

The Hindu Important News Articles For UPSC CSE

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The recent diplomatic engagements between New Delhi and Kathmandu—highlighted by External Affairs Minister S. Jaishankar's meeting with Nepal's Finance Minister Swarnim Wagle—mark a crucial pivot in bilateral ties. Grounded in India's "Neighbourhood First" policy, this outreach addresses immediate humanitarian relief following catastrophic Himalayan flash floods while laying the groundwork for a strategic "reset" in bilateral relations ahead of Prime Minister Balen Shah's upcoming visit to New Delhi.

India, Nepal hold talks on post-flood reconstruction, reset in bilateral ties

Suhasini Haidar

NEW DELHI

Nepal's reconstruction plans post-floods and the "reset" of India-Nepal ties with the newly elected government were at the top of the agenda as External Affairs Minister S. Jaishankar met Nepal's Finance Minister Swarnim Wagle here on Friday, as both sides prepare for a visit by Nepal Prime Minister Balen Shah to New Delhi later this year.

Mr. Jaishankar said he offered his deep condolences to Mr. Wagle over the recent flash floods.

"Discussed ways to strengthen our overall cooperation, especially in economic, energy and connectivity domains," he added in a social media post where he tagged the government's "Neighbourhood First" slogan.

Mr. Wagle's visit to New Delhi follows a visit by Nepal Foreign Minister Shishir Khanal in June, as part of a call by ruling Rashtriya Swatantra Party (RSP) chairman Rabi Lamichhane for a "reset" in ties between New Delhi and Kathmandu, troubled over the past few years on both boundary disputes and economic issues.

Multilateral support

Mr. Wagle met Mr. Jaishankar a day after meeting Finance Minister Nirmala Sitharaman on Thursday, during which India committed to continuing support for Nepal's recovery efforts after the floods.

According to officials, the entire reconstruction required after the floods on August 26, which have left more than 1,400 dead and more than 6,000 missing, will top \$5 billion.



S. Jaishankar greets Nepal Finance Minister Swarnim Wagle in New Delhi. ANI

Nepal will be making an appeal for multilateral support at the UN General Assembly next week in New York, as Mr. Shah is expected to make his first international speech.

Mr. Wagle is in Delhi on his first visit abroad since he took office and will travel soon to Doha for a meeting of the Board of the China-led Asian Infrastructure Investment Bank (AIIB) and to the IMF and

World Bank meetings in Bangkok.

In a readout, the Finance Ministry said Mr. Wagle had thanked India for its assistance after the floods on the Trishuli river that overflowed in areas on both sides of the Nepal-China border and destroyed a major Chinese border crossing at Rasuwa.

They also discussed strengthening of bilateral economic ties and "initiatives to enhance connectivity for deepening of trade, investments and people-to-people exchanges".

Nepal wants to explore connectivity in road and rail, but officials have said they are keen to resolve the long-pending issue of over-flight to Nepali airports.

According to the officials, the Shah government in Nepal has been positive about its engagement with New Delhi.

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Core Analysis and UPSC Dimensions

- **Humanitarian Diplomacy and Disaster Resilience:** The August flash floods, which resulted in massive casualties and structural devastation exceeding \$5 billion, have underlined the urgent need for collaborative disaster management frameworks. India's immediate medical and technical assistance reinforces its role as a preferred first responder in the region.
- **Economic Integration and Connectivity:** Bilateral talks emphasize expanding multi-modal connectivity—spanning cross-border rail, roads, energy grids, and resolving long-pending airspace and overflight permissions for Nepali airports to boost trade and investments.
- **Multilateral Climate Advocacy:** Nepal's push for international climate compensation at the United Nations General Assembly highlights the acute vulnerability of Himalayan ecosystems to global warming, bringing climate justice to the forefront of regional diplomacy.
- **Strategic Trust Deficit and Reset:** Navigating past hurdles, including boundary delineations and trade imbalances, requires pragmatic economic diplomacy. Engaging newly elected leadership aims to institutionalize mutual trust and long-term stability.

