Transforming India’s Research into Global Innovations

Mains Syllabus – *GS III* (Indian Economy and issues relating to planning, mobilization, of resources, growth, development and employment)

Why in News?

Recently, Dr. Shivkumar Kalyanaraman has been appointed as the first fulltime Chief Executive Officer (CEO) of the Anusandhan National Research Foundation (ANRF).

What are the objectives of Anusandhan National Research Foundation (ANRF)?

- **Anusandhan National Research Foundation** – It was established in 2023 through an Act of Parliament to provide high-level strategic directions for research, innovation, and entrepreneurship in the fields of natural sciences.
- **Promoting Research and Development** - To stimulate innovation in universities and colleges, facilitate industry-aligned translational research.
- **Collaboration** - ANRF facilitates partnerships among industry, academia, government departments, and research institutions.
- It bridges the gap between academic discoveries and industrial applications.
- **Funding** – ANRF funds competitive peer-reviewed grant proposals to eligible persons.
- **Infrastructure** - It enhances research infrastructure, and encourages private sector contributions.

What are the challenges in India’s R&D ecosystem?

- **Low R&D investment** – India’s Gross Expenditure on R&D (GERD) stands at just 0.7% of GDP, significantly lower than developed nations, which allocate 2.5% or more.
- South Korea dedicates 4 per cent of its GDP to R&D.
- **Structural challenges of CSIR** - CSIR depends heavily on government funding and its impact is limited to national level.
- **Inadequacy of SMEs** - Indian SMEs lack R&D, vocational training, apprenticeship.
- **Limited private sector participation** - Unlike developed nations where private firms contribute 50-70% of R&D spending, India's private sector plays a minimal role, with most funding coming from the government.
- **Inadequate focus on applied Research** - Indian academic institutions prioritize theoretical research over applied research, leading to fewer industry linkages and limited commercialization of innovations.
- **Regulatory and administrative hurdles** - Rigid rules on fund utilization, fragmented coordination among ministries, and outdated approval systems slow down research projects.

- **Weak incentive structures** - Researchers face limited autonomy and risk appetite, which discourages cutting-edge research.
- **Skill gaps** - The education system often lacks alignment with industry needs, resulting in a shortage of skilled professionals in emerging fields like AI and robotics.
- **Infrastructure deficiencies** - Many research institutions lack state-of-the-art facilities, which hampers the quality and scale of research.

What are the significances of core technologies?

- **Core technologies** - They form the foundation for multiple sectors, driving economic and industrial growth.
- **Past core technologies** - Lasers, vacuum technologies, transistors and lithium-ion batteries many of which have led to Nobel Prize-winning breakthroughs.
- **Current core technologies** - Recent Nobel Prize-winning core technologies include neural networks and machine learning, mRNA vaccines and CRISPR-Cas9 gene editing.
- **Potential core technologies** - Optical lithography and low-nanometer node transistors, crucial for semiconductor manufacturing have the potential to win prizes.
- **Commercialization** - While some high-impact technologies emerged from serendipitous discoveries, their refinement and commercialisation involved long-term, deliberate research.

Successful commercialization of Lithium Battery Technology
• While lithium's energy storage potential was discovered by accident, the development of lithium-ion batteries was a systematic effort spanning decades. • Nobel Prizes were awarded to Whittingham and Goodenough for the invention of principles and to Yoshino for creating the first commercially viable battery. • Sony Corporation took the technology to market in 1991, which was later adopted by Tesla, Nissan and Panasonic. • The Japanese government played a pivotal role by investing heavily in its domestic Li-ion battery industry.

- For a country to lead in core technologies, it must align policy, funding, education, and commercialization strategies.

What India can learn from German innovation ecosystem?

- **Systemic approach** - Germany has a structured approach to identifying and adopting critical foreign innovations.
- **Collaborative planning** - The government, along with industry leaders and research institutions, develops strategic roadmaps to acquire, adapt and commercialise cutting-edge technologies.
- **Institutional set up** - The Fraunhofer Society, established in 1949, has 76 research institutes, over 30,000 researchers and engineers.
- With an annual budget of €3 billion (70 per cent from industry collaborations), it bridges the "valley of death" between research and industry.

- **Strong medium industries** - Germany’s Mittelstand, small and medium-sized, family-owned businesses, specialise in niche markets with global demand, prioritise long-term investments in R&D and maintain strong regional and industrial ties.
- Mittelstand firms account for 60 per cent of employment, underpinning Germany’s leadership in advanced manufacturing and engineering exports.
- **Government industry collaboration** – The Fraunhofer Society works closely with Mittelstand SMEs, providing them with the necessary technological expertise.

Comparison of Council of Scientific & Industrial Research (CSIR) & Fraunhofer society	
India’s Council of Scientific & Industrial Research (CSIR) is comparable to Fraunhofer, as both focus on applied research and collaborate with industry.	
CSIR	**Fraunhofer Society**
CSIR depends heavily on government funding.	Fraunhofer is primarily industry-funded.
CSIR’s impact is more national.	Fraunhofer’s research is globally competitive.

What lies ahead?

- **Reforming CSIR for greater commercialisation** - CSIR labs could be restructured into market-driven organisations by spinning off applied R&D units into independent research-based start-ups.
- Shifting researchers’ focus from publications to patents.
- **Developing India’s own Mittelstand for core technologies** - 100 promising SMEs with a high-risk R&D appetite, specialisation in technical products and willingness to collaborate with research institutions — could be identified and supported.
- **Establishing thematic core technology centres** - Exclusive research centres could be established within the IITs, IISc and IISERs modelled after Germany’s Fraunhofer.
- **Strengthening vocational and early STEM education** - To foster a culture of innovation, hands-on training in science and engineering could be integrated from an early age.
- Introducing vocational courses in electronics, mechanics and optics by Grade 8.
- **Private-sector collaboration** – It is crucial for increasing R&D investment, promoting industry-academia partnerships and developing start-up ecosystems.
- **Industry academic partnership** - Ensuring industry experts participate in teaching and expanding Atal Tinkering Labs to 1,000 schools with advanced laboratory facilities.
- **Investing in core technology companies** - Investment in legacy companies with existing capabilities in optics, lasers and semiconductor components could be encouraged.
- By forming industry-research consortia, these companies would be able to develop indigenous core technologies, for atmanirbharta.
- With a coordinated ecosystem involving government, labs, academia and industry,

India can transform into a global powerhouse of core technology innovation, critical for a Viksit Bharat by India @ 100.

Reference

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