1. The ongoing Ukrainian crisis has once again proven the significance of developing indigenous capabilities in defense technologies. Elucidate.

Approach

Candidates need to write about the self-reliant defense technology and highlight the significance of indigenous defense technologies how much it's important to avert Ukraine like crisis.

Introduction

A strong and well-equipped military provides a country the immunity to resist attack and thwart unprovoked aggression from external sources. It works as a defence mechanism and reflects the country's military capability and capacity to defend itself against the hostile countries for example if Ukraine had defence capability it could deter from Russia.

Body

Significance of developing indigenous defense technology:

- To maintain its regional autonomy: India needs to assert its presence and sovereignty over the border regions and for that, it needs to have modernised defence products and strategic autonomy over such defence products. This strategic autonomy can be achieved by having a self-reliant defence industry which would ultimately strengthen the Indian economy as well.
- To create a robust security framework: India requires an overhaul of its defence products to meet the current requisites of modern warfare. India needs to strengthen its surveillance system which requires inducting of modernised radars and drones so that suspicious activities and trespassing at the border areas could be detected at the earliest.
- Promoting investments in R&D and production in the defence sector: Will reduce dependency on imports which will lead to a reduction in the foreign exchange expenditure and enhance the level of operational preparedness.
- Restructuring of defense with Indian based requirements: India with vast landscape with terrain like ladakh siachen and coastal areas.
- Strategic Capability: self sufficient and self reliant defence industry will place India among the top global powers.
- Nationalism and Patriotism can increase with indegenious production of defence equipment, that in turn will not only boost the trust and confidence of the Indian forces but will also strengthen a sense of integrity and sovereignty in them.
- Affect sovereignty: Depending on other countries for arms would affect the sovereignty of India with respect to military policies and decisions.

Conclusion

Indigenisation in defence is critical to national security also. It keeps intact the technological expertise and encourages spin-off technologies and innovation that often stem from it. Strategic Capability increases with self sufficient and self reliant defence industry also it will place India among the top global powers.

2. With the help of suitable examples, discuss the applications of nanotechnology in the field of medicine.

Approach

Students are expected to write about the nanotechnology and simply write application of nanotechnology in the medicine field.

Introduction

Nanotechnology is science, engineering, and technology conducted at the nanoscale, which is about 1 to 100 nanometers. It is a field of research and innovation concerned with building 'things' – generally, materials and devices – on the scale of atoms and molecules.

Body

- Drug delivery: Nanomaterials have been introduced to the therapy of multiple diseases, including drug delivery system and nanodrugs. Drug delivery is one of the typical applicliposomes Nanomaterials in medicine. For example, tumor targeting, imaging and drug delivery can be accomplished by administrated gold nanoparticles and nanorods, iron oxide nanoworms and drug loaded liposomes.
- Stem cells: The application of nanotechnology has opened a new realm in the advance of regenerative medicine. The development of nanotechnology offers more opportunities of applying stem cells in the regeneration of tissues and organs.
- Implantation: Nanotechnology has also found applications in tissue and implant engineering. The possibility to enhance the surface area of the material and to tune the roughness of its surface at the nanometric scale should yield better biological responses of osteogenic cells and effective mechanical contact between tissue and implant.
- Imaging In vivo imaging is another area where tools and devices are being developed. Using nanoparticle contrast agents, images such as ultrasound and MRI have a favourable distribution and improved contrast.

- Antibacterial treatment: Researchers are developing a technique to kill bacteria using gold nanoparticles and infrared light. This method may lead to improved cleaning of instruments in hospital settings.
- Medical Device: Neuro-electronic interfacing is a visionary goal dealing with the construction of nanodevices that will permit computers to be joined and linked to the nervous system.

Conclusion

Advancement in the field of nanotechnology and its applications to the field of medicines and pharmaceuticals has revolutionized the twentieth century. A nanotechnology is a valuable tool for the prevention, diagnosis and treatment of human diseases. The medical area of nanoscience application has many projected benefits and is potentially valuable for all human races.

3. What are gravitational waves? Why are scientists trying to detect gravitational waves? Discuss.

Approach-

Candidates need to explain gravitational waves and discuss why are scientists trying to detect them.

Introduction:

Albert Einstein suggested in 1916, that gravitational waves could be a natural outcome of his general theory of relativity, which says that very massive objects distort the fabric of time and space—an effect we perceive as gravity. But it wasn't until 2015 that the LIGO team directly detected gravitational waves, using a pair of ultra-sensitive detectors. The discovery ended a century of speculation and confirmed Einstein's original prediction. Accordingly, very massive objects spiralling toward each other should wrinkle space-time and send those distortions across the cosmos, like ripples spreading across a pond at the speed of light.

What are gravitational waves?

- Gravitational waves are ripples in the otherwise tough, stiff fabric of spacetime produced by the most violent phenomena the cosmos can offer—things like exploding stars and collisions between ultra-dense neutron stars or merging black holes.

- In essence, gravitational waves "are propagating disturbances of the shape of spacetime.
- Gravitational waves are washing over Earth all the time, but instruments have not been sensitive enough to detect them until very recently.

Why are scientists trying to detect gravitational waves?

- Since LIGO's first detection of the gravitational waves, we've gained unexpected insight into the cosmos. That's because gravitational waves are a new way of "seeing" what happens in space: We can now detect events that would otherwise leave little to no observable light, like black hole collisions.
- With the detection, astronomers were able to combine gravitational waves with more traditional ways of seeing the universe, helping to untangle mysteries about the dense, dead objects known as neutron stars.
- LIGO has opened a new 'window' on the universe. Things like colliding black holes are utterly invisible to EM astronomers. To LIGO, such events are beacons in the vast cosmic sea.
- More importantly, since gravitational waves interact very weakly with matter (unlike EM radiation, which can be absorbed, reflected, refracted, or bent), they travel through the Universe virtually unimpeded, giving us a clear view of the gravitational-wave Universe. The waves carry information about their origins that is free of the distortions or alterations suffered by EM radiation as it traverses intergalactic space.
- The gravitational waves that LIGO detects are caused by some of the most energetic events in the Universe—colliding black holes, merging neutron stars, exploding stars, and possibly even the birth of the Universe itself.
- Detecting and analysing the information carried by gravitational waves is allowing us to observe the Universe in a way never before possible, providing astronomers and other scientists with their first glimpses of literally un-seeable wonders.
- LIGO has removed a veil of mystery on the Universe and in so doing, has ushered in exciting new research in physics, astronomy, and astrophysics.

Conclusion

The first detection of gravitational waves was a very important event in science. Before this, just about everything we knew about the universe came from studying waves of light. Now we have a new way to learn about the universe—by studying waves of gravity. Gravitational waves will help us learn many new things about our universe. We may also learn more about gravity itself.