Related Static Dimensions (GS Syllabus Integration)

- **GS Paper 2 (International Relations):** India and its neighborhood-relations; Bilateral, regional and global groupings and agreements involving India and/or affecting India's interests.
- **GS Paper 3 (Disaster Management):** Disaster and disaster management, early warning systems, and regional cooperation for climate resilience and mitigation.
- **Geographical and Ecological Linkages (Static Linkage):** The vulnerability of the fragile Himalayan ecology, trans-boundary river systems (such as the Trishuli and Koshi basins), and the shared ecological security of South Asia.

Conclusion

The evolving partnership between India and Nepal demonstrates that mutual economic interdependence and disaster resilience can successfully override legacy geopolitical friction. By institutionalizing cooperation in energy, green infrastructure, and climate advocacy, both nations can forge a sustainable, future-ready framework for regional stability.

UPSC Prelims Practice Questions

Question: With reference to India-Nepal relations, consider the following statements:

1. Nepal shares an open-border arrangement with India.
2. India and Nepal are connected through cross-border railway projects.
3. Nepal is a member of the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC).
4. India and Nepal are both members of the Shanghai Cooperation Organisation (SCO).

Which of the statements given above are correct?

- A. Only one
- B. Only two
- C. Only three
- D. All four

Ans:c)

UPSC Mains Practice Questions

Question: "India-Nepal relations require a transition from episodic political engagement to institutionalised economic and strategic interdependence." Discuss in the context of India's Neighbourhood First policy. **(10 Marks, 150 Words)**

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India is undergoing a structural transformation from being primarily a technology consumer and service provider to emerging as an indigenous creator of advanced technologies. As highlighted by recent trends in patent filings and strategic breakthroughs, the country's innovation landscape is coalescing around three vital pillars: public research institutions, corporate R&D, and deep-tech entrepreneurship.

A homegrown innovation ecosystem is taking root

Technologies that once arrived in India through imports are increasingly being invented at home through local research institutions, industry, and startups. Three institutional foundations of an innovation economy are now advancing together: public research, corporate research and development (R&D), and deep-tech entrepreneurship. The transformation is yet incomplete, but the architecture is finally visible. Gallium Nitride (GaN) semiconductor technologies, critical for advanced radar, space systems, and next-generation communications, are increasingly being developed domestically, helping close a strategic gap in a tightly regulated, export-controlled field. At the same time, affordable immunotherapies developed in India are expanding access to advanced cancer care and demonstrating the country's growing capacity for biomedical innovation.

Patent filings are often cited as a ready indicator of innovation. The filing numbers continue to show impressive growth. From just over 1,10,000 patent filings in 2024-25, the number grew to more than 1,43,000 in 2025-26, a 30.2% increase. Moreover, domestic applicants now account for almost seven in 10 filings.

However, the sheer volume of applications does not tell the complete story. Even a modest enquiry reveals an innovation story that begins to fray at the edges. The number of patents in force in India (just over 2,40,000 in 2025) is a fraction of those in China (5.7 million), the United States (3.5 million), and Japan (2.1 million); all these are 2024 data.

This suggests low grant rates, high abandonment rates, or a combination of both. Add to this meagre commercialisation, low R&D spending – India still spends just under 1% of GDP on research and development, against about 2.4% in China and 3.5% in the U.S. – and we see how far we are from a truly technology-driven, innovation-led economy.

The emerging pillars

However, there lies a resilient core, and shaping it are three strong and vital strands that promise to anchor India's future. Public institutions with government support have made vital breakthroughs in long-gestation innovation. Private R&D spending exceeded that of all levels of government combined for the first time in 2024. This is expected to climb and account for 55% through 2025-26. Domestic industrial houses are beginning to reap rewards from focused and committed R&D. A maturing startup ecosystem is finding its feet beyond low-hanging service platforms, actively showcasing deep tech and complex manufacturing. That all three strands



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Gaurav Jain

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are coming of age together bodes well for India.

