Difficulty level: Hard

Relevance: Aerial metagenomics was in news in the context of Genome India Project.

EXPLANATION

Metagenomics

- Metagenomics is the **study of genomic and genetic data** inferred from environmental and clinical samples.

Aerial Metagenomics

- Aerial metagenomics is a scientific method which involves **analysis of genetic material (DNA or RNA) collected from the air in a given habitat**, usually in the form of airborne particles.
- These particles include **microorganisms (bacteria, virus, fungi etc.) and organic materials**.
- Here air samples are collected using airborne devices like drones.
- This can also be used to **track the movement of microorganisms**.
- Aerial metagenomics helps us to explore different kinds of microbes in various habitats like forests, oceans, and urban areas.

5. Microsatellite DNA' is used in the case of which one of the following?

- Studying the evolutionary relationships among various species of fauna ✓
- Stimulating 'stem cells' to transform into diverse functional tissues
- Promoting clonal propagation of horticultural plants
- Assessing the efficacy of drugs by conducting series of drug trials in a population

Difficulty level: Hard

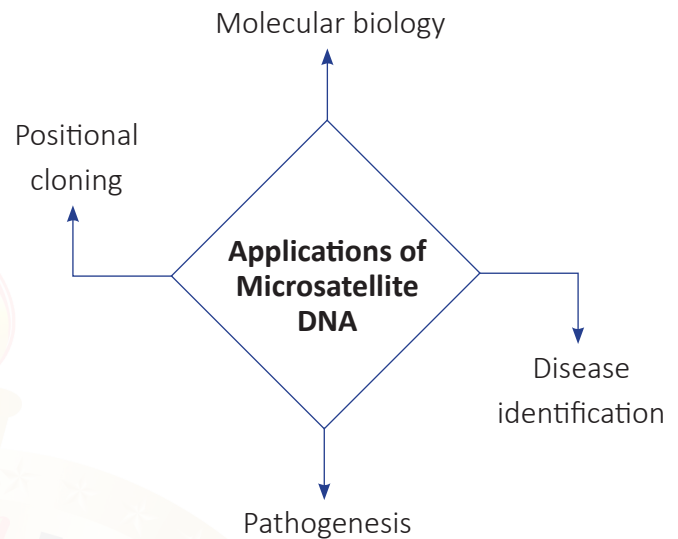
Relevance: Biotech-related; new researches are taking place

EXPLANATION

Microsatellite DNA (Short Tandem Repeats)

- Microsatellite DNA also refers to **short segment of DNA**.
- It consists of **repeating sequences of DNA** (1-6 base pairs in length).

- Microsatellites are one of the best suitable **genetic markers** for analysing pedigree, population structure, genome variation, evolutionary process, and fingerprinting purposes.
- They help in the **study of evolutionary relationships among various species of fauna**.



SUMMARY

AI

Analyzing the trends in previous years' UPSC Prelims questions from 2021 to 2023 provides valuable insights into the distribution of questions across syllabus topics, the varying levels of question difficulty, and the extent to which current affairs play a significant role in the examination.

SUBJECT EMPHASIS:

- Basic science
- Information and Communication technologies
- Bio technology
- Pathogens and associated diseases
- Defence technology and innovations
- Space related technologies

CURRENT AFFAIRS FOCUS:

- Greater attention should be directed towards topics that have remained in the news for an extended period and are closely related to both the syllabus and the foundational aspects of Science and Technology.
 - » New developments in health science
 - » Eg: Vaccines
 - » Space explorations
 - » Eg: Satellites, Space missions
 - » Defence technology
 - » Eg: Brahmos, Agni missiles
 - » Progress in cutting edge technologies
 - » Eg: Artificial Intelligence
 - » Bio technology and innovative methods in news
 - » Eg: Wolbachia method, Microsatellite DNA
 - » Government initiatives
 - » Eg: National Policy on Biofuels 2018
 - » International agreements and organisations
 - » Diseases mentioned in news
 - » Eg: Covid- 19
 - » Key terms often seen in news

SUMMARY

AI

TREND ANALYSIS:

- Certain topics are gaining relevance due to their current significance, and there is a possibility that these topics might be repeated in the forthcoming exams.
 - » Information and communication technology (ICT) questions. Eg: Near field communication technologies, Li-Fi
 - » Biotechnology is the favourite area of UPSC. Application related questions and important terms are commonly asked.
 - » Technological innovations and their applications in various fields. These application level questions demand conceptual clarity.
 - » Diseases in news and other health-related topics. Eg: Nipah, Universal Immunisation Programme.

Prelims preparation acts as the initial gateway to our aspirations of a career in civil services. As the saying goes, the first step is often the most challenging. To reach our desired destination, it's crucial to make the right, and most importantly, smart choices. At **Fortune IAS Academy**, we aim to simplify this challenging exam stage through our test series program, leading you along the correct path to achieve your goals.

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