In March 2023, Defence Research and Development Organisation (DRDO) scientists at the Solid State Physics Laboratory (SSPL) in Delhi and the Gallium Arsenide Enabling Technology Centre (GAETEC) in Hyderabad announced a breakthrough in making gallium nitride (GaN) monolithic microwave integrated circuits (MMICs). The technical know-how to make these circuits, which are critical for military and defence applications, was, by widely reported accounts, refused to India under the offset provisions of the Rafale fighter jet purchase from France. The DRDO is now actively transferring the technology for GaN High Electron Mobility Transistors (HEMTs)-based MMICs to be used in 5G/6G wireless infrastructure, electric vehicles on-board chargers, and renewable energy inverter systems. India is now one of seven countries to have mastered this technology, alongside China, France, Germany, Russia, South Korea and the U.S. AGNIT Semiconductors, a spin-off from the Centre for Nano Science and Engineering (CeNSE) at the Indian Institute of Science, Bengaluru is translating homegrown GaN technology to real-world commercial applications.

From implementer to innovator

While long-gestation R&D at public institutions is starting to pay off, there is growing optimism from academia and domestic industry-led R&D as well. The Bharat 6G Alliance (B6GA) is making rapid progress in its stated aim of contributing 10% of the global 6G patents by 2030. According to a review meeting by Union Minister for Communications Jyotiraditya Scindia, B6GA members have made more than 7,700 patent filings across 5G and 6G technologies, including over 4,400 foreign filings. But, these are applications, not yet grants or declared standard-essential patents, and their true impact remains to be seen. However, taken together with almost 3,000 technical contributions to 3GPP last year, a 15-fold increase from 2020, these figures point in the right direction. The World Intellectual Property Organization's 2025 Patent Cooperation Treaty rankings showed that Jio Platforms Limited had broken into the top 20 international patent filers for the first time, rising more than 300 places to be placed 19th overall.

While patent numbers are only a part of the story, participation in standards bodies and intellectual property ownership increasingly determine who captures value from future communication networks. India is securing ownership of critical digital infrastructure and is moving from being a standard-implementer to a standard-setting innovator.

There is also a marked shift in India's startup ecosystem. Buoyed by the government's commitment to Research, Development, and Innovation (RDI) and private capital matched by initiatives such as the more than \$2.5 billion in deep-tech commitments made by members of the India Deep Tech Alliance (IDTA), Indian startups are aiming farther and higher than before. Pixxel Space, founded by two Birla Institute of Technology and Science (BITS) Pilani alumni, is carving a niche in hyperspectral imaging technology with six satellites in orbit and a full constellation of 18 to 24 planned. The Vikram-1 low earth orbit launch by Skyroot Aerospace and the IIT Madras nurtured Agnikul Cosmos's parallel push towards fully reusable launch vehicles promise to strengthen India's role as a frugal space technology leader.

Startups such as ImmunoACT, incubated at IIT Bombay in partnership with the Tata Memorial Centre, are expanding access to advanced and affordable health care. NexCAR19, India's first indigenous CART cell therapy, has delivered effective cancer treatment at a tenth of typical treatment costs. Leveraging the Biotechnology Industry Research Assistance Council (BIRAC) early-stage support, Bengaluru-based Remidio Innovative Solutions is at the forefront in the fight against preventable blindness, such as diabetic retinopathy and glaucoma, through smartphone enabled retinal imaging systems and AI.

The direction is clear

These examples do not by themselves make India an innovation superpower but demonstrate that the three strands are coming together to weave an enduring innovation ecosystem. The GaN story illustrates the emerging innovation pipeline. Government laboratories developed the foundational capability, academic institutions nurtured the talent and research ecosystem, and startups such as AGNIT are now carrying the technology into commercial markets.

However, sustaining these three strands will demand more work, from standardising tech-transfer terms for publicly funded IP and expanding examiner capacity at the patent office, to funding the translational gap between a granted patent and a first paying customer. Yet, as we look through the innovation lens, the direction is clear. India is gradually shedding its identity as a back-office service provider and strengthening the institutions that enable nations to generate their own technology, intellectual property, and industrial capabilities. The journey remains unfinished, but the contours of an innovation economy are beginning to form.

The views expressed are personal

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Core Analysis and UPSC Dimensions

- **The Triple Helix of Innovation:** India's evolving innovation framework integrates public laboratories (such as DRDO), academic incubators (like IISc and IITs), and private enterprises. For the first time, private R&D spending has overtaken government-led allocations, signaling maturation in domestic industrial commitment.
- **Overcoming Strategic Technological Gaps:** Indigenous masteries, such as Gallium Nitride (GaN) Monolithic Microwave Integrated Circuits (MMICs)—previously denied to India under foreign offset provisions—demonstrate how domestic research achieves strategic autonomy in defense, space systems, and next-generation communications.
- **The Patent Paradox (Volume vs. Quality):** While domestic patent applications have surged past 1,43,000 (with local applicants accounting for nearly 70%), total patents in force remain low compared to global peers like China and the U.S. This points to structural bottlenecks, including low grant rates, high abandonment rates, and a lagging translation from patents to commercialized products.
- **Democratizing High-End Sectors:** Breakthroughs in affordable healthcare (such as indigenous CAR-T cell therapy for cancer treatment) and private space-tech ventures (hyperspectral imaging and reusable launch vehicles) showcase India's capability to combine high-tech innovation with frugal engineering.

Related Static Dimensions (GS Syllabus Integration)

- **GS Paper 3 (Science & Technology):** Indigenization of technology and developing new technology; awareness in the fields of IT, Space, Biotechnology, and issues relating to Intellectual Property Rights (IPR).
- **GS Paper 3 (Economy):** Mobilization of resources, growth, development, and employment; role of start-ups and venture capital in the economy; private vs. public investment in research and development (R&D).
- **Institutional Governance (Static Linkage):** The evolution of India's science policy, technology-transfer mechanisms from public funded labs to industry, and the role of bodies like BIRAC and DRDO.

Conclusion

While India's journey toward becoming a global innovation superpower remains unfinished—constrained by sub-1% GDP spending on R&D and gaps in commercialization—the foundational architecture is firmly in place. Sustaining this momentum will require scaling up patent examiner capacity, streamlining tech-transfer terms, and bridging the funding chasm between laboratory prototypes and market-ready products.

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UPSC Prelims Exam Study Questions

Question: With reference to India's innovation ecosystem, consider the following statements:

1. Public-funded research institutions can contribute to technological innovation through technology transfer to industry.
2. Deep-tech startups generally involve technologies based on substantial scientific or engineering research.
3. Private-sector R&D has no role in achieving strategic technological autonomy.
3. Collaboration among government laboratories, universities and industry can accelerate commercialisation of research.

Which of the statements given above are correct?

- A. 1 and 2 only
- B. 1, 2 and 4 only
- C. 2 and 3 only
- D. 1, 3 and 4 only

Ans: B)

UPSC Mains Exam Study Questions

Question: "India's challenge is no longer merely generating scientific knowledge but converting scientific knowledge into economic and strategic value." Discuss.. **10 Marks, 150 Words)**

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The Union Cabinet's decision to raise the wage ceiling for mandatory coverage under the Employees' Provident Fund Organisation (EPFO) from ₹15,000 to ₹25,000 per month marks a long-awaited structural shift in India's formal social security landscape. Coming after a gap of 12 years, this policy update brings over 51 lakh additional workers into the statutory safety net, aligning mandatory protections more closely with contemporary wage realities and inflationary pressures.

Core Analysis and UPSC Dimensions

- **Widening Formalization and Social Protection:** By extending mandatory coverage to employees earning between ₹15,000 and ₹25,000, the reform ensures that a larger segment of the organized workforce gains access to predictable provident fund savings, life insurance (EDLI), and pension security under the Employees' Pension Scheme (EPS).
- **The Unaddressed Minimum Pension Paradox:** Despite the upward revision in the wage ceiling, the baseline minimum pension under the EPS remains frozen at ₹1,000 per month (fixed in 2014). With nearly 45% of pensioners drawing this minimum amount, parliamentary panels and labor groups have flagged that it is entirely inadequate to cope with soaring living and healthcare costs.
- **Actuarial Transparency vs. Fund Sustainability:** Managing expectations around pension payouts requires balancing fiscal sustainability with social welfare. EPFO authorities have repeatedly cautioned that the pension fund does not possess unlimited resources, emphasizing the critical need to make actuarial assessment findings public to foster informed policy dialogue.
- **Compliance and Employer Burden:** While the move enhances long-term retirement savings, it simultaneously increases financial liabilities for micro, small, and medium enterprises (MSMEs) due to higher mandatory employer contributions, alongside a marginal dip in immediate take-home pay for newly covered employees. Stringent enforcement mechanisms are essential to prevent compliance defaults.

No hard ceilings

A rise in minimum PF pension will protect the worse-off among the retired

The Union Cabinet's approval to raise the wage ceiling for mandatory coverage under the Employees' Provident Fund Organisation (EPFO) from ₹15,000 to ₹25,000, though belated, is commendable. The BJP-led government has finally responded to this long-standing demand of workers in the organised sector. Around 51 lakh additional employees may be brought under the PF fold, which has around 7.98 crore contributing members. Those in the wage slab of ₹15,000-₹25,000 will now be covered under the Employees' Pension Scheme (EPS), 2026. Although Union Labour Minister Mansukh Mandaviya cited a government survey as the basis for the increase, the 12-year delay in implementing it should have been avoided. The Minister, who said that the average salary in private establishments was ₹23,000, should also make the survey's findings public for a better understanding of the country's overall wage situation. With some concerns having been raised that not every employer may be willing to make the additional contributions required after the revision, the government must ensure that all employers comply with the law.

So far, the government has been silent on revising the EPS minimum pension of ₹1,000, fixed in September 2014 alongside the previous revision in the PF wage ceiling. EPFO pensioners have been demanding the hike in the minimum pension amount. Before it assumed office at the Centre in 2014, the BJP had urged the Congress-led UPA government to keep the minimum pension at ₹3,000 and index it to inflation. Yet, it has not made even a symbolic beginning towards the indexation of pension to inflation. Moreover, about 45% of the nearly 82 lakh pensioners receive ₹1,000 or less. In March 2026, the Joint Parliamentary Standing Committee on Labour reminded the government that "the existing minimum pension amount is inadequate to meet even the basic needs of pensioners particularly in the ... scenario marked by ... rising healthcare and living expenses". Also, little is known about the follow-up to the panel's recommendation for "an urgent and comprehensive review of the minimum pension". The EPFO must release the findings of actuarial assessment, made by valuers in recent years. This should also be beneficial to the PF body, as EPFO CEO Ramesh Krishnamurthi observed in an interview with *The Hindu* in August that "there is a misconception that the [pension] fund has unlimited resources", while ruling out the reopening of the window for higher pensions. Even if the government is unwilling to restore the pre-2014 coverage, under which all employees were covered regardless of their wages, it should consider relaxation of the restriction on the coverage. Else, many pensioners will be pushed below the poverty line.

Related Static Dimensions (GS Syllabus Integration)

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- **GS Paper 2 (Governance & Social Justice):** Issues relating to development and management of social sector/services relating to Labour, Social Security, and Vulnerable Sections.
- **GS Paper 3 (Indian Economy):** Inclusive growth and issues arising from employment, resource mobilization, formalization of the economy, and the role of social security architectures.
- **Labor Economics (Static Linkage):** The evolution of social security legislation in India, including the Employees' Provident Funds and Miscellaneous Provisions Act, 1952, and the conceptual framework of statutory wage ceilings.

Conclusion

While raising the EPFO wage ceiling is a commendable stride toward strengthening the safety net for the vulnerable segments of the formal workforce, it must be complemented by a comprehensive review of the baseline minimum pension. Bridging the gap between expanded coverage and adequate post-retirement sustenance is vital to prevent retirees from falling into poverty.

UPSC Prelims Practice Questions

Question: With reference to the Employees' Provident Fund Organisation (EPFO), consider the following statements:

1. EPFO administers social-security schemes relating to provident fund, pension and insurance for covered employees.
2. Employees' Pension Scheme (EPS) is administered within the EPFO framework.
3. Employees' Deposit Linked Insurance Scheme (EDLI) provides life-insurance-related benefits to eligible EPFO members.
4. EPFO is directly responsible for implementing the Mahatma Gandhi National Rural Employment Guarantee Scheme.

Which of the statements given above are correct?

- A. 1 and 2 only
- B. 1, 2 and 3 only
- C. 2, 3 and 4 only
- D. 1, 2, 3 and 4

Ans: B)

UPSC Mains Practice Questions

Question: Patient safety is as much a governance issue as it is a clinical issue. Discuss. (10 Marks, 150 Words)

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The Food Safety and Standards Authority of India (FSSAI) has initiated three separate adjudication cases against Nestlé India Ltd. for alleged non-compliance with statutory norms governing infant nutrition products. This regulatory enforcement underscores heightened scrutiny on the marketing, labeling, and quality standards of baby food items in the country.

Core Analysis and UPSC Dimensions

- **Strict Regulation of Infant Food Marketing:**

The FSSAI flagged promotional claims on e-commerce platforms regarding *NAN Excella Pro Stage 1* (for references to "5 HMOs" and "Whey Protein") and *Lactogen Pro 1* (describing "Whey Protein" as easy to digest). The regulator stated these violated Regulation 4(2) of the Food Safety and Standards (Foods for Infant Nutrition) Regulations, 2020, and Section 3 of the Infant Milk Substitutes (IMS) Act, 1992, which strictly prohibit advertisements and promotional material intended to increase the saleability of infant foods.

- **Quality Deficiencies and Laboratory Standards:**

Beyond marketing violations, a sample of a Nestlé follow-up formula was found to be sub-standard during laboratory analysis due to lower-than-prescribed **Biotin (Vitamin B7)** content. This finding was further reaffirmed by a referral laboratory upon re-analysis, highlighting gaps in nutritional quality control.

- **Corporate Defense and Compliance Stand:** Nestlé India defended its position by asserting that its products are fully compliant with applicable laws and that the product labels had previously been cleared by an expert

FSSAI initiates legal action against Nestle

Press Trust of India

NEW DELHI

The Food Safety and Standards Authority of India (FSSAI) on Friday said it has initiated legal action against Nestle India Ltd. for alleged non-compliance with food safety norms in three infant nutrition products.

According to FSSAI, it examined NAN Excella Pro Stage 1, Lactogen Pro 1, and a follow-up formula along with their promotional material available on e-commerce platforms.

In NAN Excella Pro

Stage 1, the regulator flagged claims relating to "5HMOs" and "Whey Protein," while in Lactogen Pro 1, it observed a claim describing "Whey Protein" as easy to digest. FSSAI sought clarifications from Nestle India.

Nestle's response

Meanwhile, Nestle India said its infant nutrition products are "fully compliant" with all applicable regulations and that the labels of NAN Excella Pro and Lactogen Pro were approved by an expert committee of the FSSAI.

Daily News Analysis

committee of the FSSAI. The company maintained that the statements on its packaging are factual and supported by scientific literature.

- **Balancing Consumer Safety and Corporate Accountability:** The case reflects the complex friction between food corporations utilizing scientific marketing terms and regulators enforcing stringent, protective public health statutes designed to safeguard infant health and prevent misleading commercial claims.

Related Static Dimensions (GS Syllabus Integration)

- **GS Paper 2 (Governance & Social Justice):** Issues relating to health, regulation of food safety standards, and the protection of vulnerable consumer segments (infants and children).
- **GS Paper 3 (Indian Economy / Food Processing):** Consumer rights, food safety authorities, regulatory bodies, and compliance standards within the Indian food processing and manufacturing sector.
- **Institutional Governance (Static Linkage):** The statutory roles of the FSSAI under the Food Safety and Standards Act, 2006, and the overarching framework of the Infant Milk Substitutes (IMS) Act, 1992.

Conclusion

The FSSAI's legal action against Nestlé India signals a firm regulatory approach toward safeguarding infant nutrition and curbing improper commercial promotion. Ensuring strict adherence to compositional standards and transparent labeling remains vital for upholding public health and consumer trust in India's food sector.

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UPSC Mains Exam Study Questions

Question: "Food safety regulation is an essential component of preventive public health governance." Discuss with reference to vulnerable populations such as infants and children. (10 Marks, 150 Words)

Deep-sea discovery, environmental responsibility

India is standing at the threshold of a new frontier. But the most important question is not how deep we can go, how much we can mine, or how much wealth lies beneath the ocean floor. It is more fundamental: Should everything that can be technologically exploited necessarily be exploited? The question is particularly important as India strengthens its position in deep-sea exploration and develops the scientific and technological capabilities to access one of the least understood parts of the planet.

A growing deep-sea footprint

India is not new to seabed mineral exploration and holds three International Seabed Authority (ISA) exploration contracts covering approximately 95,000 square kilometres across the Central Indian Ocean Basin, Central Indian Ridge and Carlsberg Ridge in the international seabed area. Its exploration has identified an estimated 366 million tonnes of polymetallic nodules containing nickel, copper, cobalt and manganese, alongside extensive environmental and biodiversity studies.

Under the Deep Ocean Mission, India is developing deep-sea mining technology, underwater robotics and the MATSYA-6000 human submersible, while the National Institute of Ocean Technology has tested a mining machine at depths of about 5,270 metres. At the same time, biodiversity surveys across 19 seamounts have studied around 1,300 deep-sea organisms, including nearly 23 species reported as new to science. These achievements also impose a profound responsibility to decide whether technological ability should ultimately lead to exploitation.

Technological progress can create a dangerous assumption: if we can exploit something, we should. But the deep ocean challenges this logic. It is a complex and poorly understood ecosystem, and India's own biodiversity research continues to reveal previously unknown organisms. We cannot confidently predict the consequences of



P. Ragavan

Marine biologist with over a decade of professional experience in the conservation and management of coastal and marine environments

India has an opportunity to become a global leader not only in deep-sea technology but also in deep-sea ecological governance

large-scale seabed disturbance while our understanding of these ecosystems remains incomplete. This is not an argument against science, but for more science before potentially irreversible intervention. Deep-sea minerals may have legitimate strategic importance for India's renewable-energy, electric-mobility and advanced-manufacturing ambitions. However, strategic importance cannot automatically become ecological permission. Before considering extraction, India should ask whether the minerals are genuinely necessary at the proposed scale, whether alternatives exist, and whether demand can be reduced through recycling, efficiency, substitution and a circular economy. Necessity must be demonstrated, not presumed.

India's investment in deep-ocean science need not imply a commitment to commercial mining. Exploration can advance knowledge, biodiversity assessment, environmental baselines and technology without leading to exploitation. Mining, however, would physically disturb the seabed. Therefore, adaptive management alone cannot guarantee ecological protection. India has an opportunity to adopt a stronger principle before exploitation begins: the question should not be "How can we mine with minimum damage?" but "Do we need to mine at all?" Since India's ISA activities remain at the exploration stage, this is the right time to establish a high ecological threshold for any future decision to exploit.

Science must also teach us to say 'no'

The deep ocean is now emerging as the next frontier for economic growth. Yet, we expect the ocean to regulate climate and support biodiversity while extending industrial activity into its least understood ecosystems. The ocean should not become a place where the environmental costs of human consumption are simply relocated. Scientific progress should not mean making more of nature exploitable and

then calling it sustainable. True sustainable development must reduce dependence on extraction through lower demand, resource efficiency, recycling, substitution and circular consumption – principles reflected in India's Mission LiFE. Science must therefore help us use resources responsibly and, equally importantly, determine when we do not need to use them at all. This calls for a broader understanding of scientific progress. Science should not merely open new frontiers for exploitation; it should also reveal which frontiers are best left untouched. The ability to say "we do not need to go there" may itself represent a higher level of scientific and civilisational maturity than simply proving that we can

India can lead a different model

India has an opportunity to become a global leader in deep-sea ecological governance. India could take the bold step of recognising the deep ocean not merely as a mineral reserve, but as a precious ecological asset whose value may exceed that of its mineral wealth. It could use the knowledge gained through the Deep Ocean Mission to conclude that some poorly understood and potentially irreversible ecosystems are better left undisturbed. Progress is not how much nature we can convert into resources, but how much we can preserve while meeting human needs. This would reaffirm India's long-standing civilisational tradition of living in harmony with nature.

The defining environmental approaches of this century – Nature-based Solutions, the SDGs, the Circular Economy and Mission LiFE – share a common principle: nature is the capital on which development depends. They call for conserving ecosystems, reducing resource consumption and ensuring responsible development. Science and technology must therefore tell us not only how far we can go but also where we must stop. Our future depends on preserving the natural capital that sustains development.

GS Paper III: Science & Technology

UPSC Mains Exam Practice Questions: "Technological capability to exploit a natural resource does not automatically establish an ecological justification for its exploitation." Discuss with reference to deep-sea mining.. **15Marks, 250 Words)**

Context

As India rapidly scales up its oceanographic capabilities under the Deep Ocean Mission—marked by advancements like the MATSYA-6000 submersible and extensive polymetallic nodule explorations—a fundamental ethical and ecological question arises: **Should everything that can be technologically exploited necessarily be exploited?** Marine biologist P. Ragavan argues that scientific prowess must be balanced with ecological restraint, urging India to decouple deep-sea exploration from commercial mining.

Core Analysis and UPSC Dimensions

- **The Fallacy of Technological Imperative:** Modern technological progress often creates a dangerous presupposition that if an ecosystem can be mined, it must be mined. However, the deep ocean is poorly understood, and large-scale mechanical disturbances can cause irreversible damage to fragile, slow-growing marine habitats.
- **Strategic Necessity vs. Ecological Permission:** While minerals like nickel, copper, cobalt, and manganese are critical for renewable energy and electric mobility, strategic importance should not automatically translate into ecological clearance. True necessity must first be proved by exhausting alternatives through recycling, efficiency, and circular economy models.
- **Exploration vs. Exploitation:** India's engagement with the International Seabed Authority (ISA) and its discovery of new marine species highlight that scientific exploration can advance ecological knowledge and environmental baselines without culminating in destructive commercial extraction.
- **Leadership in Ecological Governance:** India has a unique opportunity to champion a new model of global ocean governance—proving that civilizational maturity lies as much in knowing where *not* to drill as it does in proving technological capability.

Related Static Dimensions (GS Syllabus Integration)

- **GS Paper 3 (Environment & Ecology):** Conservation, environmental pollution and degradation, environmental impact assessment (EIA), and the protection of marine ecosystems.
- **GS Paper 3 (Science & Technology):** Indigenization of technology, Deep Ocean Mission, marine technology development (submersibles, underwater robotics), and resource security.
- **Governance and Ethics (GS Paper 4):** Ethical dilemmas in technology deployment, sustainable development goals (SDGs), and intergenerational equity.

Conclusion

True sustainable development demands that nature be treated as the foundational capital on which human progress depends. By integrating principles from Mission LiFE and circular consumption, India can leverage its scientific achievements not to convert nature into commodities, but to establish a global benchmark in preserving vulnerable frontiers.